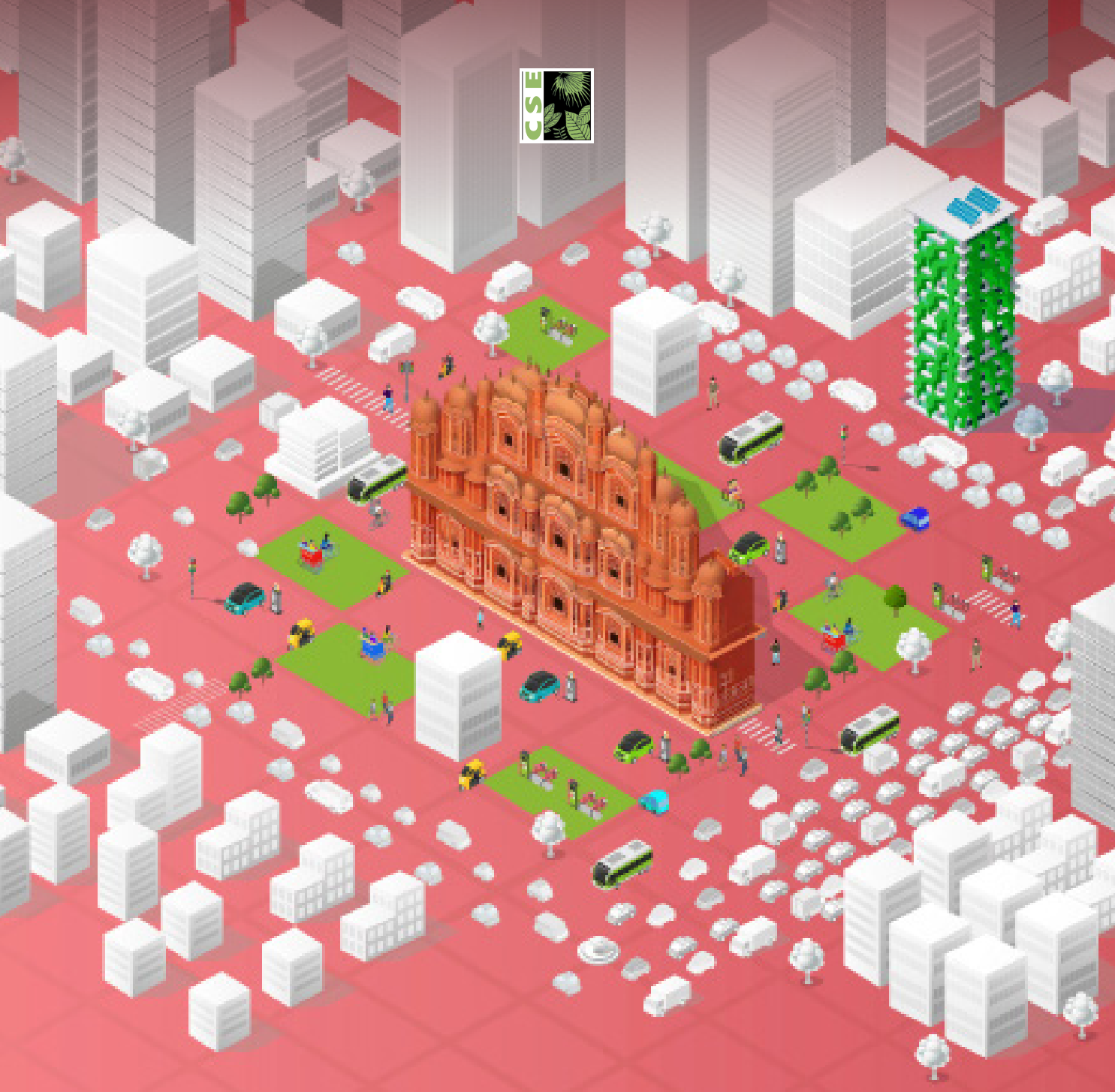

LOW-EMISSION ZONES

OPPORTUNITIES AND IMPACTS

THE CASE OF JAIPUR

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Why this spotlight on low-emission zones?

Nationally, several transport sector policies that are emerging to address both toxic and carbon emissions from the transport sector require community-wide adoption of new generation vehicle technologies especially electric vehicles with zero tailpipe emissions, sustainable commuting practices, and new transit oriented urban design and planning approaches at the neighbourhoods and municipal ward scale.

This requires community-wide adoption that is possible with area-based approaches to planning and implementation. Traditionally, zoning based regulations and urban planning in cities have been the key focus of city master plans. But increasingly, the interest is growing in taking similar area based or zone based approaches for aligned and synergistic implementation of clean vehicle technology solutions and mobility solutions to maximise benefit and also to accelerate the change.

This can bring together the emerging regulation related to faster adoption of electric vehicles and policies related to public transport strategy, service level benchmarks and Transit Oriented Development (TOD) policies as developed by the Ministry of Housing and Urban Affairs (MoHUA). The TOD approach aims to regenerate and redevelop about 400-800 square meters around the transit nodes to densify to allow more people of different income classes to live close to transit lines. This will further enhance safe and convenient access to the transit nodes through walking and cycling infrastructure, regeneration of public spaces, improved last-mile connectivity and restraints on parking. This area-based planning is expected to reduce dependence on personal vehicles and increase the use of transit.

Complimentary to this development is the compact urban form-based code that allows small block sizes, and high street density. The railways have adopted this for the development and redevelopment of their station areas.

Leveraging pollution hotspot plans for electrification and mobility

Clean air policies have led to the identification of pollution hotspot in cities for mitigation of local pollution sources that include dispersed sources of pollution

including waste burning, road and construction dust, and traffic bottlenecks. Even though this strategy is working for the other dispersed sources, it is not working for vehicles. Limited road engineering and traffic circulation changes in a local area cannot reduce vehicular pollution adequately and effectively.

This requires more targeted transformation and renewal of the vehicle fleet and upscaled uptake of mobility solutions. Most cities have begun to focus on the old vehicle phase-out and scrappage for vehicle fleet renewal and also for targeted electrification of vehicles. They have also started to implement public transport strategy. But these need to come together for targeted implementation in priority zones in cities that can then have cascading effect city-wide.

Towards low-emission zones

It is from this perspective that the interest has grown in developing low-emission zones (LEZs) in cities. This is the direction in which the global cities are moving. They are adopting the policy of LEZs. The scope of implementation varies across global cities of Europe, United Kingdom, China without any uniform definition or harmonised scope of application.

The most classical application is in London that has grown in stages over two decades – from parking management and pricing to congestion pricing to emissions pricing in the central London -- to mature as a low emissions zone. In other European cities like Berlin, it works more like reclamation of streets in neighbourhoods for walkers and cyclists while restricting vehicular movement to improve liveability. Stockholm, Barcelona and other cities may have relatively broader application of pricing entry of polluting vehicles into the zones. The LEZ strategy targets polluted and congested areas to catalyse city-wide changes.

In Indian cities there is a nascent beginning of the policy conversation around LEZ for integrated implementation of enhanced public transport services, walking cycling strategies, fleet renewal, phase-out of old vehicles, clean and zero emissions vehicles to compliment the ongoing pollution control efforts in that area.

Under the NCAP programme, a few states are inclined to include low emissions zones in their city action plan. The city of Bhubaneswar has taken the lead to create such zones and have also come up with a detailed plan based on multi-stakeholder consultation. The municipal corporation of Pimpri Chinchwad is proposing to take such an area-based approach for pollution control under their graded response action plan. Several studies are getting initiated by different stakeholders to understand its potential application.

The CSE assessment

The Centre for Science and Environment (CSE) has taken a step forward to assess the potential of application of LEZ approach in different city typologies. The first is the series is the assessment of the potential application of LEZ in Delhi that is a mega city with associated complexities of scale.

This is the second in the series and puts a spotlight on Jaipur, the capital city of Rajasthan. Jaipur is smaller than Delhi. The smaller cities have their own imperatives and opportunities that can be leveraged more efficiently. The mobility solutions have begun to take shape in this city. A combination of strategies including improved bus system, electric buses and metro system are in place. The additional strategies including improving pedestrian infrastructure and accessibility are also taking shape. Also under the direction of Jodhpur High Court, proof of parking policy as a demand management strategy are also in place. This creates the opportunity or combined and synergistic application in targeted zones for a scalable impact.

Assessment of potential application of LEZ strategy requires a certain assumption with respect to the scope nature of the programme as currently, there is no legally defined programme on LEZ in India. Therefore, its potential application needs to be approximated based on the emerging global good practice and aligned with the relevant principles of the existing regulations and policies, to build the scenarios for implementation.

While there are several design implications for LEZ implementation, this assessment has focussed largely on understanding the possible impact of LEZ restrictions on the communities especially those belonging to different income classes as the acceptance of this policy will largely be determined by the adaptive capacity of the of the communities. Any potential LEZ policy framing has to assess what is needed to minimise any disproportionate impact of the proposed measures on different commuting groups and income classes.

Keeping in mind that such applications may have disproportionate impact on some income classes and vulnerable groups, special attention has been given to understand the nature of impact on these groups to be able to identify the mitigation impact. The global experience that has shown that implementation of such community-oriented strategies requires strong public support. That is possible only if there is an advanced strategy is in place to prevent and mitigate disruptive impacts on communities with well-designed interventions and strategic support. In fact, when after the initial success with the low emissions zones in

Central London it was planned to expand ultra-low emissions zone (ULEZ) there was a strong public backlash. There were concerns around additional new expense, increased cost-of-living, inflation, higher levels of car ownership in new areas, and less public transit than the city centre. These required more nuanced planning.

About the study

Location of the study: The heritage area of Pink City-Jaipur attracts major traffic of the city as the city's main shopping area is located there. Apart from that the old city area is declared as a UNESCO World Heritage site. The influx of vehicles for passenger as well as freight traffic is also high. It is also the most important area in terms of tourist attractions. To safeguard the old city from deteriorating due to vehicular emissions implementation of LEZ in this area seems to be a better proposition.

Locational advantages: The selected area is a UNESCO World Heritage site and a major Tourist attraction. Apart from that major retail shopping area is located at the same location. This makes this area a high-impact area with the interventions of parking plans implementation and LEZ.

Good connectivity: As far as connectivity is concerned, the major roads in the north and south of the study area have good Public transport connectivity. Most of the study area is accessible within 5 minutes of walk from the public transport stops/stations. The streets are well connected in grid and lock pattern making it easier for pedestrians to connect the entire area by walk.

