Special challenge of vehicular pollution and congestion during 2022 Diwali week in Delhi

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New Delhi November 1, 2022:

Among the local pollution sources in Delhi, vehicles caused half of Delhi's own contribution to PM2.5 concentration during Diwali week (21-26 October) in Delhi. Substantial role of the vehicles was evident in the day long congestion that had nearly erased the difference between peak and non-peak hours during that week. This indicative findings for the Diwali week of 2022 is also consistent with the findings of similar analysis carried out for different phases of previous winter of 2021.

A city with 1.4 crore registered vehicles (as per the VAHAN database) and annual addition of 5 lakh vehicles a year, (of which 97 per cent are personal vehicles of two wheelers and cars), has failed to build transportation strategies to scale for transformative changes. With more than 200 lakh population (estimate of World Population Prospect by the UN, 2018), the city is estimated to be generating at least 276 lakh daily travel trips. If most of these commuting trips have to be self-organized with personal vehicles, Delhi cannot meet the clean air target or the benchmarks for liveability.

This has emerged from the new assessment by the researchers of the Centre for Science and Environment (CSE) that include: I) Analysis of dynamic estimation of hourly source contribution to the PM2.5 concentration by the Decision Support System (DSS) for Air Quality Management of the Indian Institute of Tropical Meteorology (IITM). This provides quantitative information on the contribution of emissions from Delhi's own sources and the surrounding 19 districts in the National Capital Region (NCR) and beyond. This is an indicative trend as the data for October 22 and 26 is available until 14:30 hours and data for October 23 is available from 15:30 hours. ii) Analysis of hourly traffic speed with the help of real time data from Google Maps to assess the level of congestion. The speed has been taken as a proxy for congestion and not to advocate high speed motorized traffic. For this purpose Google Maps data have been taken for 15 major arterial roads. Iii) Analysis of the real time hourly air quality data from the portal of the Central Pollution Control Board to corelate pollution with the traffic build up in the city.

Key highlights

Vehicles' contribution to Delhi's PM2.5 concentration was maximum during the week: When taken together – biomass burning, from NCR districts, other districts and Delhi's own local sources, vehicles contribute nearly 17 per cent of the total PM2.5 concentration. But if only Delhi's local sources are considered, transport sector tops the rank (see Graph 1: Average fractional contribution of sources of pollution in Delhi (October 21–26, 2022). Vehicles contributed around half of the PM2.5 concentration from the local sources during that week. This indicative data shows that the daily share of vehicles' contribution varied between 49.3 per cent to 53 per cent during that week. Vehicles are significant contributors.

This is followed by household pollution (residential), which is 13 per cent, industries– at 11 per cent, construction-- 7 per cent, waste burning and energy sectors—at 5 per cent each and road dust and other sectors—at 4 per cent each. This observation is consistent with the trend evaluated during the previous winter in Delhi.

