PRESS BRIEFING NOTE

Mobility crisis is behind the pollution in Delhi

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Despite taking several technology measures to curb pollution from vehicles, vehicular pollution has emerged as the top polluter in the capital city of Delhi. Explosive motorization, choking congestion and inadequate public transport services are undercutting the emission gains from technology measures in the transport sector of the city.

This has emerged from the new analysis by the Centre for Science and Environment (CSE) that has shown how even after implementing the largest ever CNG programme for the public transport and local commercial transport, phasing out of 10-year-old diesel and 15-year-old petrol vehicles, restrictions on entry of non-destined trucks, introduction of Bharat Stage 6 emissions standards, and onset of the fleet electrification, vehicles are still the key polluter due to the growing mobility crisis.

In view of this, CSE has assessed the factors that are responsible for the growing mobility crisis and congestion woes that are contributing to the toxic pollution build up. CSE has carried out a deep dive analysis of the current trends in particulate matter pollution, trend in motorisation, congestion impacts, and the state of public transport to understand this growing challenge.

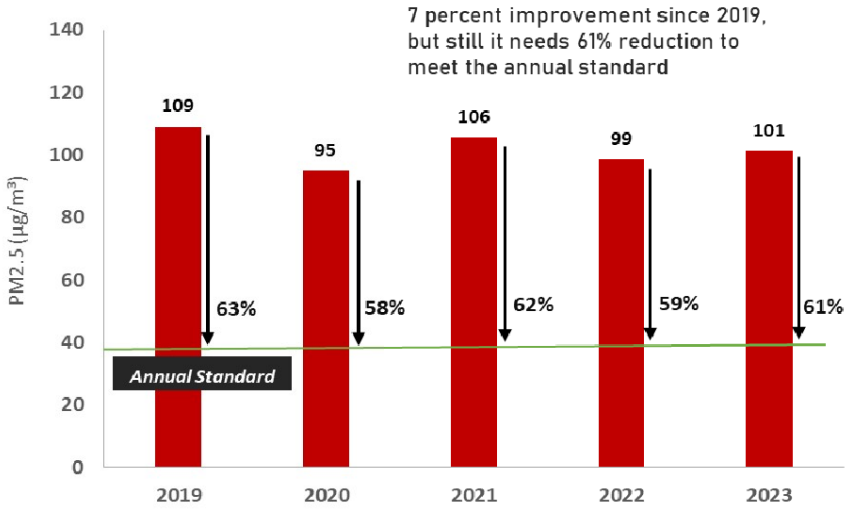
This analysis has been done based on the:
(i) Publicly available granular real time data from the CPCB's official online portal Central Control Room for Air Quality Management. The data has been captured from 37 official stations under the Continuous Ambient Air Quality Monitoring System (CAAQMS) spread across Delhi.
(ii) Dynamic estimation of real-time data on source contribution by the Decision Support System for Air Quality Management of the Indian Institute of Tropical Meteorology (IITM) to assess the real-time trend in the relative contribution of different sources of pollution.
(iii) Farm fire counts from the Indian Agricultural Research Institute (IARI) and contributions from farm stubble fires to Delhi's air quality, as estimated by the Ministry of Earth Science's SAFAR (System of Air Quality and Weather Forecasting and Research).
(iv) Traffic speed in the city based on Google Maps API data- a measure of congestion during early winters (September 15 –October 29, 2024) on 25 road stretches of key roads in Delhi and relate it with the pollution trends.
(v) Congestion and productivity loss-based congestion data from Google API has been calculated based on State's labor law department figures.
(vi) Year-wise registered city bus fleet trend based on Socio Economic Report for various years
(vii) Bus and metro accessibility analysis using geographical information system (GIS), based on the ward-wise population and station locations.
(viii) Ridership trends analysis of DTDC and Cluster buses based on GNCTD Economic Survey of Delhi.
(ix) Comparative analysis of journey cost of public transport vs. private transport based on primary data collected by CSE.

Key findings:

1. State of Delhi's air: What is the emerging learning?

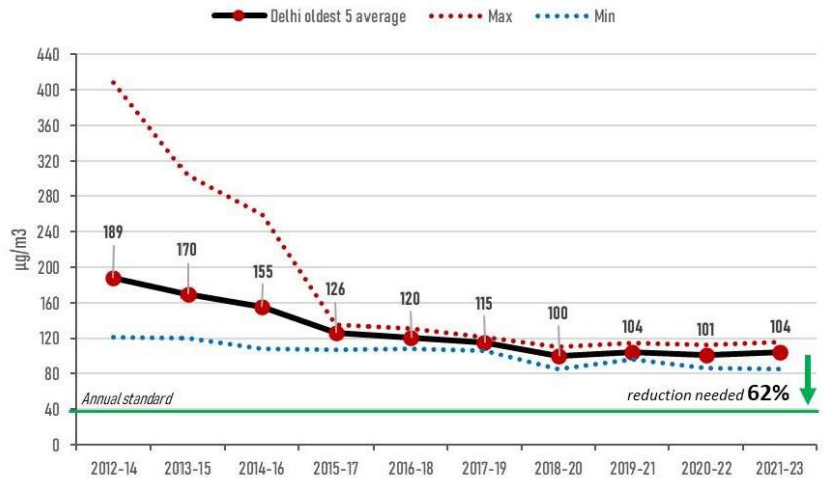
Despite the initial decline PM2.5 levels have shown upward trend last year – requires massive cuts to meet the clean air benchmark: Even though the long term PM2.5 levels have shown a downward trend, since 2022 the annual levels have remained and even shown an upward trend. The annual PM2.5 levels show an improvement of 7 per cent in 2023 when compared to the 2019 levels. Delhi requires another 60 per cent reduction to meet the National Ambient Air Quality Standards for PM2.5. Similar trend is reflected in the winter pollution, even though the winter peaks have declined the average level for the winter months have stayed elevated and also seen an increase. (See Graph 1a & b: Trend on annual average of PM2.5 level in Delhi).

Graph 1 a: Trend on annual average of PM2.5 pollution in Delhi (based on 38 stations data)



Note: Average PM2.5 concentration is based on the mean of daily values recorded at CAAQM stations in the city that have adequate data for all years. **Annual average data(January – December).**
Source: CSE analysis of Central Pollution Control Board (CPCB's) real-time air quality d

Graph 1 b: Trend on annual average of PM2.5 pollution in Delhi (based on oldest 5 stationsdata)

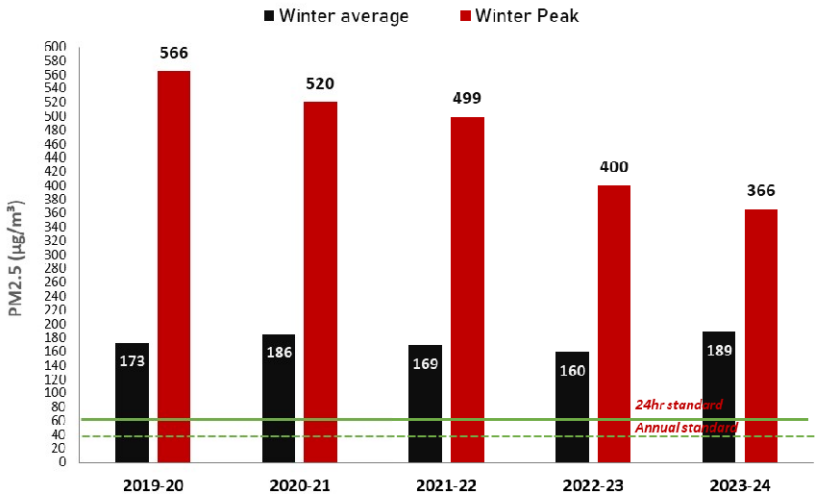


Source: CSE analysis of Central Pollution Control Board (CPCB's) real-time air quality data

Growing average level of winter pollution indicates bigger trapping of high local pollution: The PM2.5 winter peak has reduced by almost 35 per cent in 2023-24 compared to the 2019-20 level but the average PM2.5 concentration has almost stagnated and is the highest in the last 5 years. Peaks can be highly variable due to the atmospheric conditions. But the increase in average level is a matter of worry.