Perception survey to assess public response to LEZ implementation: This assessment has applied survey techniques to generate data and responses from a wide spectrum of road users, vehicle users and owners, public transport providers, and public transport users. This thus addresses both polluters and beneficiaries.

To understand the potential impact of the LEZ implementation on the community, a wide spectrum of target groups was covered that include private two-wheeler and car owners, auto operators and users, cab operators and users, and freight service providers.

For perception analysis, a specific focus was on auto, cab, bus, and metro users, private e-two-wheeler and e-car users, commercial e-two-wheeler and e-car operators and e-auto/rickshaw operators.

Understanding the commuting pattern and the profile of the communities: To relate the user responses and perception to the reality of their commuting needs, the survey has included travel-related factors that include Origin-destination, trip purpose, trip frequency, primary and secondary trips choice of modes, vehicle ownership etc.; socio-economic and demographic factors (i.e., sex, age, employment status, education level, income level etc.); psychological factors (i.e., Concern about environment related issues, political orientation and perception of the stringency of the intervention - in this case LEZ) of various social group/s who on daily basis access the study area; and the perception of public/ semi-public and electric vehicle users to under the reason behind choosing these modes and existing challenges of these modes.

The samples are well distributed across the targeted geography.

Primary issues under scanner: As there is no established policy on LEZ yet, for the purpose of the study, a possible scope of the programme have been considered. But this is guided by the overall objectives of mobility and clean energy transition in the transportation sector. The overall objective was to find out can LEZ implementation influence vehicle owners (personal vehicles) and vehicle operators (commercial vehicles) to replace older vehicles with cleaner vehicles? Can LEZ implementation accelerate electrification among vehicle owners/ operators? Can LEZ implementation influence influence commuting preferences and shift commuters to sustainable modes? How LEZ implementation can have a differentiated impact on different income classes?

The main interest has been to understand how can LEZ accelerate usage and adoption of clean vehicles and zero-emissions electric vehicles in the targeted zone. And how can LEZ influence commuting choices of commuters and shift towards use of public transport, walking and cycling, and use clean vehicles.

The possible strategy for LEZ implementation to assess public perception: For the purpose of the assessment two possible policy scenarios have been proposed for implementation in Jaipur.

Policy scenario 1:

- What if pre-BS-VI emission standards and non-electric vehicles are not allowed to enter a designated LEZ area – a complete ban.
- A heavy penalty is imposed on the defaulters -- penalty amount can be high to ensure compliance.

Policy scenario 2:

- What if pre-BS-VI emission standards and non-electric vehicles are allowed to enter, but only after paying access charge.
- This fee-based approach is expected to gradually incentivize vehicle owners to switch to cleaner alternatives.
- The entry fees can be substantially lower than the penalty suggested for the scenario one.

This assessment brings out the differential opinion across vehicle segments and income classes.

Responses from different vehicle segments

Widely different views have emerged from the different vehicle users and public transport users with respect to their adjustments and responses if the LEZ is enforced.

Two-wheelers users

Analysis of responses from the two wheeler users bring out that most of them make primary trip to this zone. Most of the fleet belong to the BS-III and BS-IV genre.

If there is a ban on entry of older vehicles in the LEZ region, as many as 56 per cent of Rs 12 to 18 lakhs income group would opt to shift to BS-VI vehicles and 33 per cent in the income group of Rs 3-6 lakhs will opt for buses. One of the reasons for lesser preference for public transport is the high cost if interchange that increases the overall journey cost. However, there are serious concerns about unreliable bus service and overcrowding.

There also seems to be a strong potential for electrification of LEZ comes into existence. About 17 per cent have shown interest in opting for electric 2W.

In the second scenario of access fee to enter the zone, about half of the respondents have indicated an elastic range of charges that they are willing to pay beyond which they will shift. But about 34 per cent will continue with their current modes and pay the charges. About 16 per cent are willing to shift.

The higher income group will prefer to shift to metro system. For other income groups, this percentage is very low. However, this needs to be understood with a caveat that Jaipur city has only one metro corridor and not a network that can

cater to widely dispersed journey requirements. This may increase the journey cost.

Two-wheeler users expect purchase incentives, free parking facilities, expansion of charging network, and awareness building.

Car owners

The demand for car usage is more inelastic and most will prefer to continue to use cars. If there is a ban on older vehicles, about 39 per cent of the primary trip car users will continue with BS-6 vehicle. About 20 per cent may shift to public transport. The share is little higher for the lower income group.

However, safety concerns, lack of access, over-crowding and unreliability have been cited as the reasons for not using public transport facilities.

In the case of access fees to enter LEZ, the lower income group may opt for park and ride options, or shift to public transport. bus. It is interesting that about 50 per cent in the income group above Rs 25 lakhs have shown preference for electric cars.

Across income groups, unlike in the case of two-wheelers, car owners have a greater affinity to continue with private mode.

It may also be noted that as much as 36 per cent of car users do not pay anything for parking while 46 per cent pay the parking fee up to 100 rupees cumulatively for the entire journey.

Auto drivers

This is a challenging commercial vehicle segment. About 59 per cent of the respondents operate BS IV, 23 per cent BS III and 18 per cent BS II vehicles. Around 71 per cent are operating vehicles older than eight years.

If the older vehicles are banned, around 64 per cent of drivers will upgrade their vehicles to compliant modes. Out of them 24 per cent will upgrade to EV and 40 per cent to BS VI vehicles. The rest will continue with the present vehicle and operate outside the LEZ area.

About 36 per cent will not get a new vehicle due to financial concerns. The drivers opting for an electric auto have indicated that they need the fiscal subsidy.

If there are access charges, about 44 per cent of auto drivers worry that this will adversely impact their profits. About 26 per cent are concerned that this will impact both profit and ridership.

Auto users

Around 77 per cent of auto users are taking autos for work purposes, followed by recreation (14 per cent). If older vehicles are banned, about 27 per cent think this will not have any impact. Another 27 per cent have claimed that they will reduce the number of trips they make to the LEZ. Another 27 per cent have stated that they may shift to public transport.

Among auto users, 77 per cent will prefer electric autos if the option is available.

However, they have pointed out concerns related to unfair fares, and lack of standardized fare system and high waiting time.

Cab drivers

Among the cab drivers, the majority (64 per cent) are currently driving BS-4 cabs and around 36 per cent are operating vehicles older than eight years.

If the older vehicles are banned in the LEZ zone, around 45 per cent will upgrade their vehicles to compliant modes. The rest will stop operating in this area.

Of those who will upgrade their vehicles, about 31 per cent will opt for BS VI vehicles and 14 per cent for electric vehicle.

There is however concern that the LEZ will adversely impact their profits and ridership.

Cab users

The majority of the cab trips are made for work purposes (74 per cent) followed by medical and recreational reasons,

If BS-4 and older cabs are banned in the LEZ area, substantial number of users may switch to sustainable modes (32 per cent). About 19 per cent have claimed that they will reduce the number of trips to LEZ area. Interestingly 29 per cent have claimed that this will not have significant impact on their choices.

Cab users have expressed concerns around unfair fares, delays and cancellations.

Goods service providers

This segment is a more complex mix of vehicles - -around 83 per cent of the sample are light-duty commercial vehicles (LDVs), followed by 17 per cent medium-duty commercial vehicles (MDVs). As heavy duty vehicles are not allowed during the day this sub-segment is missing in the sample.

About 29 per cent of LDV operators believe that there will not be much impact on them if older vehicles are banned. About 25 per cent have stated that they will seek to operate outside the LEZ area. About 33 per cent of LDV operators stated that they will continue to operate and 13 per cent stated that they will shift to electric vehicles. MDV operators were divided between no impact and will be ready to pay if a ban is implemented.

If access fees are implemented, as many as 67 per cent of the LDV operators would pay. About 25 per cent will discontinue their services. Amongst MDV operators, 60 per cent will discontinue their services.

About 46 per cent of LDV operators and 13 per cent of MDV operators have claimed they will not upgrade their vehicles yet. About 38 per cent have also indicated that they may procure electric vehicles or already have BS-VI vehicles.

Most MDV operators have asked for financial incentives, such as subsidies, tax breaks, and low-interest loans to help upgrade to compliant vehicles.

Most LDV operators have sought designated areas at LEZ priority to facilitate transfer of goods, support for businesses and vehicle sharing programs.

They have further requested exemption for small businesses and phased implementation of the LEZ restrictions, with ample grace period to either switch their vehicles, or for choosing new business areas. Infrastructure development was highlighted as a priority, by MDV operators.

Perception of public transport (metro and bus) users

As LEZ implementation will require massive increase in public transport ridership, it is necessary to understand the perception of the public transport users. This can provide the feedback on the further improvement needed in public transport connectivity to meet the new demand.

A significant portion of user of buses (30 per cent) and metro (39 per cent) consider cost-effectiveness a major factor for using public transport. Similarly, 27 per cent

of bus and metro users consider public transport to be faster than other modes. Implementing an LEZ might push more people to use public transport due to potential restrictions or increased costs associated with private vehicle usage in the zone. With more people are likely to opt for public transport, there could be an increased demand for buses and metro services with extensive route coverage.

About 37 per cent of bus users and 51 per cent of metro users stated that they use E-rickshaw to commute to the LEZ area. A significant portion (47 per cent) of bus users walk and 22 per cent of metro users use walking as an alternative mode. This suggests that improved pedestrian infrastructure could further encourage walking and usage of public transport.

The implementation of LEZ in the heritage area is likely to lead to a shift in commuter behaviour towards increased use of public transport and non-motorized modes like walking and cycling. To maximize the benefits and address current challenges, it is crucial to improve last-mile connectivity, enhance pedestrian infrastructure, integrate multi-modal transport solutions, and promote non-motorized transport.

Auto-rickshaws are used by 27 per cent of respondents (11 per cent of bus users and 30 per cent of metro users), indicating a significant dependence on this mode for short first-mile/last-mile trips within the LEZ area, especially by metro users. Cabs are not used for accessing public transport by any of the respondents. Cars and two-wheelers are less commonly used. Bicycles do not appear as an option for last mile connectivity.

Almost all public transport users consider poor access, unreliable service and overcrowding to be serious concern.