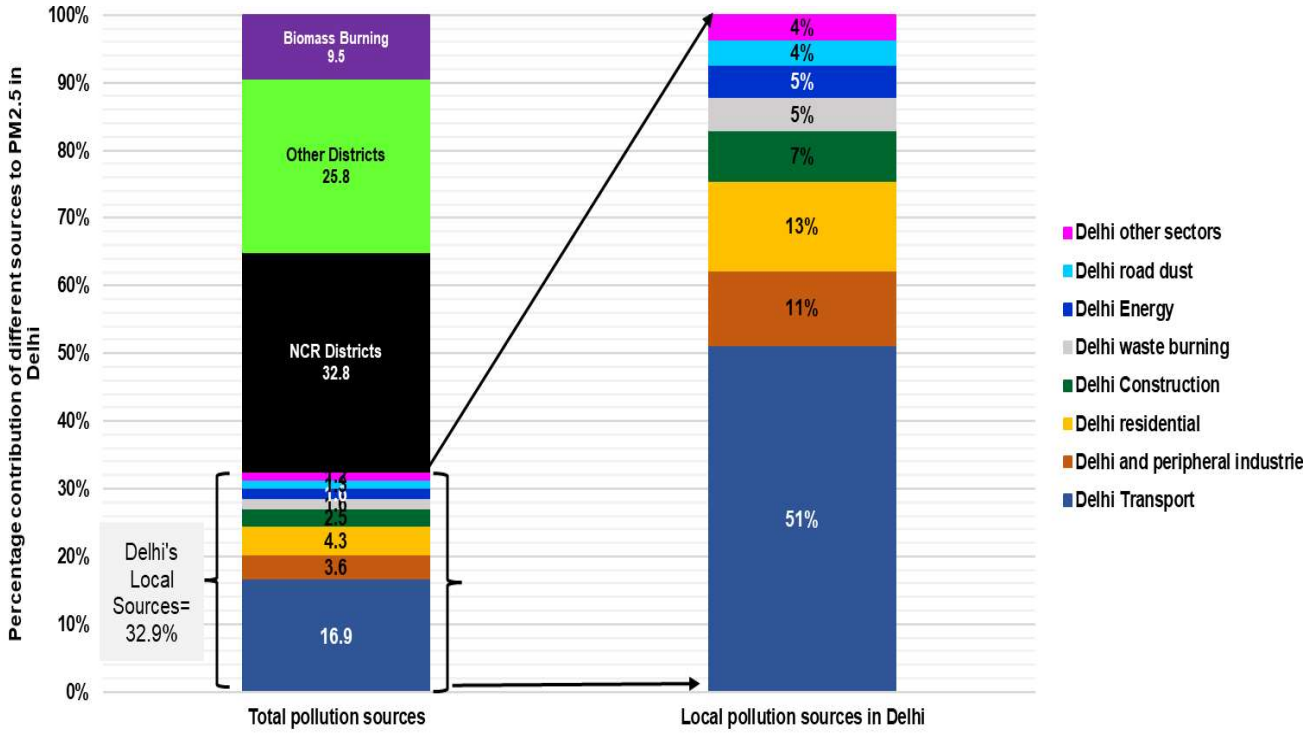
There is hourly and daily variation in the contribution of different pollution sources to Delhi's air quality but despite the variation the share of transport remains the highest. (see Graph 2: Variation in hourly fractional contribution of Delhi's local sources to Delhi's PM2.5 (October 21-26, 2022 and 24, 2022).

Combustion sources have contributed more than the dust sources: CSE researchers further show that the overall share of all combustion sources that include vehicles, peripheral industries

energy sector, waste burning and residential cooking among others, have contributed higher than the dust sources that include construction and road dust.

This has emerged from the CSE analysis of dynamic estimation of hourly source contribution to the PM2.5 concentration by the Decision Support System (DSS) for Air Quality Management of the Indian Institute of Tropical Meteorology (IITM). The DSS of IITM is part of the 'Air Quality Early Warning System' and provides information on the potential emission sources to air quality in Delhi. This uses online chemistry transport model 'Weather Research and Forecasting with Chemistry' (WRF-Chem), and its modelling uses available emissions inventory for Delhi and the surrounding 19 districts, biomass burning and from other regions/ districts and other districts of Haryana, other states and across the border and beyond. as well as the PM2.5 data from the Central Pollution Control Board (CPCB) monitoring stations and satellite imaging of pollution. This provides quantitative information on the contribution of emissions from Delhi's own sources and the surrounding 19 districts and beyond. This provides fractional contribution to PM2.5 in Delhi from 29 sources out of which eight are in Delhi (local sources). The pollution sources include Delhi transport, Delhi and peripheral industries, Delhi residential, Delhi Construction, Delhi waste burning, Delhi Energy, Delhi Road dust and Delhi other sectors. Delhi's other sources include all those emission sources in Delhi apart from the already included seven broad categories such as crematoria, restaurants, airports, usage of non-energy solvent, DG sets, etc.