In the last five years, the winter average of PM2.5 concentration was the highest in 2023-24 at 189 µg/m3. There is a 9 per cent increase in the winter average concentration in 2023-24 compared to 2019-20. This upward trend needs immediate action (See Graph 2: Trend on winter average and winter peak of PM2.5 pollution in Delhi). This reflects elevated levels of pollution and high impact of atmospheric conditions.

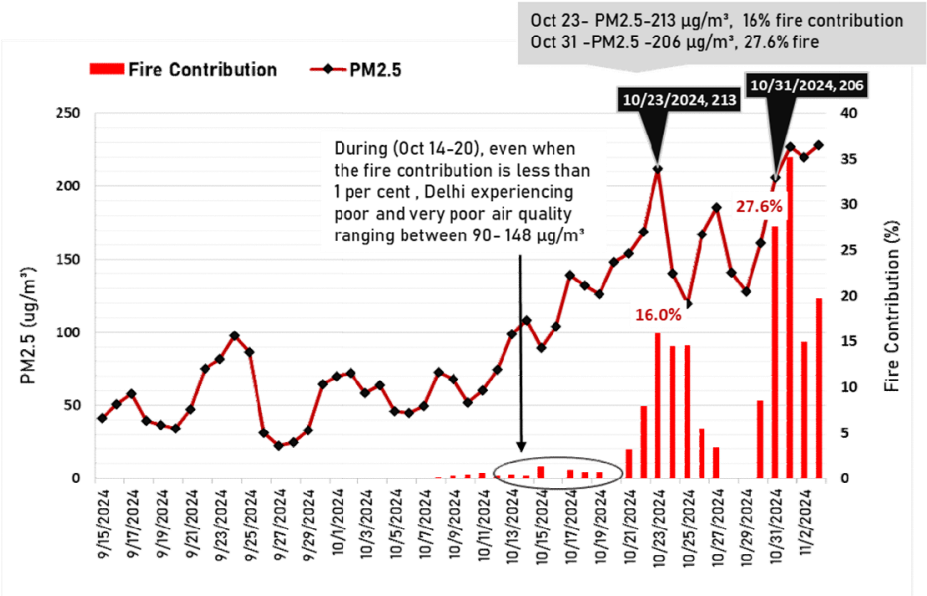
Graph 2: Trend on winter average and winter peak of PM2.5 pollution in Delhi



Note: Winter Average and winter Peak $PM_{2.5}$ concentration is based on the mean of daily values recorded at CAAQM stations in the city that have adequate data for winter months. **Winter Average and Winter Peak data (October – January)**
Source: CSE analysis of Central Pollution Control Board (CPCB's) real-time air quality data.

High influence of local pollution sources this winter –Days with low contribution of farm fire Delhi's air quality has turned poor and very poor this October: Initially this year, between October 10-20, the average farm fire contribution to Delhi's PM2.5 levels was only 0.7 per cent, indicating minimal impact from stubble burning to PM2.5 concentration. The rising impact of farm fire was evident as the contribution from stubble burning has sharply increased since October 22. On October 23, the contribution of stubble burning was 16 per cent, with PM2.5 levels reaching 213 µg/m³, which falls in the 'very poor' category. Despite this, PM2.5 concentrations remained high; on October 31, the concentration was 206 µg/m³, only 3 per cent lower than the October 23 peak, even though the stubble burning contribution on October 31 has doubled compared to October 23. The data clearly indicates that local sources are the primary contributors to the elevated PM2.5 levels in Delhi, as concentrations remained high even when the impact of stubble burning was minimal. The airquality has remained poor with no days recorded in the "good" category.

Graph 3: Daily mean of PM2.5 concentration and farm fire contribution to PM2.5 over Delhi



Note: Average $PM_{2.5}$ concentration is based on the mean of daily values recorded at CAAQM stations in the city

that have adequate data. ***Data (15 Sept 2024 – 03 Nov, 2024).***
Source: CSE analysis of Central Pollution Control Board (CPCB's) re l-time air quality data.

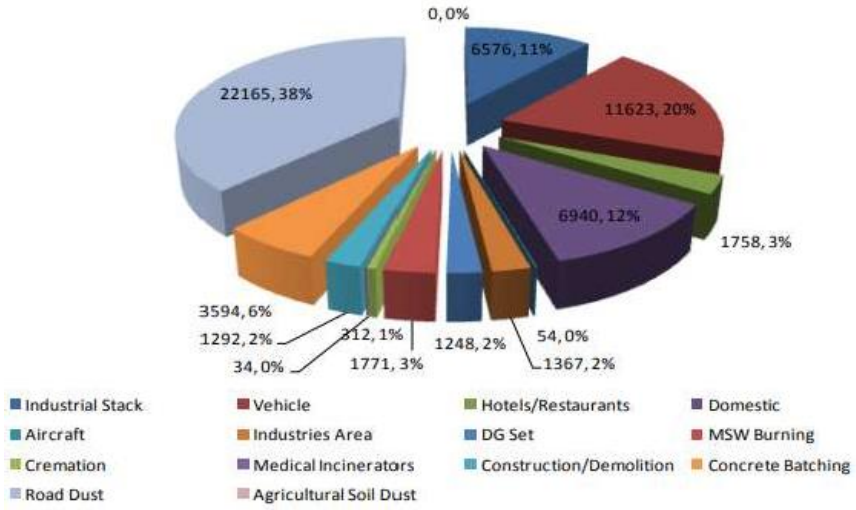
What is contributing to Delhi's pollution?

Vehicles have emerged as the top polluter in the city: The detailed source apportionment and emission inventory studies carried out by multiple agencies including Indian Institute of Technology Kanpur, The Energy Research Institute and Indian Institute of Tropical Meteorology – SAFAR based on round the year assessment of pollution contribution of different sources have alread established vehicles as the top polluter among all the combustion sources. Among combustion and dust sources it ranks second.