LEZ can create opportunity for fleet electrification

Currently the number of electric vehicles (EVs) intercepted in the sample is very small – about 43 that includes cars and two-wheelers. Most of them are used for work trips. Majority of e-two-wheeler users and e-car users charge their vehicles at the origin of travel (home charging). Some e-car users also go for top up charging in during the trip. Travel distances are less than 10 km.

About 100 per cent of the commercial e-two wheelers are used for delivery purpose and e-cabs are for passenger services. There is a strong expectations regarding the fiscal incentive to scale up these segments.

Willingness to pay if access charges are introduced to enter LEZ

A willingness-to-pay survey was carried out to understand what is the most acceptable access fee that can be considered for older or non-compliant vehicles to enter LEZs. All users were asked to indicate the maximum that they are willing to pay emceeing which they will either replace their vehicles or shift to public transport.

The maximum access fee for each segment that allows 90 per cent compliance varies across vehicle segments. And the average that works out based on all the responses indicatively shows lower level of compliance possible.

When the commuters indicate the maximum cost that they are willing to pay to access LEZ, is called the critical cost. This is dependent on their respective economic capacity and travel budget to meet the current journey cost.

However, based on these critical costs derived for different commuter groups and vehicle segments, policy makers derive the compliance costs to work out the access fees. Any value of cost will have different compliance rates that will have to be generalised for a population of commuters and not according to the individual choices. For example, the willingness to pay survey in Pink city of Jaipur shows that Rs. 80 is the cost that only 10 per cent two wheeler commuters can pay to enter an LEZ area. In other words, at Rs 80, about 90 per cent compliance among commuters is expected.

Two-wheelers: The willingness to pay survey shows that for two-wheeler commuters, 90 per cent compliance is expected at an access fee of Rs 200 to Rs 350.

The average cost that the daily two-wheeler users are willing to incur indicates that they can pay Rs 178 to enter the LEZ.

Cars: Among the daily car commuters, 90 per cent compliance is expected beyond Rs 600. No absolute numbers could be achieved through the analysis. The average cost(Rs 227) is much lower than the cost required for a more stringent implementation.

Auto-rickshaw users: The results show that 90 per cent compliance can be expected at Rs 430 for auto users. The average cost auto user can pay is Rs 213 which has compliance of 45 per cent.

Cab users: The results show that 90 per cent compliance can be expected at Rs 545 for cab users. The average cost a cab user can pay is Rs 315, at which 59 per cent compliance can be expected.

Goods operators: The average critical cost that the goods operators can pay is Rs 327, at which 46 per cent compliance is expected.

The 90 per cent confidence interval at this price is beyond Rs 700. An absolute number or interval could not be achieved through the analysis.

The way forward

LEZ is an important enabler to connect policies with ground implementation of mobility and electrification strategies. Several mobility and fleet electrification policies have evolved but these require an integrated and aligned approach to transform the urban spaces. This strategy has direct bearing on the commuters and communities in targeted zones.

While solutions related to technology, transportation and design are possible, their adoption within given socio economic context is challenging. As its effectiveness depend on the wider acceptance by the community it is necessary to understand the disproportionate impacts on different socio-economic groups to identify the appropriate mitigation and support action.

The assessment brings out that potentially LEZ can influence technology and commuting choices – but this will have to be enabled at individual and community levels.

Harsher restrictions including an outright ban on entry of older vehicle technologies can have stronger impacts on choices as such measures do not provide options. But this may be more politically difficult to push through. This may also be the cause of public resistance jeopardizing the entire strategy. As the city of Jaipur may not be ready for the

There is also a sizeable inelastic section among the personal vehicle users who despite the harsher measures on entry and exit from the LEZ may continue to stay on with their vehicle usage and also resist change. This requires community-oriented inclusive strategies.

Take steps

Identify key strategies that require city-wide implementation to precede the LEZ implementation: Identification of common strategies for city wide implementation to cover all wards and neighbourhoods is necessary to enable LEZ approach. As the city is already mandated to phase out old vehicles that needs to be fully implemented. Alongside, reform and scale up public transport strategy for intensification of bus and metro service and well-designed last mile connectivity. Moreover, as per the Jodhpur High Court order proof of parking is to be implemented across the city. This needs to be done along with the implementation of parking management are plans and variable parking pricing across all wards and neigbourhoods. Augment and implement the city-wide electric vehicle policy and programme along with the charging infrastructure.

Delineation of area for implementation of LEZ: The Nagar Nigam, Heritage Jaipur (Municipal corporation) may identify the ward-wise zones that can implement LEZ. To lead the process, it is possible to identify the heritage area of Pink City-Jaipur that has several locational advantages to start the LEZ programme.

The study area falls under the jurisdiction of Nagar Nigam, Heritage Jaipur (Municipal corporation). The Nagar Nigam, Heritage Jaipur (Municipal corporation) may delineate the area for implementation of LEZ along with the parking management area plan.

Notify LEZ policy and regulatory framework for implementation: It is necessary to frame and notify the LEZ policy along with the strategy for implementation. This needs to outline the guidance framework for the implementing agencies.

Phase in LEZ implementation for the targeted zone:

- **Phase 1**: All area management plans need to converge for implementation. Combine implementation of the parking management area plans (PMAP) along with variable parking pricing policy across all neighbourhoods of the zone; initiate pedestrianization of key commercial areas; introduce access based charges for entry of pre-BSIV vehicles; ban BS I and BS 2 vehicles; make entry of electric vehicles free, charge a nominal entry fee for BSVI vehicles that may increase after BSVII vehicles come into effect. Eliminate end-of-life vehicles from the zone. Simultaneously, enhance public transport services and accessibility of the zone.

- **Phase 2**: In the second phase while all the provisions of the phase one will continue, the strategy will be ramped up by restricting pre-BS-IV vehicles. Introduce more direct fiscal and non-fiscal incentives for promoting electric vehicles and apply polluter pay principle. Scale up electric vehicle charging infrastructure in the zone.

Addressing differentiated impacts on income groups: Moderate to high economic impacts on different income groups are expected in personal vehicle segments. This is particularly so in the policy scenario one that aims to ban entry of pre-BSIV vehicles, scale up electric vehicle requirements to be in the zone and encourage use of public transport.

It is evident from the survey that the economically vulnerable groups like old people, small income self-employed categories may require some fiscal support for the shifts to cleaner technology.

The overall assumption for the general category of owners of personal vehicles is that they need to move to public transport for primary trips and mobilise their own investments if purchase of new vehicles is required. However, a targeted and purposeful fiscal incentive can be considered if old vehicles are encouraged to be replaced with electric vehicles.

Commercial vehicle need interest subvention, fiscal incentives - co-join with fiscal incentive for electric vehicles

Recalibrate the policies for fleet renewal, scrappage and electric vehicles to incentivize the special efforts in LEZ and support lower income groups: Already the state government and the city government are mandated to implement the old vehicle phase out, vehicle scrappage policy, and electric vehicle policy. These schemes can be designed to include special incentives for the lower income categories for targeted electrification of the fleet that can be leveraged for the LEZ areas.

Creation of dedicated funds for local area development: Dedicated fund from parking management area plans and the access fees to enter the LEZ can help to fund the cost of transition, and the fiscal strategy to help people to tide over to adjust to the LEZ requirements.

Earmark revenue for local area improvement and to regenerate infrastructure, connectivity and improve the service levels.

Augment public transport accessibility and service level of LEZ: This needs to be supported by enhance safe walking and cycling access in the targeted zone.

Public campaigns and awareness on the benefits of LEZ will be a critical entry point.

The advantage of the LEZ approach is that it can integrate multiple strategies to achieve both vehicle technology transformation and mobility transition. This can combine fleet renewal for quicker adoption of clean, energy efficient, and zero emissions electric vehicles. At the same time it can enable scalable, integrated, connected and reliable public transport system and services; upscaled network of walking and cycling infrastructure and efficient last mile connectivity; reduce automobility; promote compact urban form to keep jobs and home close; reduce distances, demand for travel and vehicle usage; improve infrastructure for sustainable mobility; integrate the needs of urban poor and vulnerable groups and improve liveability of neighbourhoods.

SECTION 1: Towards low-emission zones in Jaipur

Implementation of low emissions zones (LEZ) will be a critical strategy to combine technology and mobility pathways for an accelerated adoption of clean and zero emissions vehicles and sustainable mobility options community-wide.

The initiation of LEZ policies needs strategic planning to avoid disruption, and sensitivity to reduce disproportionate impact on the lower income groups to be affected by LEZ.

An ideal LEZ pilot area should be a locale where existing conditions favour the establishment of an LEZ, thereby enhancing the probability of its effectiveness.

The assessment of the potential application of LEZ in Jaipur has been carried out from this perspective.

Rationale for identifying heritage area/old city area for LEZ impact assessment

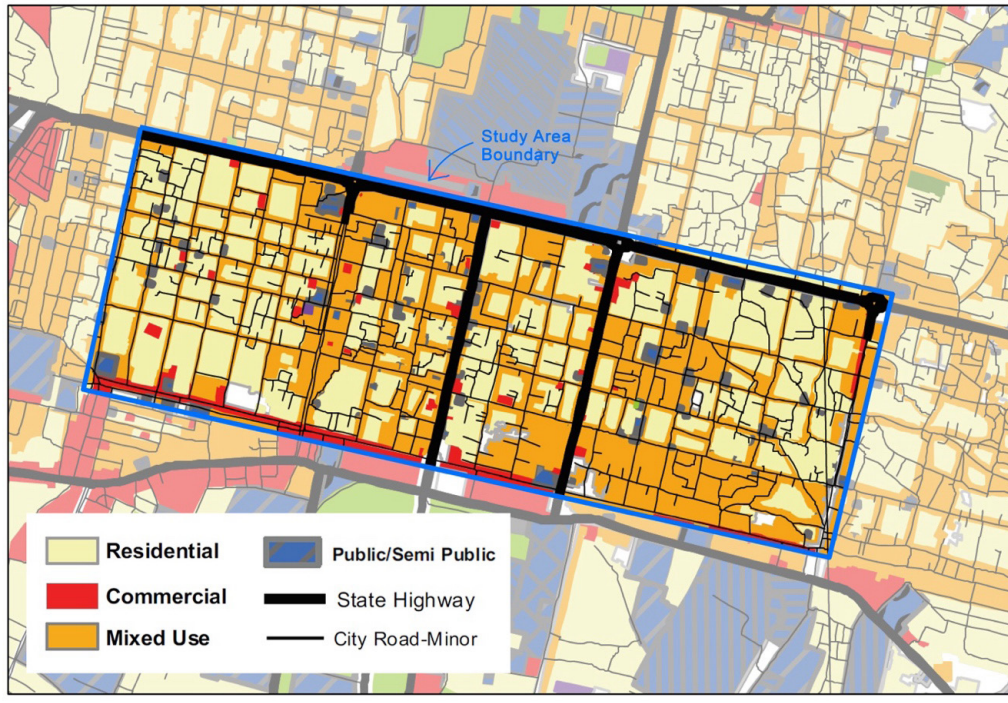
The heritage area of Pink City which is the old city area and has been declared as a UNESCO World Heritage site, is one of the most visited part of the city. Major commercial areas and market places are located here. Its heritage value also draws high share of tourist traffic. This city core is also under huge traffic pressure and the quality of life is deteriorating due to congestion and vehicular emissions. Given the heritage and commercial importance of this area, high density development, and good connectivity, this area is suitable for piloting LEZ implementation.