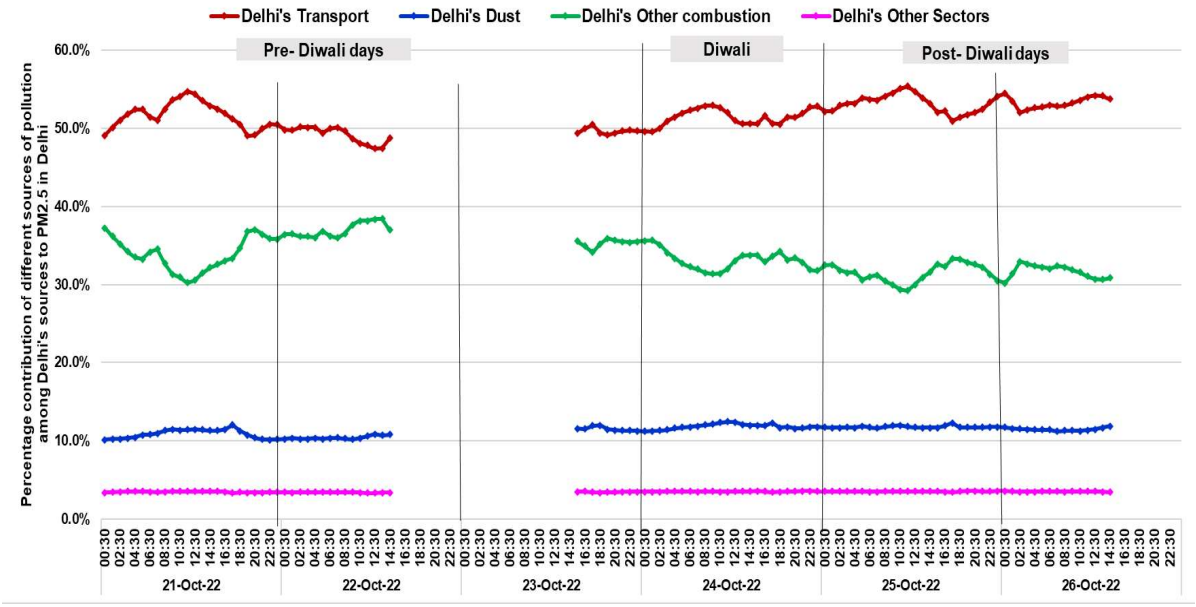
Graph 1: Average fractional contribution of sources of pollution in Delhi (October 21–26, 2022)



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

Note: 1) Data for October 22 and 26 is available until 14:30 hours and data for October 23 is available from 15:30 hours. 2) This is the mean of the daily average contribution for period October 21–26, 2022

Graph 2: Variation of hourly fractional contribution of Delhi's local sources to Delhi's PM2.5 (October 21-26, 2022 and 24, 2022)



Source: CSE analysis of data provided by DSS of IITM

Note: Delhi's Dust includes Delhi's Construction and road dust; Delhi's other combustion includes Delhi's Energy, Delhi & peripheral Industries, Delhi Waste burning and Delhi Residential; Delhi's other sectors include all those emission sources in Delhi other than those already included in seven broad categories -- crematoria, restaurants, airports, usage of non-energy solvent, DG sets, etc.

Sizeable pollution is coming from outside Delhi requiring action at a regional scale but vehicles remain a challenge: The DSS estimation show that during this phase contribution of the NCR districts was 32.77 per cent, other districts 25.84 per cent and biomass burning 9.52 per cent. This once again underscores the fact that the action will have to be scaled up across the region. But among all source transport is a substantial contributor.