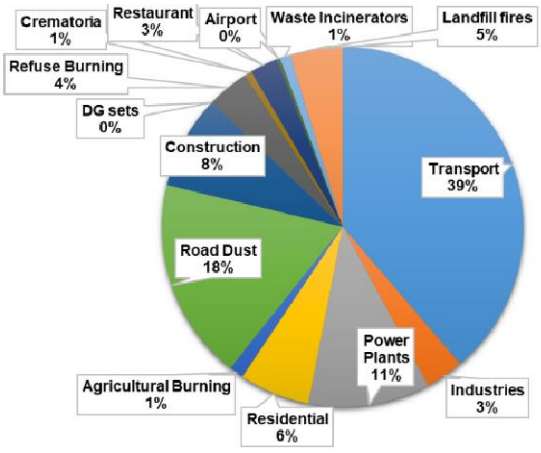
The emission inventory studies for Delhi done by IIT-Kanpur ,2015, TERI-ARAI, 2018 and SAFAR, 2018 point out that the transport sector contribution to PM2.5 is 20 per cent, 39 per cent and 41 per cent respectively. This makes vehicles the second major contributor to air pollution is the transport sector. (See Graph 4: Emission inventory of PM2.5 for Delhi).

Source apportionment study by IIT Kanpur shows that during winter when the city is gripped by the choking haze of pollution and the share of dust reduces to less than 15 per cent the share of vehicles to the overall pollution increases even more.

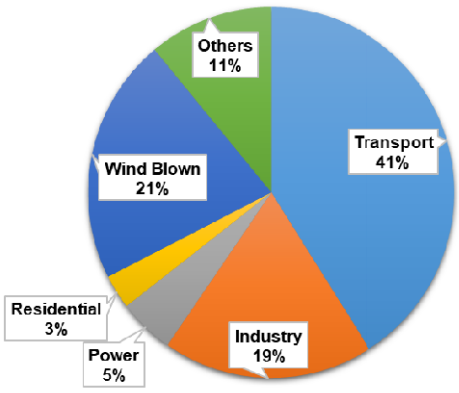
Graph 4: Emission inventory of PM2.5 for Delhi



IIT Kanpur, 2015



TERI-ARAI, 2018

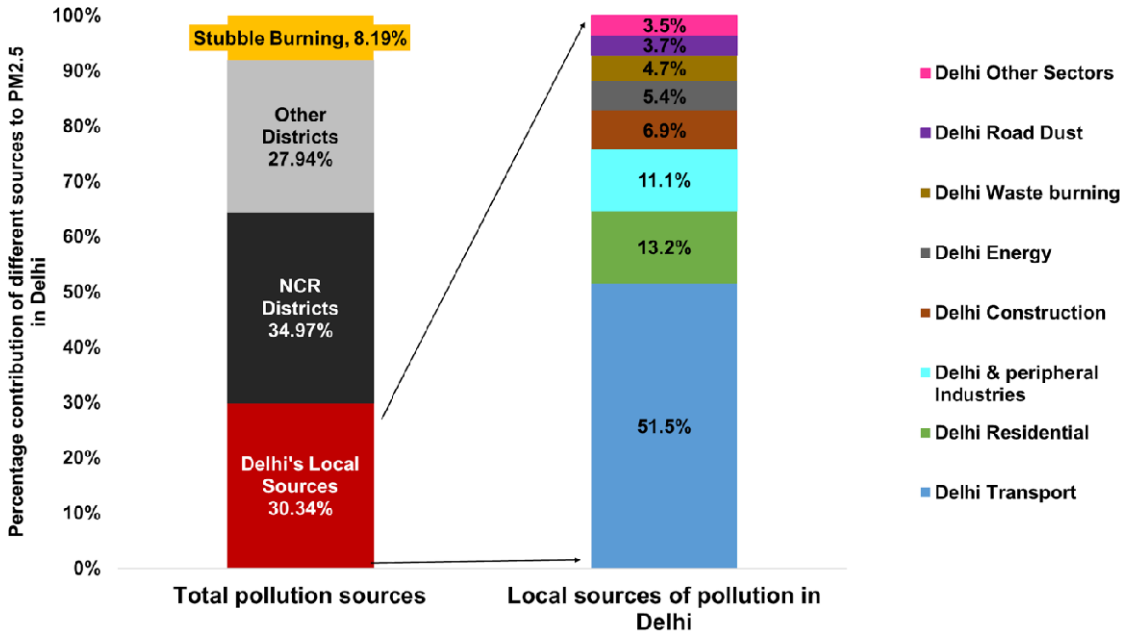


SAFAR, 2018

Vehicles dominate real time pollution source contribution to Delhi's particulate pollution during winter: CSE has analysed the real time data on the dynamic estimation and forecasting of the relative contribution of different pollution sources to Delhi's PM2.5 concentration during winter put out by the IITM. This Decision Support System (DSS) provides insight into the fractional contribution to PM2.5 in Delhi from 29 sources out of which eight are in Delhi (local sources). CSE has accessed the daily data for a period from October 12 to November 3, 2024.

If only the local sources of Delhi are considered as the total and contributions from outside sources are excluded, then the average transport sector contribution to PM2.5 is more than half of the pollution (51.5 per cent) from only the local sources. This is followed by the residential (13.2 per cent), Delhi and peripheral industries at 11 per cent, 6.9 per cent from construction, 5.4 per cent from energy, 4.7 per cent waste burning, 3.7 per cent from road dust and 3.5 per cent from other sources of Delhi. (See Graph 5: Average fractional contribution of sources of pollution to PM2.5 in Delhi (October 12 to November 3, 2024).

Graph 5: Average fractional contribution of sources of pollution to PM2.5 in Delhi (October 12 to November 3, 2024)



Source: CSE's analysis based on the Decision Support System for Air Quality Management in Delhi of IITM

Note: 1) Data for dates 13, 16, 20, 28 and 30 October was missing. Data for these dates were estimated based on the forecast available

2) The "other districts" category includes contributions from all the other regions/districts (apart from the 19 districts already included in the NCR districts). This includes the remaining districts of Haryana, UP, MP, Bihar, Rajasthan, etc. and also across the borders.

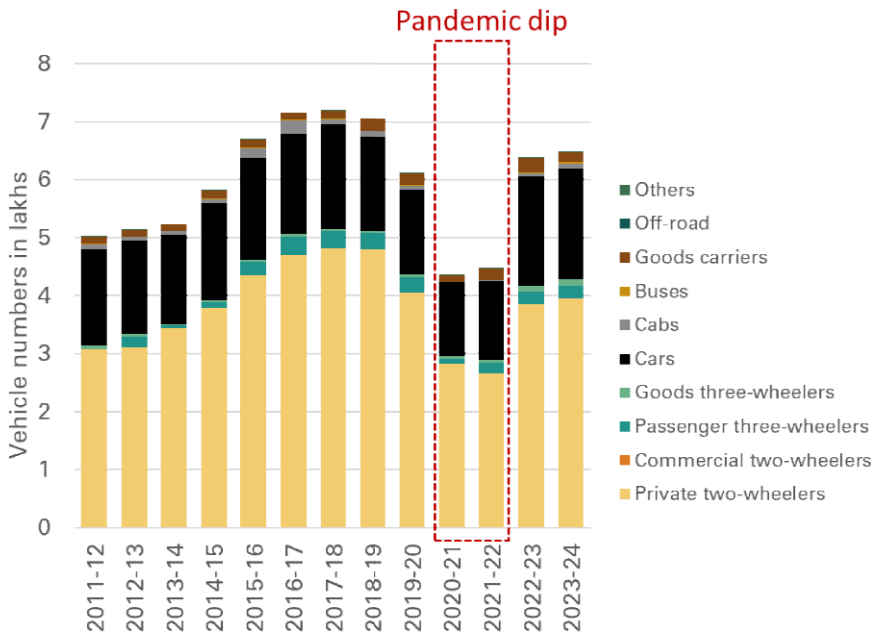
3. What is contributing to the mobility crisis in the city?