Understanding the study areas in Jaipur

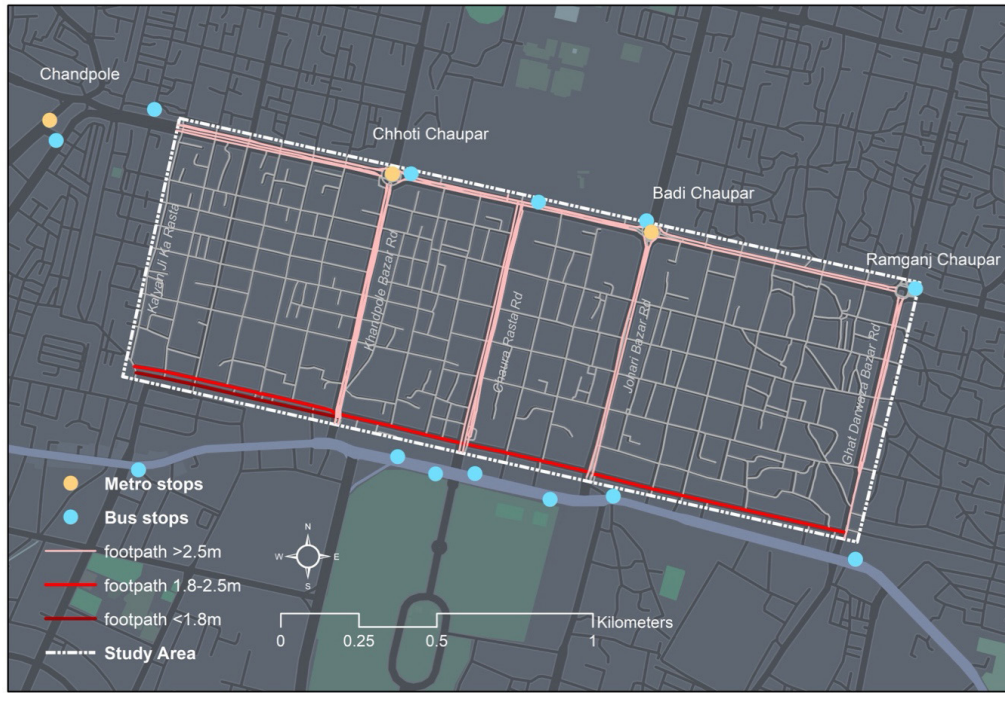
Three blocks in the old city area are taken as study areas. This mixed use area has residential complexes, market areas and offices. The area is surrounded by Galta Road in the north periphery, Sanjay Bazaar Road in the south, Kalyanji ka rasta in the west and Ghat Darwaza Bazaar Road in the east. Metro stations are located on the Galta road including Badi Chaupar and Choti Chaupar metro stations. Buses do not ply on Galta road or any of the internal roads of the study area. The buses ply on Agra Road which is parallel to the study area on the south. Kalyanji ka rasta, Khandpole Bazaar Road, Chaura rasta road, Johri bazaar road and Ghat Darwaza Bazaar Road are other major roads in the study area.

Map 1: Study (Heritage) area for the potential of developing LEZ in Jaipur and Distribution of road network within study area

Map 2: Distribution of existing land use and land cover pattern in Jaipur



Map 4: Distribution of footpath network in the study area Locations of various transport facilities (including IPT stops, on-street and off-street parking) within the study area.



Kalyanji ka rasta, Khandpole Bazaar Road, Chaura rasta road, Johri bazaar road and Ghat Darwaza Bazaar Road are other major roads in the study area. These are the only roads that have a shaded pedestrian walkway which also act as a shop frontage. The internal roads are narrow around four meters with drains on both sides and no footpaths. Map 7(Public Transport Coverage) shows that around 70-75 per cent area in the study area have good coverage requiring five minute walk to the Public transport modes (Metro and bus stations).

Map 7: Public transport coverage (via roads) within the study area

SECTION 2: Methodology for impact assessment

Assessment of impacts of mobility interventions, require a comprehensive understanding of various factors which govern the individual mode choices. It is necessary to understand the travel-related factors (i.e., Origin-destination, trip purpose, trip frequency, choice of modes, vehicle ownership etc.); socio-economic and demographic factors (i.e., sex, age, employment status, education level, income level etc.) and psychological factors (i.e., moral obligation towards environment related issues, political orientation and perception of the stringency of the intervention of different socio economic groups that come to this area.

LEZ interventions primarily restrict the usage of polluting vehicles. It is assumed that all the electric vehicle and Bharat Stage-6 (BS-6) vehicle user and operators will not be affected by the LEZ interventions. All non-compliant vehicle users or operators operating within this study area will be impacted. Thus, Survey questionnaire was designed for all user/ operator groups including two-wheelers, cars, autos, goods carriers among others to capture their perception about the LEZ interventions.

Additionally, user perception survey was also conducted to include those social groups who use public transport (PT) or intermediate public transport (IPT) services for daily commute and those who operate electric vehicles including two-wheeler, car and autos, within the proposed LEZ area. These surveys were conducted to understand the present challenges and opportunities of these modes and what more can be done to promote clean and sustainable options.

Developing scenarios for the assessment

Impact assessment was carried out on the basis of two scenarios, firstly, complete ban on the entry of the non-compliant vehicles in the study (LEZ) area and secondly, limited access of non-compliant vehicles within the LEZ area with penalty provisions. Survey questionnaire was framed for each scenario to test and capture the response of different user or operator groups. Brief summary of both the scenarios are provided below:

Policy scenario 1: This scenario assumes non-compliant vehicles are those, which do not meet the BS-VI emission standards or are not electric vehicles. These

need to be completely prohibited from entering the proposed LEZ area. If non-compliant, a heavy penalty needs to be imposed on the defaulters. The penalty amount will be kept higher to ensure absolute compliance.

This scenario will test the readiness of the vehicle owners or operators (in case of auto and goods carriage) to switch to LEZ compliant vehicles or opt for alternative modes of transport and evaluate the economic and operational impact on those who rely on non-compliant vehicles for their daily operations or commute.

Policy scenario 2 – access charge to enter LEZ with non-compliant vehicles: Under this scenario, non-compliant vehicles are allowed entry into the LEZ, but at a financial cost or by paying access charge. This fee-based approach is designed to gradually incentivize vehicle owners to transition to cleaner alternatives. The fee to enter the LEZ will be substantially lower than the penalty in case of scenario one .
This scenario will help gauge the elasticity of demand for entry into the LEZ and identify a critical cost threshold, which could inform the optimal pricing strategies for LEZ implementation without causing undue hardship to the stakeholders, and ensuring policy justice to all groups.

Surveys and data collection

Impact assessment is done based on the results received from primary surveys. All the surveys were conducted through the questionnaire survey method where responses of all the stakeholders were captured on a set of previously decided questions. The samples were collected using Stratified Random Sampling method, where the samples were divided into some selected stakeholder groups or strata and then a random sampling technique was used to collect the required number of samples from each group. To ensure geographical spread, NDMC area was divided into eight zones, based on neighbourhood boundaries and almost equal number of survey samples were collected from each zone. Map

Broadly two types of surveys were conducted; firstly, to understand the impact of LEZ interventions on non-compliant vehicle users or operators. The second types of survey were conducted to capture the perception of existing PT/ IPT users, and also electric vehicle users (both private and commercial two-wheeler and car users and auto users).

Non-compliant vehicle owner/ operator survey: Under this category five different stakeholder groups were identified which includes private two-wheelers, private cars, auto operators, cab operators and freight service providers and views

Map 5: Zonal map for collecting data within the study (NDMC) area

were captured to understand and assess the impact of both LEZ scenarios. The main aim of this group of surveys was to analyse the maximum amount (critical cost) people will be willing to pay to enter the LEZ after which they will shift to a cleaner mode of transport.

Around 573 samples were collected from different stakeholder groups. In all of these surveys, data was collected on the socioeconomic profile of the individual stakeholder to understand their age, gender, income, vehicle ownership details, daily trip dairy, daily cost of travel and what will be their potential behavioural change (according to both scenarios). in case LEZ is introduced and what is that critical cost point above which they will consider shifting from existing mode or altering their travel habits.

To analyse the willingness to pay among different groups, the Gabor-Granger method was used. The Gabor-Granger method is a market research technique used to assess the price sensitivity of consumers and determine the optimal price point for products or services. In the context of LEZ, the service is access to the low-emission zone. In other words, this method enables gauging the different

levels of compliance for entering the LEZ area that can be expected at different fee price points.

Study limitations: Due to lack of data related to actual number of vehicles which enters/ exists the study area on daily basis and their emission standards, actual emission benefits of both the LEZ scenarios were left unaddressed.

SECTION 3: The assessment: key results

All the surveys were administered within the Heritage City of Jaipur. A total of 573 survey samples were collected. This included 267 samples of non-compliant vehicle users/operators and the perception of all vehicle users/ operators. Both the survey samples were collected across three identified sub-zones to ensure geographical coverage.

Stakeholder-wise impact assessment: Non-compliant vehicle user/owner
The main objective of this study is to understand the stakeholder-wise impacts of LEZ implementation on vehicle users whose vehicles are older than BSVI – or non-compliant.

Private two-wheelers

Profile of the two-wheeler users: As much as 98 per cent of two-wheeler (2Ws) users use their vehicle for primary trips which are predominantly work trips (97 per cent of all primary trips). Those using 2Ws for secondary trips are using only for recreational activities like shopping, and social visit.