Choking congestion: CSE has further analysed the real time data from Google Maps to assess hourly traffic speed data. The traffic speed has been taken as a proxy for congestion and not to advocate high speed traffic. For this purpose Google Maps data have been taken for 15 major arterial roads. Length of roads selected are representative of the geographical spread. The travel time from origin to destination was noted for every hour from 8 AM to 9 PM for the period, which was later converted into speed in km per hour. The data was further analyzed for traffic accumulation during peak and off-peak hours in the day. (see Graph 3: Average speed on roads on different days and Heatmap 1: Traffic accumulation during Diwali week of 2022)

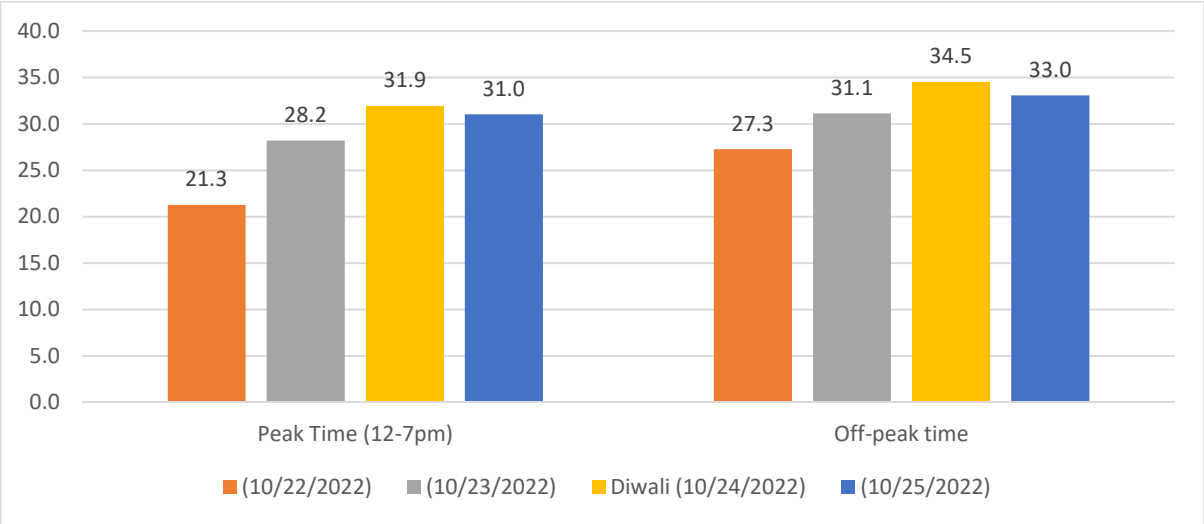
This analysis shows:

High level of congestion on all roads: Average speed on Delhi roads as observed ranged from 27 kmph to 32 kmph. The mean speed was 28 kmph against design speed of 60 kmph and regulated speed of 40km/h. Speed has been taken as a proxy to understand the level of congestion but not to advocate high speed vehicles or infrastructure for that. This should not lead to more car centric high speed corridors to promote motorized personal vehicles but to augment public transport infrastructure to reduce volume of traffic on road.

No distinct peak hours due to high traffic for long hours: Instead of two distinct traffic peaks during morning and evening, the duration of the congestion extended from 12 pm to 8pm indicating high traffic accumulation. An 8-hour long traffic congestion indicates significant traffic accumulation and traffic intensity in Delhi.

Traffic build up highest on pre-Diwali: The working day before Diwali (21 October - Friday) and the Saturday (October 22) witnessed heavy congestion and average speed was observed at 23.7 and 23.8 respectively. On Diwali day (October 24) and post Diwali day (25 October), when overall traffic reduces normally, average speed on road was relatively higher at 33 and 32 kmph respectively. Diwali day had the least traffic build-up.