Explosive motorisation: Vehicles are emerging as one of the fastest growing source of pollution in the city. As per the Economic Survey of 2023-24, Delhi has a total stock of 79 lakh vehicles as per the Economic Survey of 2023-24 and has added 6.5 lakh vehicles during 2023-24, - as per the VAHAN database. As much as 90.5 per cent of these are two-wheelers and cars. On a daily basis as much as 1100 two-wheelers and 500 private cars are registered on an average daily (FY2023-24) in Delhi. (seeGraph 6: Rising Motorization in Delhi).

The motorisation rate has recovered quickly after the pandemic slow down and the average annual growth rate is 15.6 per cent. Two-wheelers and cars are growing at the same pace at 15 per cent each year.

According to an estimate of the TUMI e-bus mission of the Wuppertal Institute, Germany,National Capital Territory of Delhi that already has one of the highest numbers of registered vehicles among cities, also sees daily entry and exit of approximately 1.1 million vehicles daily.

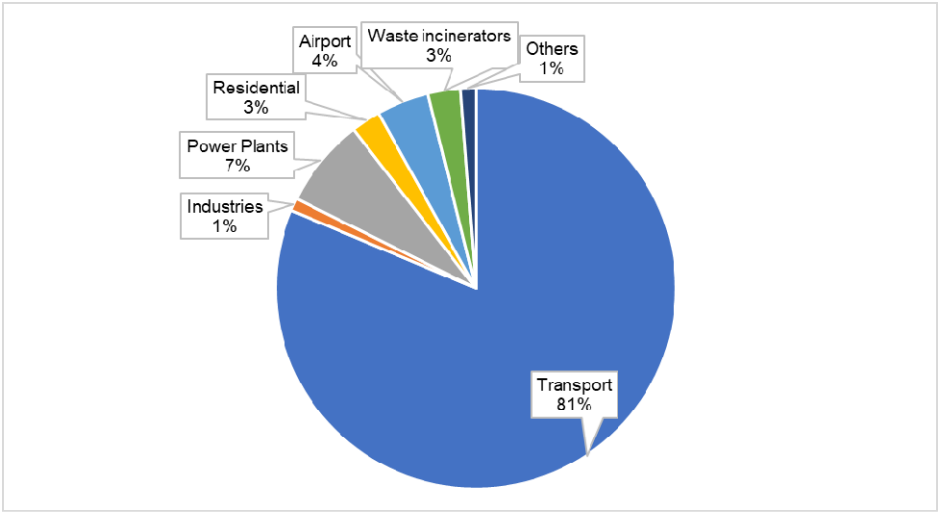
Graph 6: Rising Motorization in Delhi



Source: Vahan Database

High congestion builds up worsens local air quality: Vehicles are not only contributing to the particulate pollution but also enormously to the nitrogen oxide levels as well. In fact, the emission inventory by TERI-ARAI in 2018 shows that the transport sector's contribution to the NOx emissions is the highest at 81 per cent, followed by power plants at 7 per cent (See Graph 7: Emission inventory of NOx by TERI-ARAI, 2018).

Graph 7: Emission inventory of NOx by TERI-ARAI, 2018

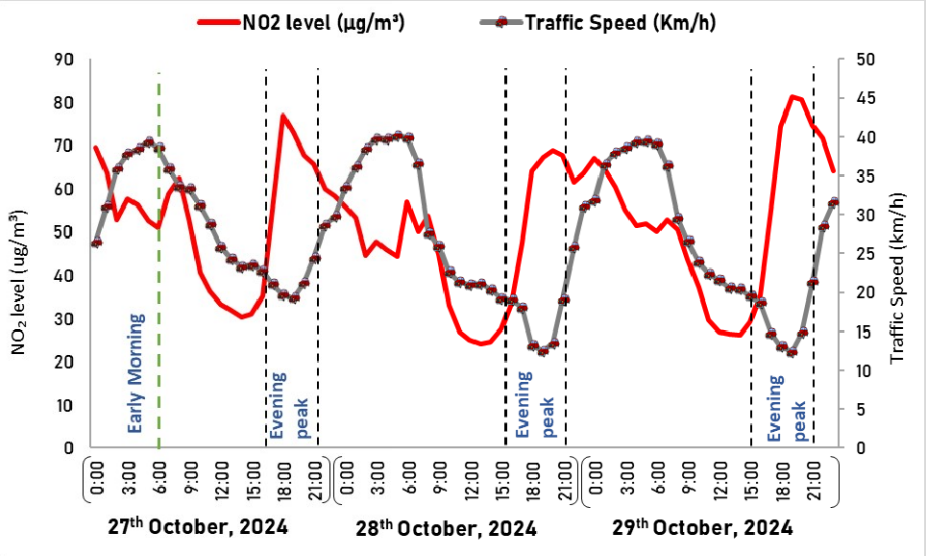


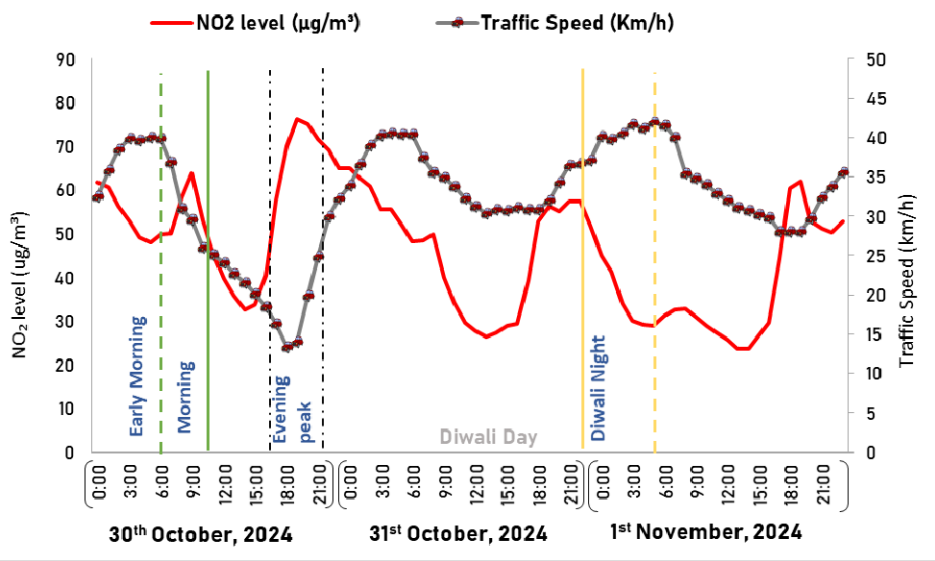
Source: Source apportionment and emission inventory by TERI-ARAI, 2018

Vehicles caught in congestion and idling can spew emissions several times higher than their normal emissions on roads. Since vehicles are the dominant sources of nitrogen oxide levels, there is a strong correlation between vehicles and hourly changes in NOx levels.