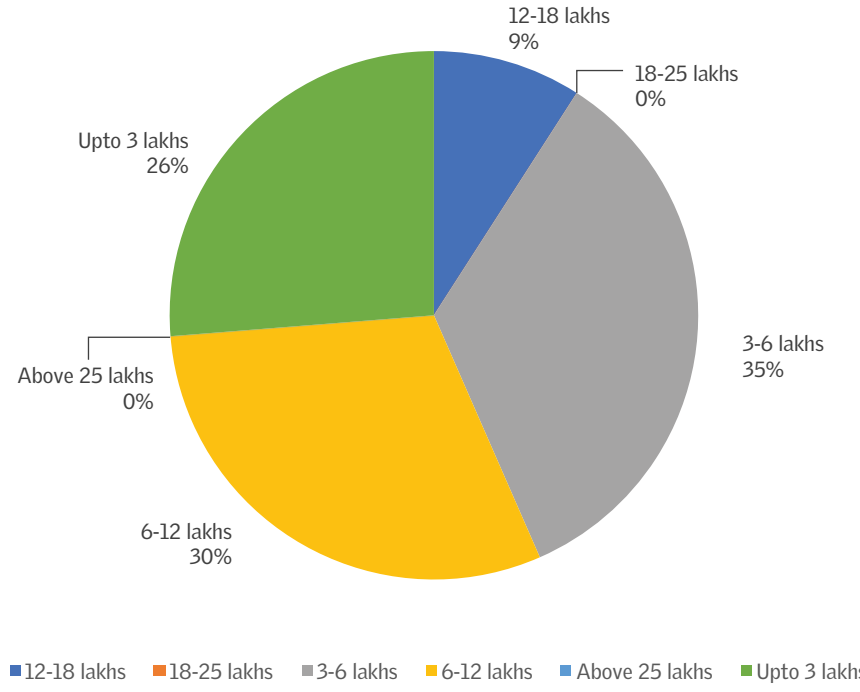
The majority of the primary trips (93 per cent) are made daily, whereas all of the secondary trips take place weekly.

The income distribution pattern reveals that almost 66 per cent of all trips are up to Rs 6 lakhs per annum and 30 per cent earn between Rs 6 to 12 lakhs. 9 per cent of two-wheeler users earn Rs 12–18 lakh (see *Graph 1: Income distribution pattern of two-wheeler users*).

Analysis of the emission profile of non-complaint two-wheeler users reveals that around 23 per cent and 67 per cent of primary-use vehicles with a BS-3 and BS-4 engine type respectively. While 50 per cent of the vehicles in secondary trips have BS-3 and BS-4 engine types each.

Interestingly, 76 per cent of the primary trip users and 100 per cent of secondary trip users of the private two-wheeler group do not pay anything for 2W parking

Graph 1: Income distribution pattern of two-wheeler users



Source: Primary data collected by CSE

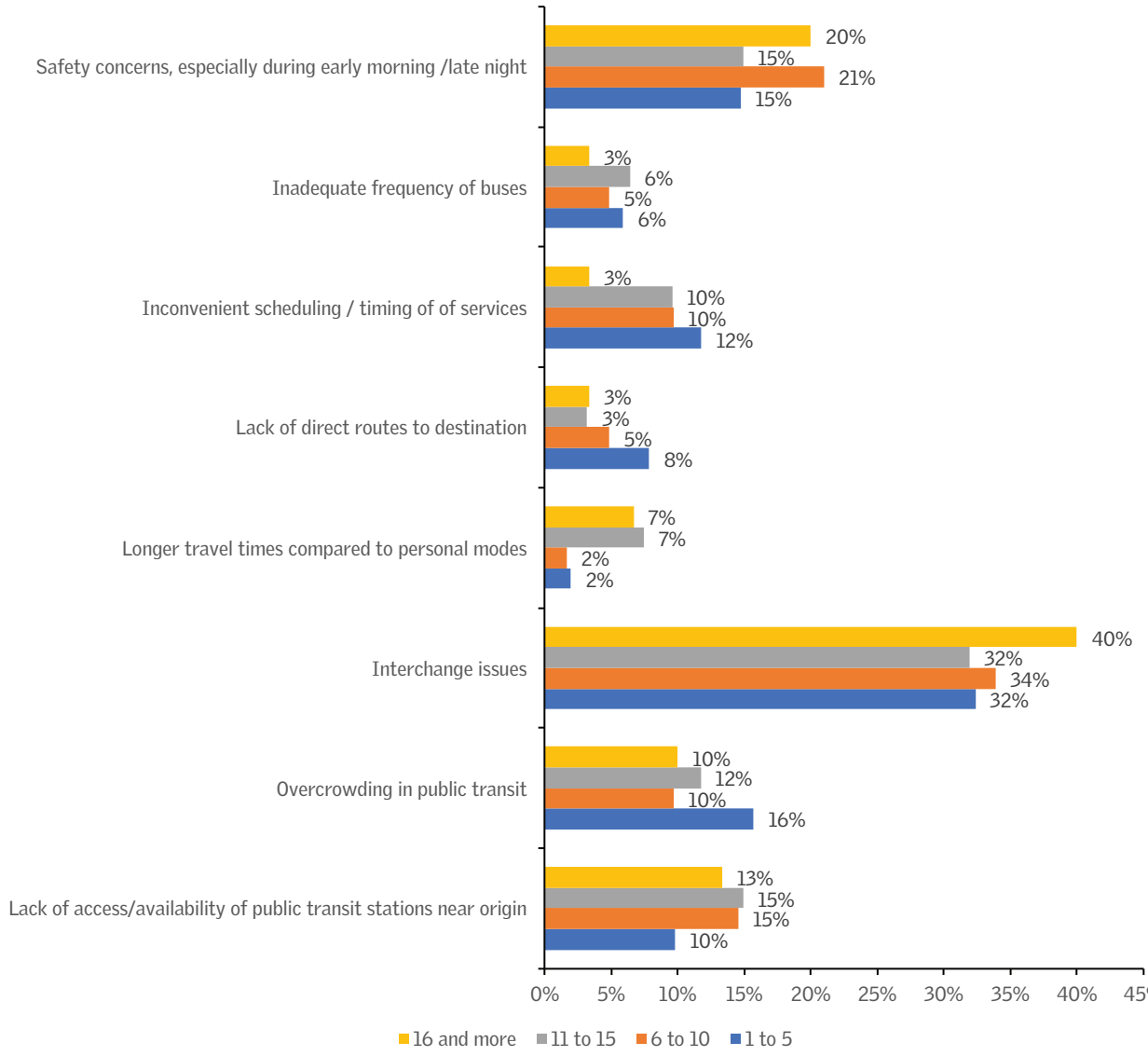
while 22 per cent of the primary trip users pay up to 50 rupees and only one per cent pay Rs 100.

When asked for their preference to use personal two-wheelers over existing public transport facilities, mixed responses were received based on their commuting distance, and these responses are more or less similar for both primary and secondary trip users (see *Graph 2: Ranking of major reasons for not preferring public transport facilities for daily commuting).*).

It is interesting to know that for short as well as long trips, interchange issues are the most stated reasons for not taking public transport. Instead they prefer to use two-wheelers.

The safety concerns were stated as the second most important reason for not using public transport. The third highest reason for not taking public transport is overcrowding in public transport.

Graph 2: Ranking of major reasons for not preferring public transport facilities



Source: Primary data collected by CSE

Impact of scenario 1 – Complete ban on two-wheeler users

In scenario-on a complete ban on all non-compliant 2Ws (i.e., BS-4 and older vehicles) in the LEZ zone and heavy penalty for non-compliance is assumed.

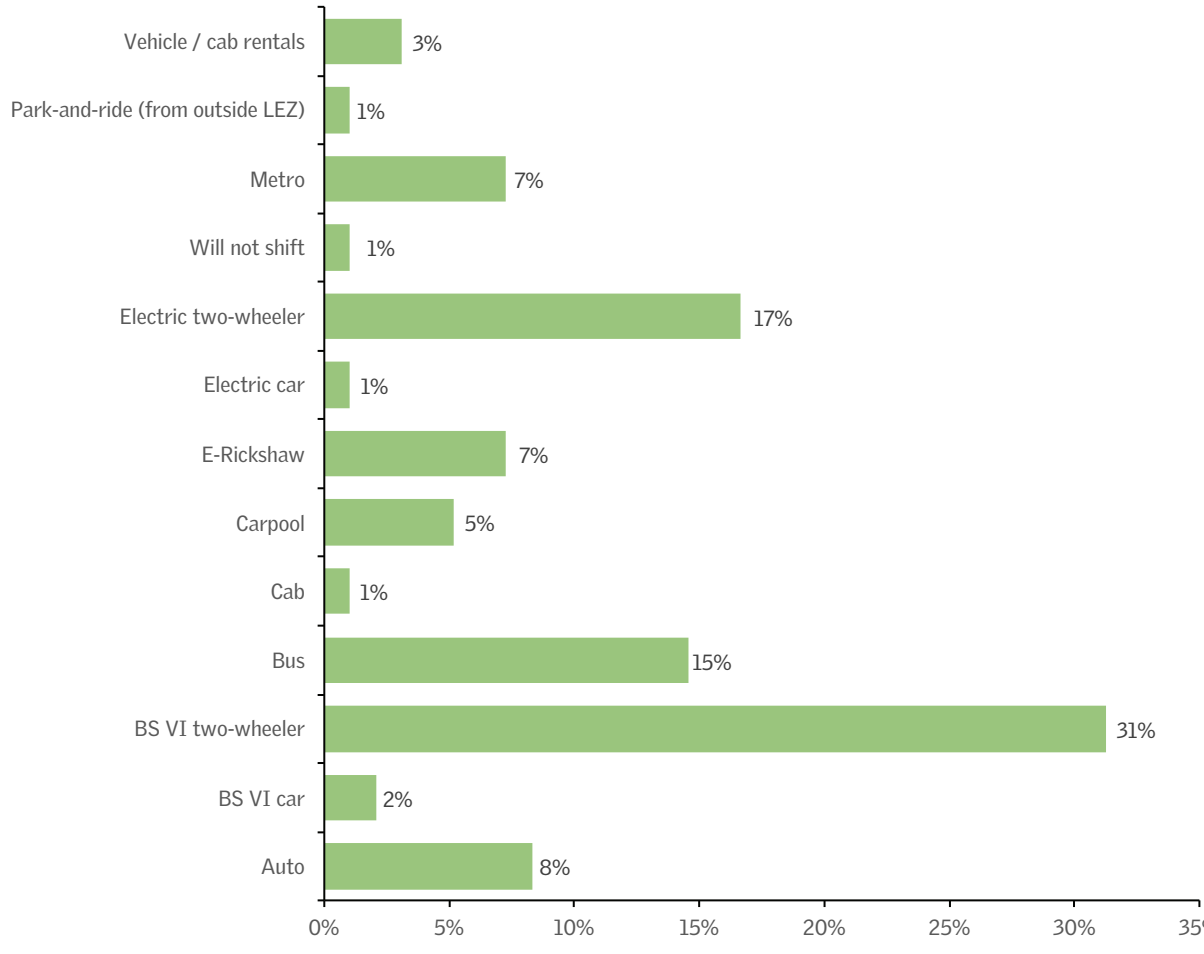
About 50 per cent of the two-wheeler users who make secondary trips stated that they would switch to the metro and buy an electric two-wheeler for commuting

to LEZ. Among the two-wheeler respondents for primary trips, 32 per cent stated that they would switch to a BS-VI two-wheeler. Around 16 per cent stated that they would opt for an electric two-wheeler and 15 per cent stated that they would shift to a bus. Only about one per cent of the primary trip users have shown their reluctance to shift to any other mode than two-wheeler (see *Graph 3: Preferred mode/vehicle choice for travel in scenario-1*).