Graph 3: Average speed on roads on different days



Source: CSE analysis of google map data

Heatmap 1: Traffic accumulation during Diwali week of 2022

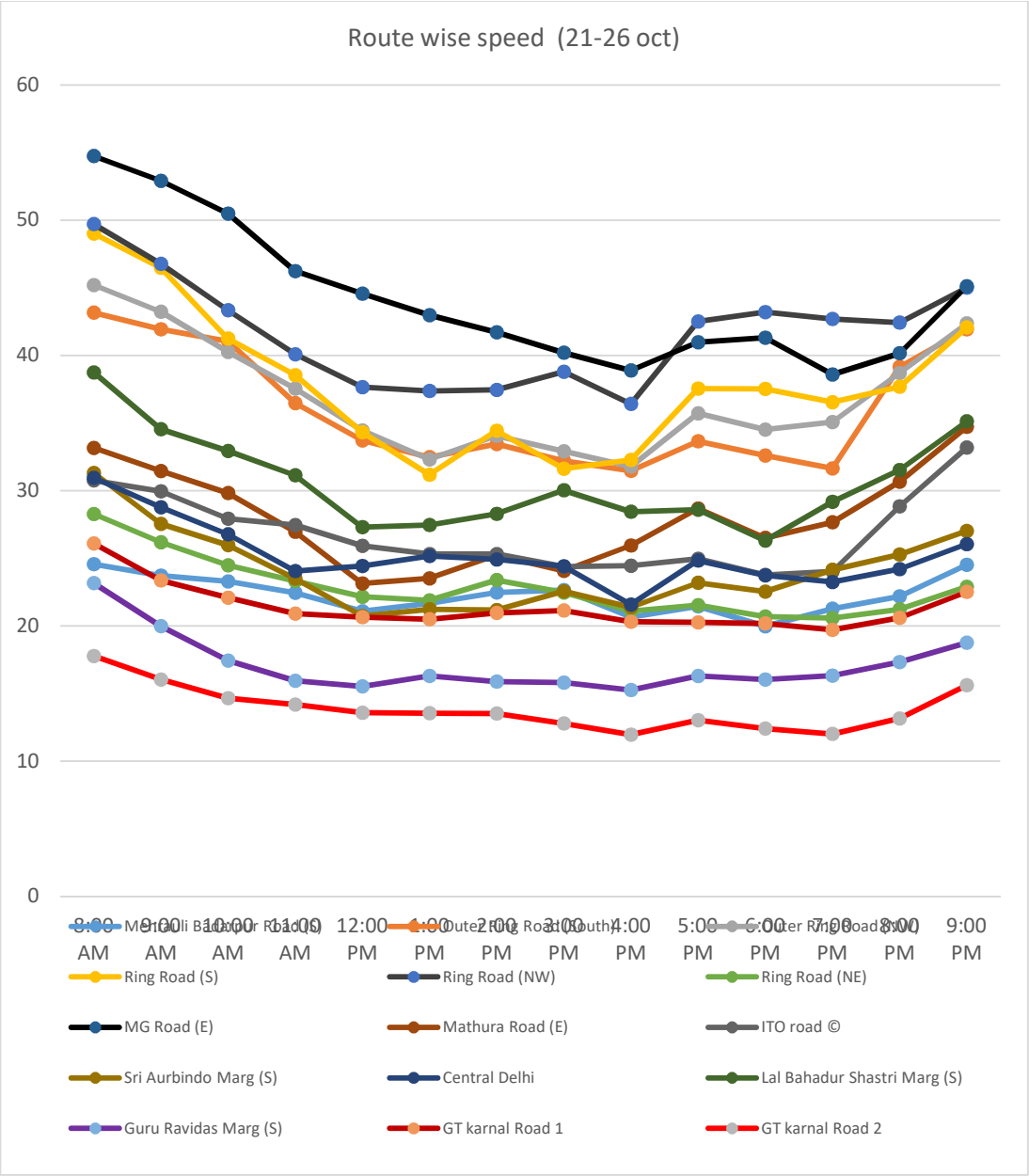
AVERAGE SPEED (21/10/2022 - 26/10/2022)														
Time	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM
21-Oct														
22-Oct														
23-Oct														
24-Oct														
25-Oct														
26-Oct														

Source: CSE analysis of google map data

Congestion hotspots: While congestion had built up on all corridors GT Karnal Road and Guru Ravidas Marg witnessed more congestion compared to others. The average speed on both was 17 kmph respectively -- much lower than mean speed observed in other roads during the period. Guru Ravidas Marg connects some of the densest settlement and ongoing metro construction. GT Karnal road connects multiple business districts and high density residential settlements of north west Delhi.