The data for 6 days (27th October - 1st November) presents the correlation between O2 and traffic speed. The data indicates that during peak hours on working days (27th- 30th), travel speeds are low, and NO2 levels were found to be notably high, however, on 1st November (holiday), NO2 levels were found to be low. (See Graph 8: Correlation between NO2 and traffic speed).

Graph 8: Correlation between NO2 and traffic speed



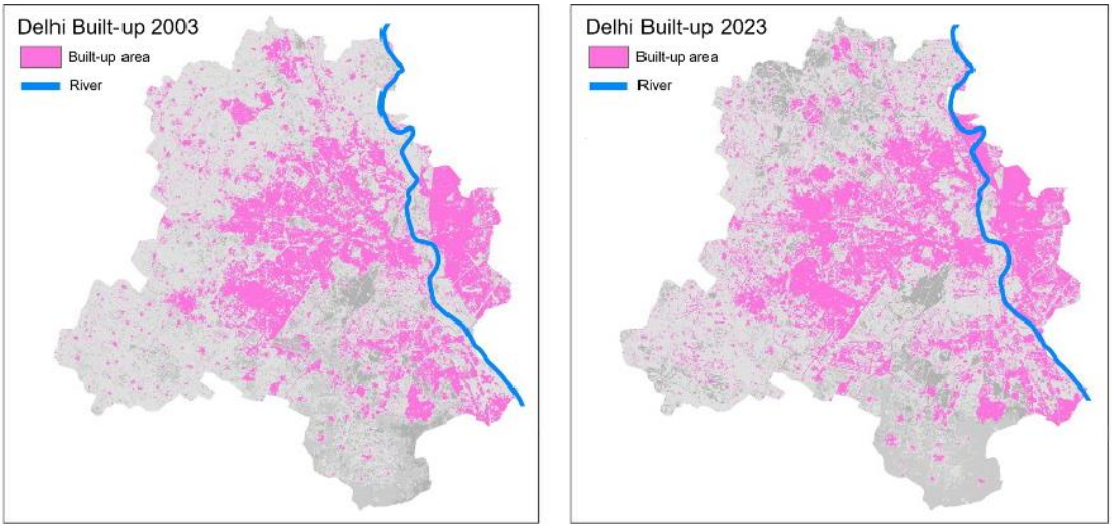


Source: CSE analysis of CPCB's real-time air quality data and traffic data from Google map

Urban sprawl, and growing travel distances in Delhi: The city's expansion into peripheral areashas also led to an increase in both the per capita trip rate and average trip lengths. Overall travel

volume has increased in the city. Specifically, the per capita trip rate has risen by 12.3 per cent, and average trip length have increased by a staggering 81.7 per cent (See Graph 9: Sprawling City - Built-Up Area Comparison between 2003 and 2023). This urban sprawl, combined with longer commutes, is contributing to the rise in private vehicle usage, further challenging the effectiveness of existing public transport systems.

Graph 9: Sprawling city- Built up area comparison between 20023 and 2023

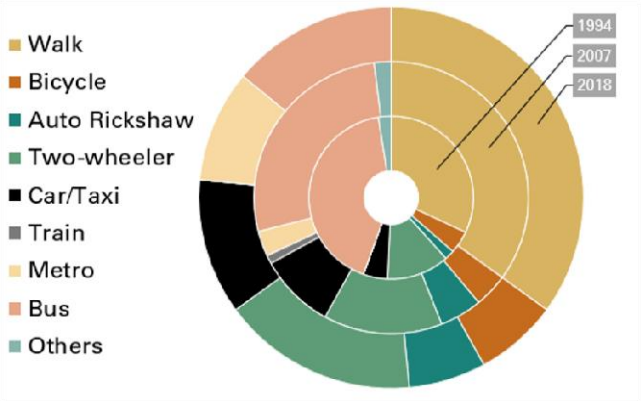


Source: NASA Earth Explorer Satellite Data, NIUA, GNCTD data

Public transport is losing out as the share of private vehicles is increasing: As cities expand and travel distances grow, the modal share of motorized trips tends to increase. This trend is evident from several studies carried out (though not directly comparable) over the last decade in Delhi. Indicatively, the modal share of private vehicles has risen from 38 per cent to 49 per cent over the past decade, while the share of bus trips has decreased by 20 per cent. This shift reflects a growing reliance on private vehicles for commuting, even as public transport use has declined (See Graph 10: Modal Split of Delhi).

How can Delhi meet the Delhi Master Plan target of modal split of 80:20 in favour of public and shared transport by 2041. This will require a 1 per cent increase in the public and shared mode trips every year and an equal reduction in private vehicular trips.