It is noted that the income group below Rs 3 lakhs will prefer to opt for an electric two-wheeler and BS-6 two-wheeler if there is a ban on non-compliant vehicles.

Under the income category of Rs 3-6 lakhs, 12 per cent have opted to shift modes while the same percentage of people in the Rs 6-12 lakhs have opted for BS-6 two

Graph 3: Preferred mode/vehicle choice for travel in scenario 1



Source: Primary data collected by CSE

Table 1: Income class-wise mode/ vehicle choice in scenario 1 – complete ban

	Upto 3 lakhs	3-6 lakhs	6-12 lakhs	12-18 lakhs
Auto	13%	9%	7%	
BS VI car			3%	11%
BS VI two-wheeler	21%	27%	37%	56%
Bus	4%	33%	7%	
Cab				11%
Carpool		3%	10%	11%
E-Rickshaw	13%	3%	10%	
Electric car			3%	
Electric two-wheeler	33%	9%	13%	11%
No Shift	4%			
Metro	8%	9%	7%	
Park-and-ride (from outside LEZ)		3%		
Vehicle / cab rentals	4%	3%	3%	

1) *' Park and Ride' stands for parking private vehicles on the outskirts of the LEZ and using a compliant vehicle/service to enter the LEZ; 2) Percentages are representing the share within each subgroup.
Source: Primary data collected by CSE

wheeler category. In the income category of Rs 12-18 lakhs, highest percentage of people have opted for shifting to BS-6 two wheeler category (see *Table 1: Income class-wise mode/ vehicle choice in scenario 1 – complete ban*).

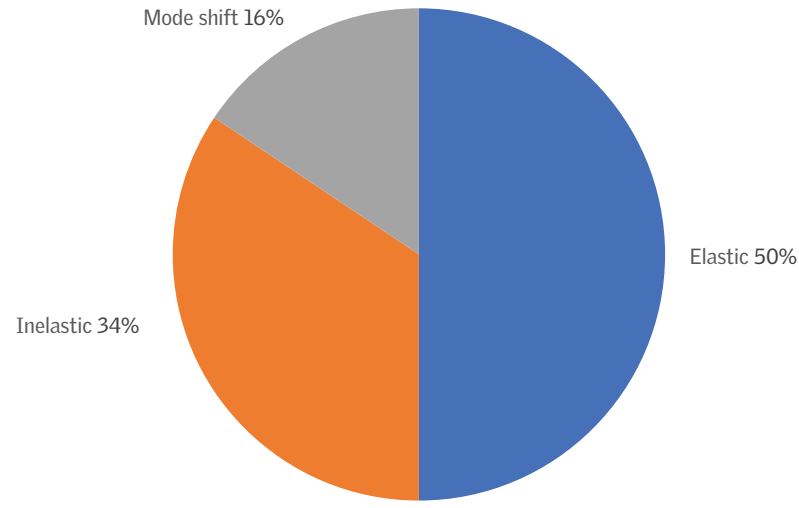
Impact on two-wheeler users due to scenario 2: Access Charge to enter LEZ

In the second scenario in which commuters need to pay a fee to enter the LEZ area, respondents can be divided into three groups. Those with an "elastic demand" who have indicated a maximum fee to enter the LEZ, exceeding which they will shift to another mode; those with "inelastic demand" who will continue to use their current non-compliant private vehicle irrespective of the LEZ charge which they are willing to pay irrespective of the cost; and those who are not willing to pay any charge, and will shift to an LEZ compliant mode as soon as the fee comes into effect.

Around 50 per cent have shown elastic demand whereas 34 per cent have shown inelastic demand. The rest of the commuters will opt for a change in their mode (16 per cent) (see *Graph 4: Impacts of scenario 2 on private two-wheeler user*).

A deeper analysis according to income class reveals that for all income groups, 40 to 58 per cent of private two-wheeler users will prefer to pay in case prices escalate beyond their accepted range. While 30 to 42 per cent of them will be inelastic to the entry fees. But it is interesting to know that 30 per cent of the commuters in

Graph 4: Impacts of scenario 2 on private two-wheeler user



Source: Primary data collected by CSE

Table 2: Income class-wise response of private two-wheeler user in scenario 2

	Upto Rs 3 lakh	Rs 3-6 lakh	Rs 6-12 lakh	Rs 12-18 lakh
Elastic	50%	58%	40%	56%
Inelastic	42%	33%	30%	33%
Mode shift	8%	9%	30%	11%

Source: Primary data collected by CSE

the income range Rs 6 to 12 lakhs, will prefer to shift to a complaint mode (see *Table 2: Income class-wise response of private two-wheeler user in scenario 2*).

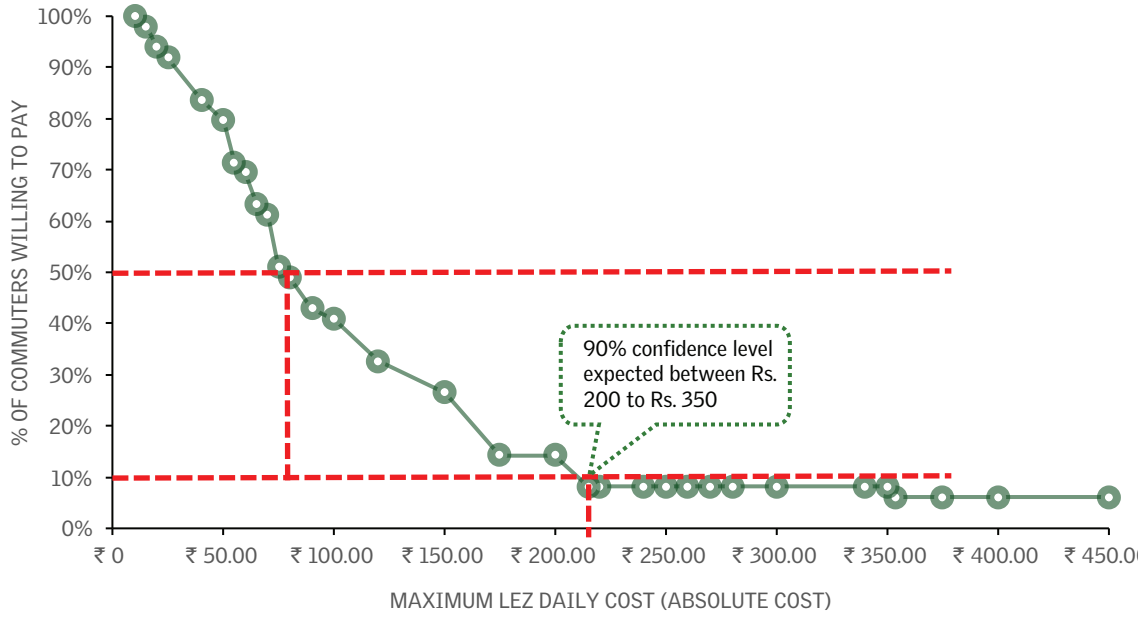
The sample population with elastic demand, that was willing to pay a fee to enter the LEZ were asked their maximum price or the "critical cost" to enter exceeding which they will shift away from their private mode of transport.

The results from the curve-plotted graph from the willingness to pay survey suggest that among daily two-wheeler commuters, a 90 per cent confidence level is expected after Rs 200 (see *Graph 5: Willingness to pay and critical cost or two-wheeler user*). It is interesting to note that 50 per cent of respondents are willing to pay up to Rs. 80 to enter LEZ area.

The average cost that the daily two-wheeler users are willing to incur indicates that they can pay Rs 178 to enter the LEZ.

In the context of low-emission zone pricing, compliance in the Gabor-Granger

Graph 5: Willingness to pay and critical cost or two-wheeler user



Source: Prepared by CSE based on primary data

method can be read as the percentage of the population not agreeing with a particular price point, since it is expected that they are not willing to pay more than that amount. As an example, if only 10 per cent of the sample population agrees with a particular fee amount, 90 per cent compliance is possible.