Comparatively lower congestion was observed in MG road and ring road that had an average speed of 44 kmph and 41.7 kmph respectively. (see Graph 4: Congestion on different roads)

Graph 4 Congestion on different roads

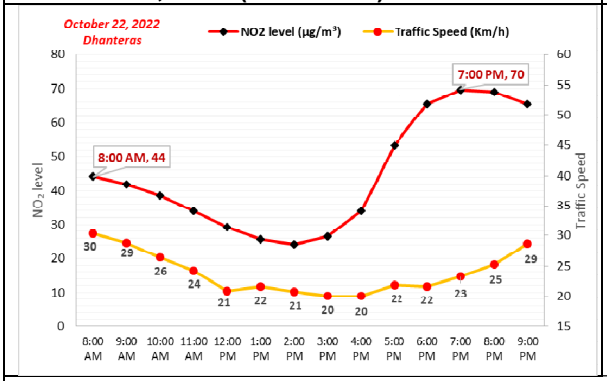
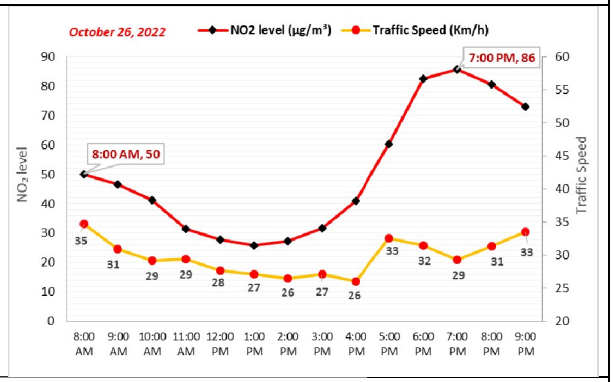


Source: CSE analysis of google map data

Hourly nitrogen di-oxide levels corelate well with congestion in the city: CSE has further analysed the real time hourly nitrogen dioxide (NO2) level as vehicles are responsible for substantial NO2 pollution in the city.

The hourly level of NO2 corelated with congestion levels though there have been dilution due to dispersion during afternoon. Hourly NO2 levels during evenings could be high ranging between 73 µg/m³ to 86 µg/m³. This is the time when congestion is also high. *(See Graph 2: Correlation between NO2 and traffic speed during 8 am- 9pm).* There is also an inversion effect as early morning hours and the evening hours recorded high NO2 concentration.

Graph 2: Correlation between NO2 and traffic speed during 8 am- 9pm

October 22, 2022 (Pre-Diwali)	October 26: Post Diwali
	

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

Next steps: Need verifiable and measurable shift to public transport

Even though the vehicles are the top polluters in Delhi, action to control their explosive numbers and usage have remained the slowest. Even the air emergency measures enforced for the very poor and severe categories of Air Quality Index (AQI) under the Graded Response Action Plan (GRAP) do not include action, barring increased parking charges, to reduce vehicle numbers on road to control smog episodes. This is primarily because of inadequate public transport systems, poor quality services, lack of last mile connectivity and restrain measures. Even though action on transportation is underway it is too little too late. Sustained and stringent action is needed for mobility transition. Otherwise explosive vehicle numbers will negate the air quality gains of the leapfrog to Bharat Stage VI emissions standards.