Graph 10: Modal Split of Delhi



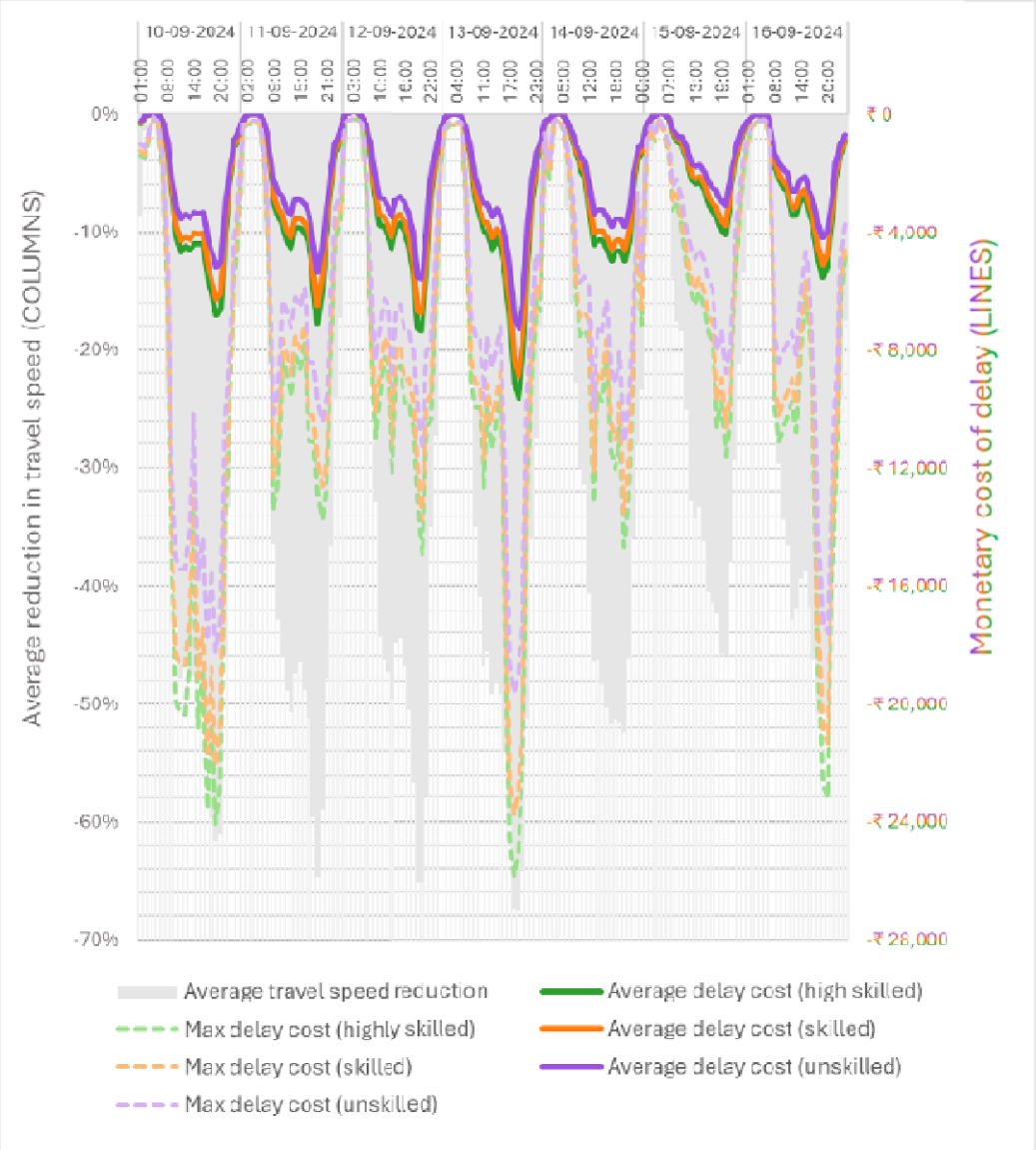
Source: IIT-D, NIUA, GNCTD data

High cost of congestion: The cost of congestion extends beyond delays to include loss of productivity and fuels. Sparse indicative assessments are available for Delhi.Yearly fuel waste cost due to congestion was estimated by the University of Leeds at USD 1.6 million in 2010 in in 2013. IIT Madras projected in 2015 that by 2025, USD12,003 million, and by 2030, USD 14,658 million will be the cost of congestion in Delhi, which includes productivity loss, air pollution loss and damage cost.

A rapid assessment by the CSE shows that an unskilled worker stands to lose between Rs 7,500 –Rs 20,100 in a year due to congestion. Similarly, skilled and highly skilled workers can lose RS 9,100 – Rs 24,400 and Rs 9,900 –Rs 26,600 in a year, respectively.

Lowe journey Further, the study confirms that private vehicles tend to have lower fuel costs compared to public transport fares. However, public transportation bears higher time costs, with interchanges and transit times significantly adding to overall journey expenses. This was proven in a hypothesis test that focused on comparing journey costs of private and public transport modes.(See Graph 11: Congestion and productivity loss (10th Sep – 16th Sep 2024)

Graph 11: Congestion and productivity loss(10th Sep – 16th Sep 2024)

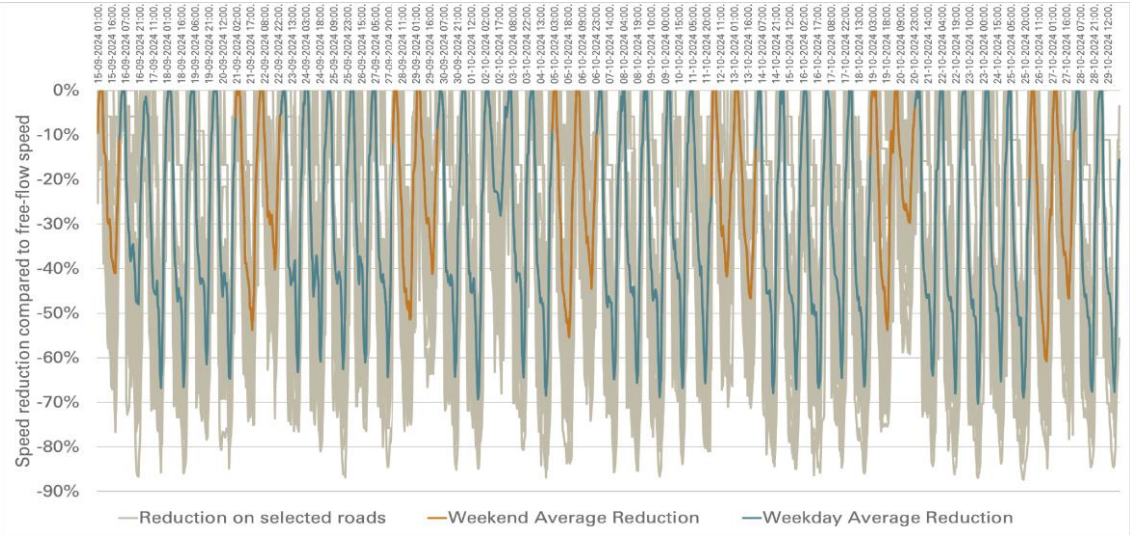


Source: Calculations based on Google Maps API data, and State's labour law department figures

Severe congestion level with spikes during festive days: Even though congesti n is a regular phenomenon, festive days observe severe congestion leading to much higher spikes in pollutants as well. Observation of traffic speed data from Google on major road stretches in Delhi from 15th September to 29th October reveals reduction in travel speed during festive periods. During weekdays morning peak speed decreased by 40.8 per cent, while evening peak speeds fell by 57.9 per cent. Whereas, on weekends morning peak speed reduced by 27.6 per cent and evening peak speed reduced by per cent.

Notably, congestion escalates further during or just before weeks approaching actual festivals; by 5-8% during Durga Puja week and by 7-10% during the pre-Diwali period.(See Graph 12: Reduction in travel speed observed on 25 selected stretches in Delhi.)

Graph 12: Reduction in travel speed observed on 25 selected stretches in Delhi (past 45 days starting September 15, 2024)



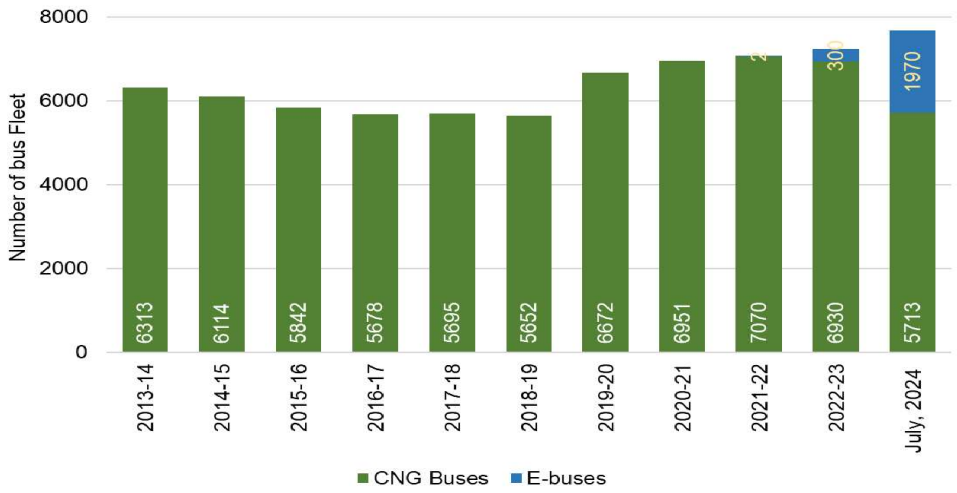
Source: Google API data

4. What's going wrong? Solutions are not being built to scale

Not enough buses to meet the growing travel demand: Buses that can penetrate all neighbourhoods and are expected to be the prime mover are losing ground. The city has not yet met the 1998 Supreme Court directive for 10,000 buses. As of July, 2024, only 7,683 buses are in place including 1970 are electric buses.Delhi has the highest number of electric buses. Since, 2019-20 years numbers have started to increase. 4000 buses in procurement stage can help to alleviate the problem.