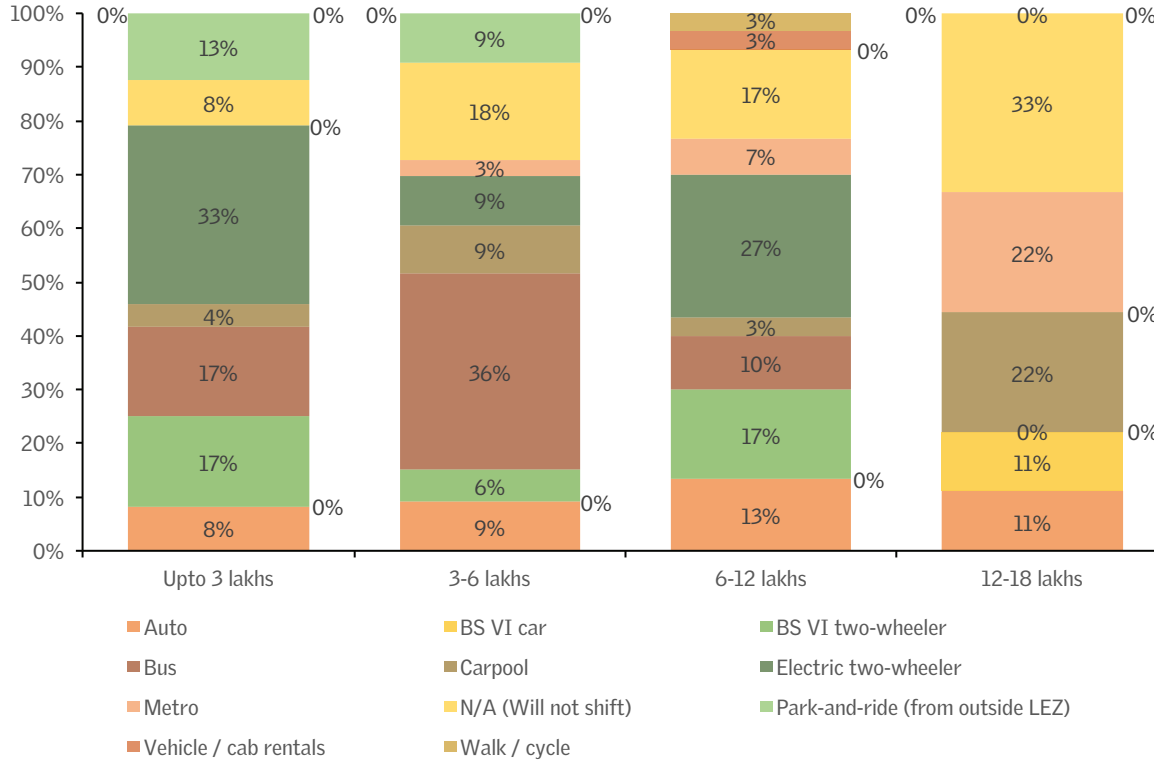
It can be inferred from the analysis of critical cost that the average indicated critical cost is much lower than the cost required for a more stringent implementation (90 per cent compliance).

The respondents who were not willing to pay any fee and were readily willing to shift to another compliant vehicle was asked about their preferred compliant mode.

Lower-income group (up to Rs 3 lakh) tend to prefer bus and BS VI two-wheelers in equal proportion (17 per cent). Interestingly, the income group between Rs 3 to 6 lakhs tend to prefer to shift to bus (36 per cent) and 22 per cent to metro in case of entry fees (see *Graph 6: Preferred mode /vehicle choice for travel in scenario 2*).

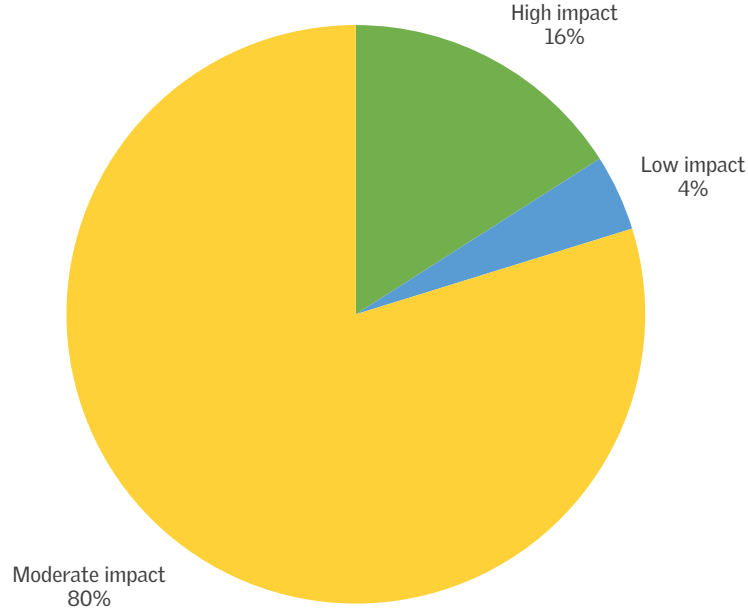
It is interesting to know that 80 per cent of the two-wheeler users said that entry fees would impact them moderately while 16 per cent stated that the impact would be high. Only 4 per cent thought oy would have low impact (see *Graph 7: Type of impact on two-wheeler user in scenario 2*).

Graph 6: Preferred mode/vehicle choice for travel in scenario 2



Source: Primary data collected by CSE

Graph 7: Type of impact on two-wheeler users in scenario 2



Source: Primary data collected by CSE

Responses of private cars users

Profile of car users: As much as 93 per cent of car users use their vehicle for their primary trips. Out of all trips made by car 85 per cent took this trip for work purposes. The second highest purpose-based trip was made for recreational visits which is 7 per cent. The majority of the car trips are made (80 per cent) daily.

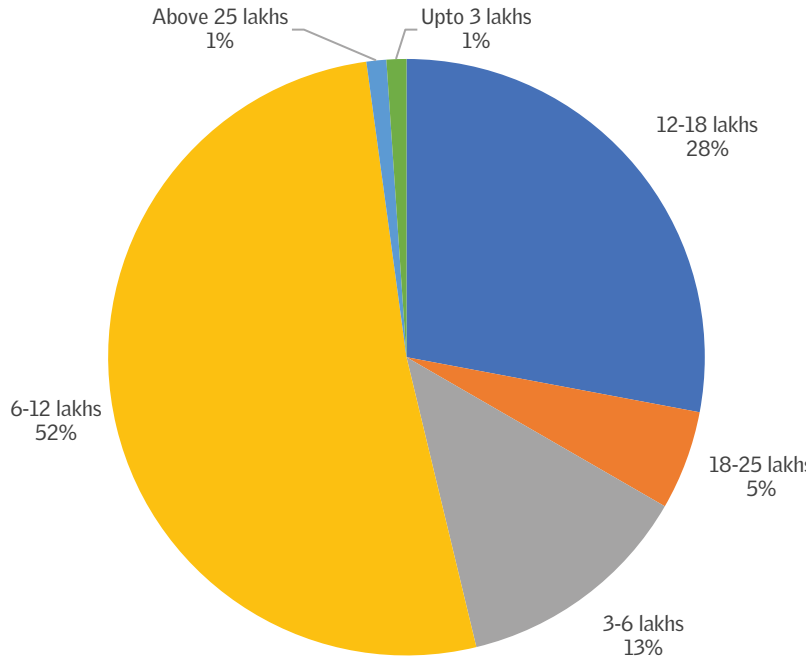
The income distribution pattern reveals that almost 47 per cent of all the car users earn between Rs 6 and 12 lakhs per annum; 25 per cent of all the car users are in Rs 3 and 6 lakhs bracket and 17 per cent in Rs 12 and 18 lakhs category. (see *Graph 8: Income distribution pattern of two-wheeler users*).

Analysis of the emission profile of non-compliant car users reveals that around 61 per cent of respondents use BS-4 vehicles and 29 per cent BS-3. About 8 per cent are unsure about their engine type.

About 36 per cent of car users do not pay anything for parking while 46 per cent pay parking fee up to 100 rupees cumulatively for the entire journey.

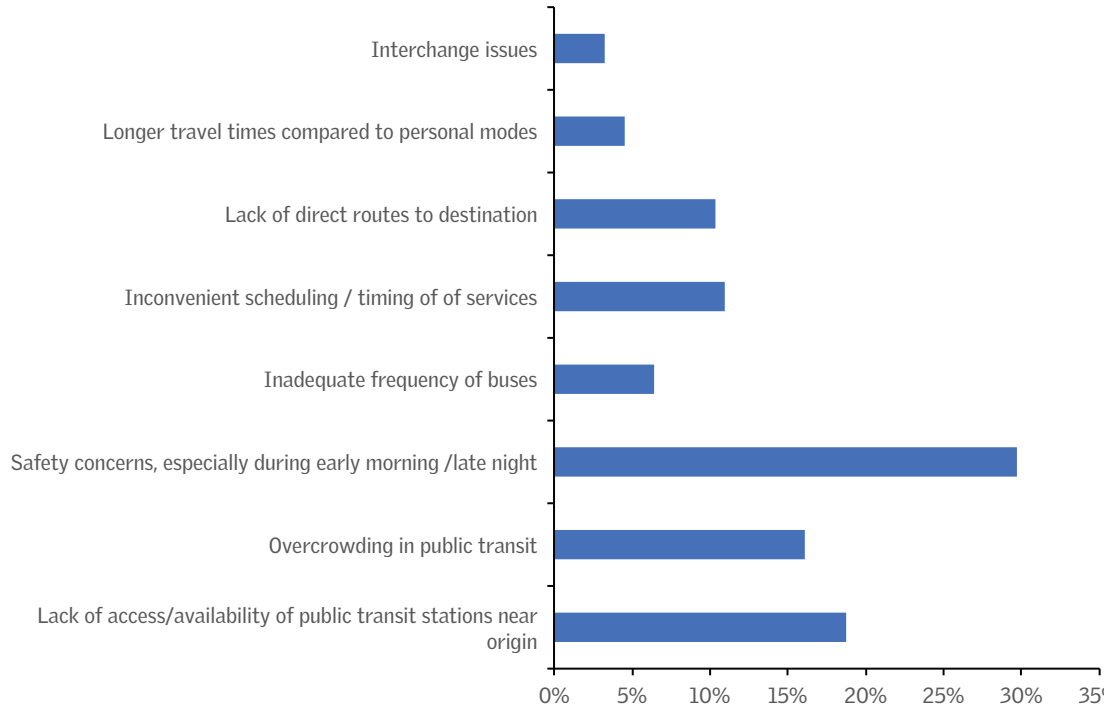
Most of the reasons cited for not using public transport include safety concerns, inconvenient scheduling and unreliable service, lack of access, overcrowding