Augment and improve service quality of buses: Steps have been taken to add new buses to the existing fleet recently, but the numbers are still inadequate. Retirement of old buses also limit the net addition. Delhi with 7320 buses currently, has close to 37 buses per lakh of population against the recommended 60 buses per lakh population for the size of a city like Delhi (as per the service level benchmark of Ministry of Housing and Urban Affairs). Need time bound augmentation of bus fleet and modernization of bus services and infrastructure to improve quality of passenger service across the city

Ensure physical and fare integration of bus and metro systems: Though the process of physical integration of major metro stations with other modes of transport has started for seamless transfer, fare integration has not been possible yet and last mile connectivity with safe at grade access for people needs immediate attention.

Scale up walking and cycling infrastructure to connect neighbourhoods and implement low emissions zones: There are plans to redesign 500 kms of PWD roads by 2023 by Delhi Government and also 200 km of dedicated corridors for pedestrians and cyclists by DDA among others. But the implementation that is underway needs scale and speed. But the city also needs extensive networks of walking and cycling infrastructure to connect different neighbourhoods for functional usage at local level. Though there are proposals to pedestrianise more streets/commercial areas, the full implementation has been possible only in Ajmal Khan and Shahajanabad.

Immediately implement Parking Management Area Plans with parking caps and pricing in all municipal wards: Only increasing parking rates during severely polluted days in a few commercial sites cannot work if the notified parking rules and Parking Management Area Plans along with parking pricing and caps as per the rules are not implemented by the Municipal Corporations city wide. This has not progressed beyond the three initial pilot schemes that were directed by the Supreme Court. Follow the parking rules under the Transit Oriented development Policy within the influence zones of metro stations. Delhi needs congestion and pollution pricing and other restraint measures to control the traffic volume.

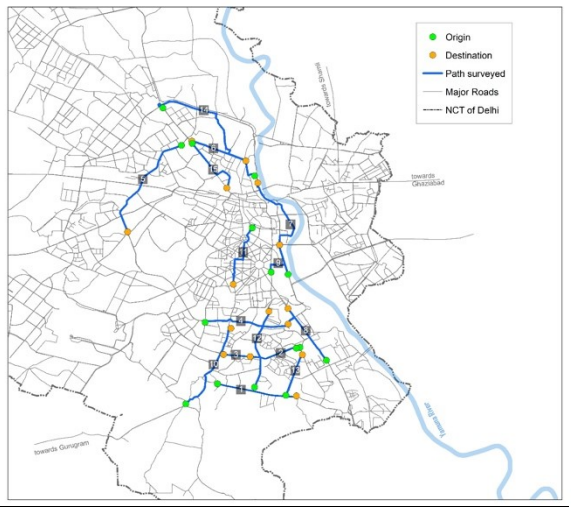
Meet all the mile stones and targets set for the implementation of electrification of new vehicle fleet: The target for 25 per cent fleet electrification by 2024 is a good step forward. This needs

acceleration. Promote low emissions zones linked to electric vehicles, walking and cycling and public transport access.

Annex

Table 1: Details of road stretches taken for the study

S.No.	Route	Length (in km)	**Diwali 2022** 21st October 2021 – 26th October 2021 **Map 1: Location of road stretches taken for the study**
1	Mehrauli Badarpur Road (S)	6.7	
2	Outer Ring Road (South)	3.7	
3	Outer Ring Road (NW)	6.2	
4	Ring Road (S)	6.5	
5	Ring Road (NW)	9.6	
6	Ring Road (NE)	6.3	
7	MG Road (E)	10.5	
8	Mathura Road (E)	5.0	
9	ITO road	3.4	
10	Sri Aurbindo Marg (S)	7.8	
11	Central Delhi	5.7	
12	Lal Bahadur Shastri Marg (S)	7.1	
13	Guru Ravidas Marg (S)	3.7	
14	GT karnal Road 1	8.1	
15	GT karnal Road 2	4.6	



Source: CSE analysis