But in relation to the needs of the population the bus numbers are highly inadequate. Delhi has around 45 buses per lakh population (considering 2011 census data). (See Graph 13: Year-wise registered city bus fleet in Delhi.)This is woefully short of the service level benchmark of 60 buses per lakh population specified by the Ministry of Housing and Urban Affairs. As opposed to this, some of the theGlobal citieshave 90 per lakh of population include London, Hong Kong (80), Shanghai (69), and Seoul (72) among others.

Graph 13: Year-wise registered city bus fleet in Delhi

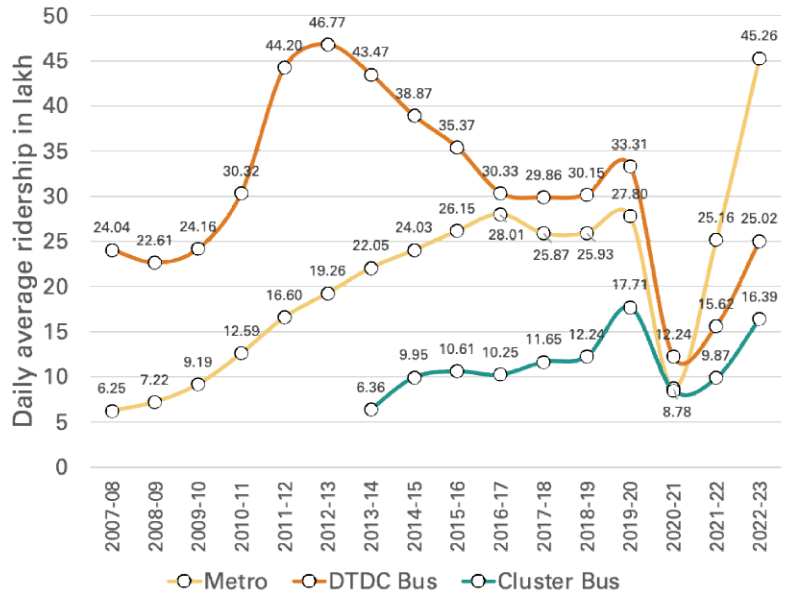


Source: Socio-economic report, Delhi

Usage of buses have gone down alarmingly - bus ridership has not yet recovered to reach the pre-pandemic level: The increase in the bus numbers since 2021 has increased the ridership somewhat but it hasnot yet recovered to pre pandemic level.While ridership sees an increase, numbers still lower than pre-COVID levels (25 per cent for DTC buses, 7 per cent for cluster buses).

Even though bus ridership is increasing, numbers are still below pre-COVID levels, with DTC buses seeing a 25 per cent reduction in ridership and cluster buses experiencing a 7 per cent drop.

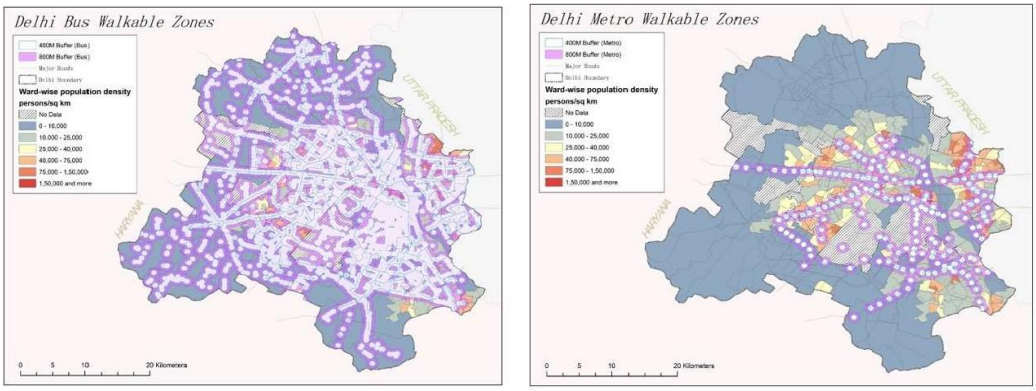
Graph 14: Daily average ridership of public transit services in Delhi



Source: GNCTD Economic Survey of Delhi

Even though infrastructure for accessing busses has expanded the service level is poor: In Delhi, 57.95 per cent of the population live within 400 meters (a 5-minute walk) to a bus stop, and 83.15 per cent are within 800 meters (a 5-minute cycling distance) of a bus stop. Despite the extensive reach to the bus network in Delhi, ridership remains lower than expected. This discrepancy highlights challenges such as last-mile connectivity, accessibility, reliability of service, and the overall inconvenience of the public transport systems. Even though the infrastructure is in place, factors like poor integration, infrastructure gaps, and competition from private transport options continue to limit the effective use of these public transport networks.(See Graph 15:Delhi bus and metro accessibility)

Graph 15: Delhi bus and metro accessibility



Source: NASA Earth Explorer Satellite Data, NIUA, GNCTD data

Unreliable and inadequate bus service despite the growing numbers: CSE has analysed the data available from "Open Transit Data" of the Delhi Transport department on the waiting time for buses in bus stops. This shows that less than one percent of the bus stops have 10 minutes waiting time with a maximum of 5 minutes of delay. As much as 50 per cent of the bus stops have very highwaiting time – more than 15 minutes. As noted earlier, calculations based on ward-wise population and route/bus station locations show that 59 per cent of the population are within the 400 meters or 5minutes walking distance from the available bus stops. But bus service is not upto the mark.

This low frequency and long wait times act as a major deterrent to the use of public transport. Despite the city's efforts to expand and modernize the fleet, the infrequency of buses remains a critical barrier to making public transport a more attractive and reliable option for daily commuters.

Metro service increasing but inadequate: Metro network in Delhi has around 351 km of operational network with close to 256 stoppages.Metro ridership has recovered more rapidly post pandemic. Also, since 2019-20, the Delhi Metro Rail Corporation (DMRC) has altered its ridership counting method, now tracking the number of corridors used rather than unique trips made by commuters. This change makes it difficult to gauge the comparative extent of ridership recoveryvis a vis buses.

Prior to 2018, DMRC reported ridership at only 47per cent of the projected figure, indicating a significant gap between actual use and expected demand. A more refined method of counting trips would provide a clearer picture of the metro's recovery and performance.Delhi's DMRC has achieved the highest ridership compared to others, and it is less than half of the projected demand.

Journey cost in public transport is higher than personal transport – creating more incentive for personal vehicles: A serious deterrent is the high cost of journey by public transport in the city. CSE's analysis based on sample survey in 2024 shows that the total journey cost increases substantially for public transport users, compared to private transport users due to hidden cost of time taken, waiting/ interchange --especially for buses.

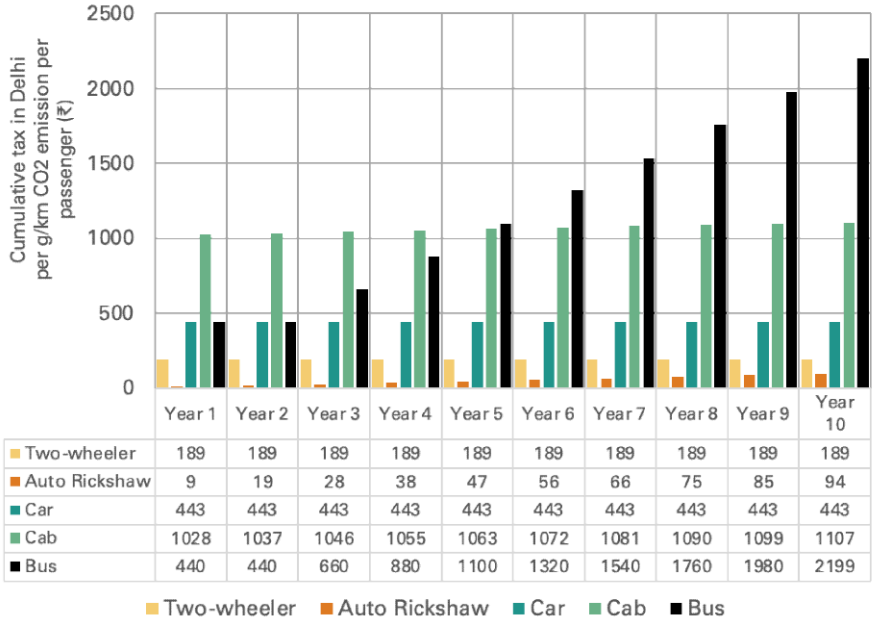
Comparative cost by modes are as follows -- Two-wheeler - Rs. 16/km, Cars - Rs. 35/km, Bus – 40/km and Metro – 47/km.

Around 50 per cent public transport users are spending 18 per cent of their annual income on the transport, whereas private transport users are spending around 12 per cent of their annual income.

An earlier study by CSE in 2018 shows that in relation to the accepted threshold of 10- 15 per cent of income can be spent on transport as the upper cap for affordability. In that year, almost one third or 34 per cent of Delhi's population stood excluded from basic non-AC bus services --- as it could not afford it.

Vehicle taxation structure-favors personal vehicle users: The cascading impact of taxes on public transport buses is higher than the personal vehicles. Over a period of 10 years, bus operators have paid twice as much as cab operators, and about 5 times as much as private car owners. This hidden cost of subsidy for personal vehicles needs to be recovered from the users through more rationalised taxation, and emissions and congestion charges. Taxes need to be aligned with emissions and road usage, based on the "polluter pays" principle. (See Graph 16: Cumulative tax in Delhi per g/kg CO2 emission per passenger)

Graph 16: Cumulative tax in Delhi per g/kg CO2 emission per passenger



	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Two-wheeler	189	189	189	189	189	189	189	189	189	189
Auto Rickshaw	9	19	28	38	47	56	66	75	85	94
Car	443	443	443	443	443	443	443	443	443	443
Cab	1028	1037	1046	1055	1063	1072	1081	1090	1099	1107
Bus	440	440	660	880	1100	1320	1540	1760	1980	2199

Source: Transport Department

Lack of multi-modal integration for easy and affordable transfer to different public transport modes inhibits expansion of public transport usage: Even though physical integration of metro stations with the other modes have begun and several stations have undergone change, it is not enough.

Integration and last mile connectivity can transform mobility in the city. According to the Delhi Master Plan 2040, 50 per cent of the population would be living within the transit influence zones by 2041. About 60 per cent of urban area will be within 15-minute walking distance from the MRTS stations. This is a big advantage. With mixed-use development in these zones substantial shift towards public transport is possible. This advantage is not being leveraged.

Lack of focus on walking and cycling: too little, too small- A long way to go: According to MoRTH, Delhi has around 16,170 km of road network. Almost 42% Delhiites use NMT modes including walk and cycle for their daily commuting. (2018, NIUA). Around 44% of roads in Delhi have no footpath, and only 26% of footpaths meet the IRC norms. ((IIT Delhi). In 2018 the Delhi governmenthad identified 21 road stretches to be developed to encourage walking and cycling.Pedestrianization projects have been implemented only in Karol bagh'sAjmal Khan road and Shahjanabad area development project. Even though the change has begun, there is only sporadic development or improvement work on small road ride segments

The Supreme Court directive to implement the parking rules 2019 and the associated Parking Management Area Plan (PMAP) as a vehicle restraint measure remains a non-starter: Whileroadnetwork takes up 22 per cent of Delhi's area, parking uses up more than 10 per cent of the urbanized land. For the new cars registered annually demand for new parking space is equivalent to finding land area equivalent to about 615 football fields.

Following the Supreme Court directions and implementation of the three Pilot Parking Management Action Plans (PMAPs) in Lajpat Nagar III (South Delhi Municipal Corporation), Kamla Nagar (North Delhi Municipal Corporation), and Krishna Nagar (East Delhi Municipal Corporation) in 2019, the efforts to scale up city-wide implementation is stalled.

While emergency action under the Graded Response Action Plan demands increasing parking fees to disincentivize personal vehicles, without the PMAPs and city-wide variable parking pricing systems in place this measure remains ineffectual. PMAP requires identification of and demarcation of legal parking areas in each ward while meeting the needs of all other street activities. Parking needs to be prohibited in parks and green areas, footpaths, near traffic intersections, on emergency vehicle

routes, etc. This requires penalty on illegal parking outside demarcated areas and variable parking pricing based on duration and user pay principle among others.

Need urgent action

While meeting clean air benchmark requires deep cuts in emissions from all key sources of pollution in the region, the mobility crisis will require immediate attention and upscaled intervention to cut down the prime contributor to the toxic pollution build up. The mobility crisis cannot hide behind the smokescreen of pollution from farms and other sources.

Slow incremental change in public transport systems, lack of integration, inefficient last mile connectivity and hidden subsidy for usage of personal vehicles cannot address this mobility crisis in the city.

This immediately requires a game changing strategy to upscale the infrastructure for buses, metro and their integration, incentive for usage of these systems and disincentives for usage of personal vehicles as is the global good practice.

Need urgent action for:

- **Ambitious electrification target supported by fleet renewal programme**
- **Scalable, integrated, connected and reliable public transport system and services**
- **Upscaled network of walking and cycling** and **efficient last mile connectivity** and **low emission zones**
- **Restraint and demand management measures** (PMAP, congestion pricing, tax measures etc)
- **Reform taxes to recover true cost of owning and using personal transport**
- **Compact and transit oriented urban form** to keep jobs and home close: Reduce distances, demand for travel
- **Shift budgets from road-building to public transport, active transport and zero-emissions mobility**
- **Address urban freight**
- **Adopt innovative financing of transport solutions**
- **Adopt measurable and verifiable impact monitoring systems**

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