Graph 8: Income distribution pattern of two-wheeler users



Source: Primary data collected by CSE

Graph 9: Ranking of major reasons for not preferring public transport facilities



Source: Primary data collected by CSE

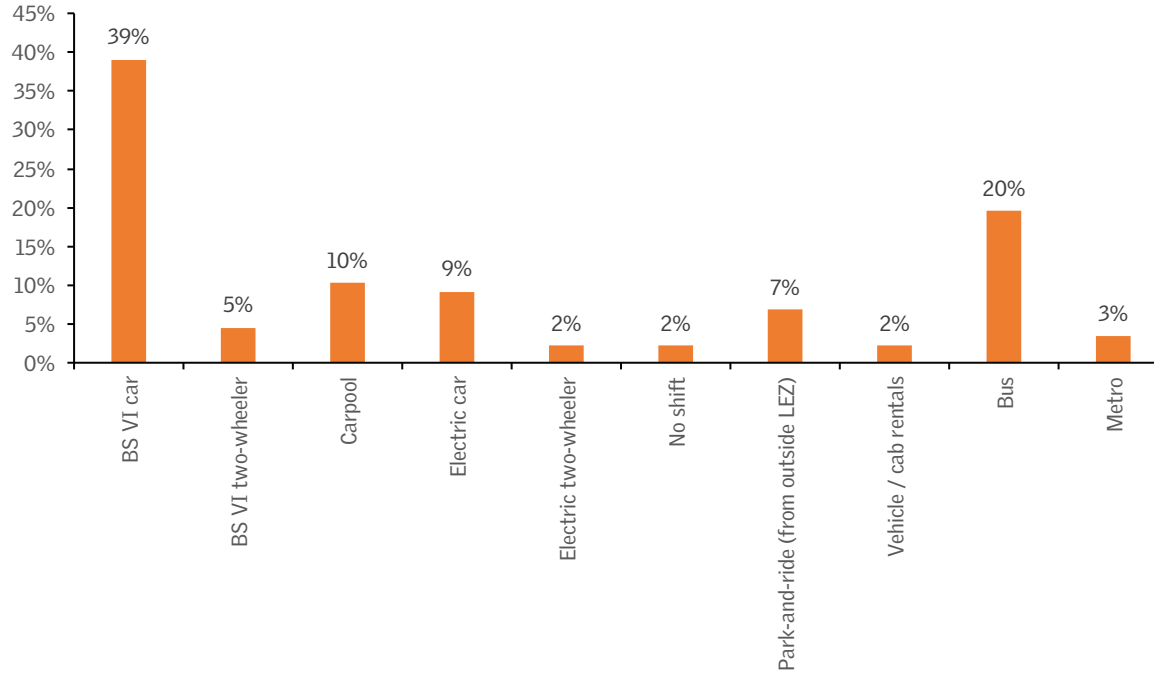
among others. This is common for both primary and secondary trips. (see *Graph 9: Ranking of major reasons for not preferring public transport facilities*).

Impact of complete ban on car users

In the scenario of complete ban and high penalty, about 39 per cent of the primary trip car users will stick to a car (BS-6) after the ban, with 20 per cent indicating a preference to shift to a bus and 10 per cent would like to carpool (see *Graph 10: Preferred mode/ vehicle choice for travel in scenario 1*).

Further analysing these choices based on income levels reveals that across all income groups, car owners want to continue with cars, more likely a BS-6 car than an electric one. All respondents in the low-income group up to Rs 3 lakh per annum preferred to opt for park and ride from outside LEZ area. The second highest choice under each income group is to shift to bus. It is interesting to note that 50 per cent of all respondents in the income group above 25 lakhs will prefer a car. The other 50 per cent will opt to buy electric cars (see *Table 3: Income-class-wise mode/vehicle choice in scenario 1*).

Graph 10: Preferred mode/ vehicle choice for travel in scenario 1



Source: Primary data collected by CSE

Table 3: Income class-wise mode/ vehicle choice in Scenario 1

	Upto 3 lakhs	3-6 lakhs	6-12 lakhs	12-18 lakhs	18-25 lakhs	Above 25 lakhs
BS VI car		32%	52%	40%	27%	
BS VI two-wheeler			6%	7%	9%	
Bus		32%	12%	13%	18%	50%
Carpool		16%	9%	7%	9%	
Electric car		8%	9%	13%		50%
Electric two-wheeler				7%	9%	
No shift				7%	9%	
Metro		4%	3%		9%	
Park-and-ride (from outside LEZ)	100%	8%	9%	7%	9%	
Vehicle / cab rentals						

1) *'Park and Ride' stands for parking private vehicles on the outskirts of the LEZ and using a compliant vehicle / service to enter the LEZ; 2) Percentages are representing the share within each subgroup.

Source: Primary data collected by CSE

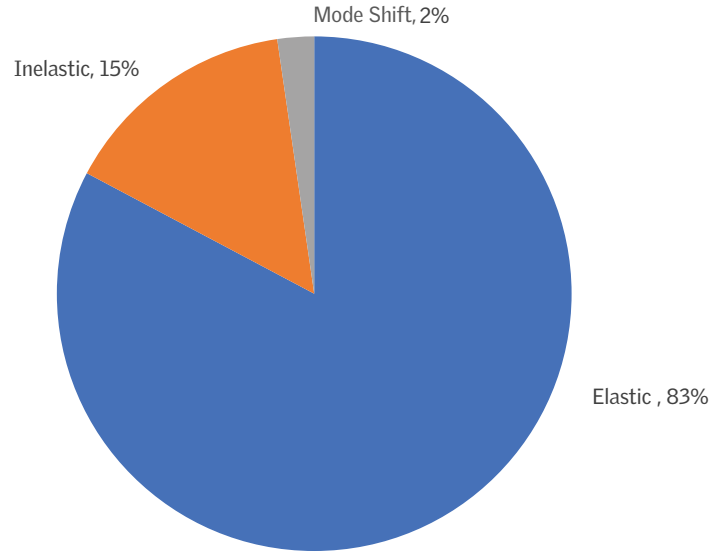
Impact of access fees on car owners

Similar to two-wheeler samples, car owners in the second scenario are divided into three groups. Those with an "elastic demand" who have indicated a maximum fee to enter the LEZ exceeding which they will shift to another mode; those with 'inelastic demand' who will continue to use their current non-compliant private vehicle irrespective of the LEZ charge which they are willing to pay irrespective of the cost; and those who are not willing to pay any charge, and will shift to an LEZ compliant mode as soon as the fee comes into effect.

Among frequent commuters, 83 per cent have shown elastic demand whereas 15 per cent have shown inelastic demand. The rest of the commuters will opt for a change in their mode (see *Graph 11: Impacts of scenario 2 on car users*).

Interestingly, unlike in the case of two-wheelers, car owners show greater preference to continue with their private vehicles across the income groups. Both low- and high-income groups display stronger resistance against mode change. Therefore, pricing strategies must be carefully considered to effectively influence travel behaviour of car users (see *Table 4: Income class-wise response of private two-wheeler users in scenario 2*).

Graph 11: Impacts of scenario 2 on car users



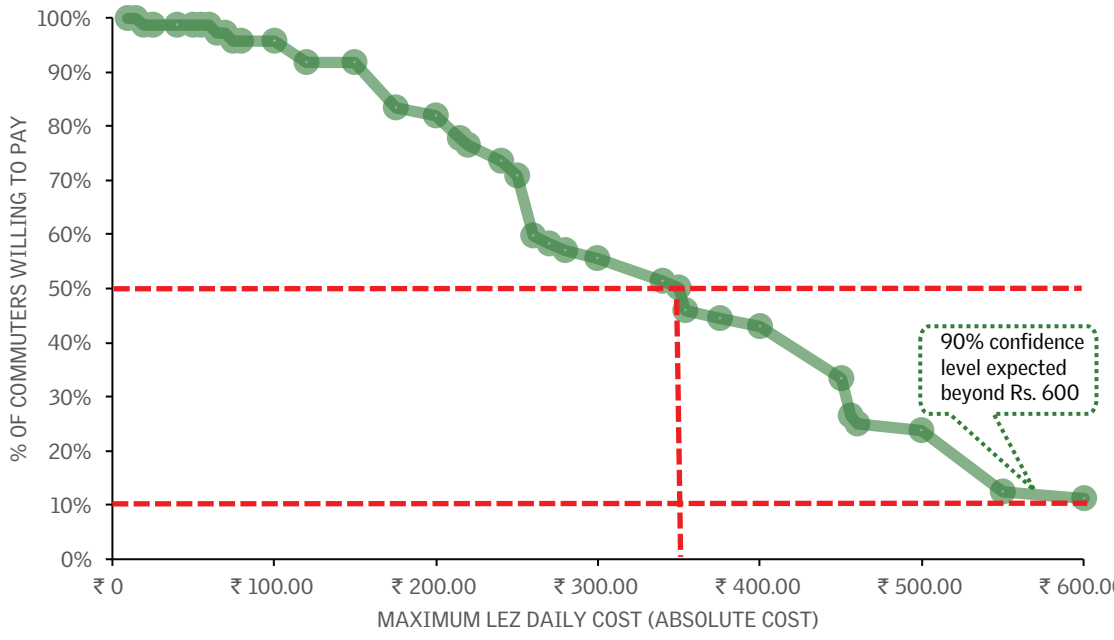
Source: Primary data collected by CSE

Table 4: Income class-wise response of private two-wheeler user in scenario 2

	Upto 3 lakhs	3-6 lakhs	6-12 lakhs	12-18 lakhs	18-25 lakhs	Above 25 lakhs
Elastic	100%	82%	80%	80%	100%	100%
Inelastic		9%	20%	20%		
Mode Shift		9%				

Source: Primary data collected by CSE

Graph 12: Critical cost analysis of car users



Source: Primary data collected by CSE

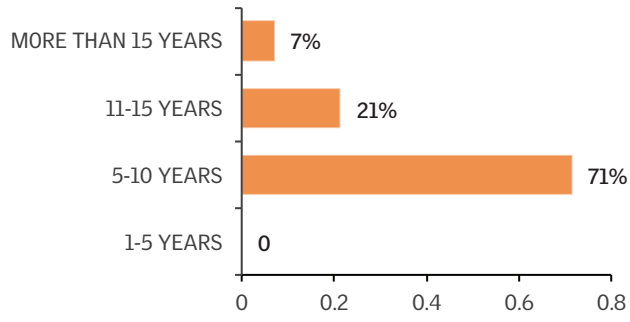
As much as 90 per cent confidence level is beyond Rs. 600. It is important to note that none of the respondents stated that they are willing to pay more than Rs. 600. However, from the graph, it can be inferred that the high number of the respondents are willing to pay up to Rs. 100 and 50 per cent of respondents are willing to pay upto Rs. 350(see *Graph 12: Critical cost analysis of car users*).

In the context of low-emission zone pricing, compliance in the Gabor-Granger method can be read as the percentage of the population not agreeing with a particular price point. For example, if only 10 per cent of the sample population agrees with a particular fee amount, 90 per cent compliance is possible. The average indicated critical cost is much higher than the cost required for a more stringent implementation (90 per cent compliance).

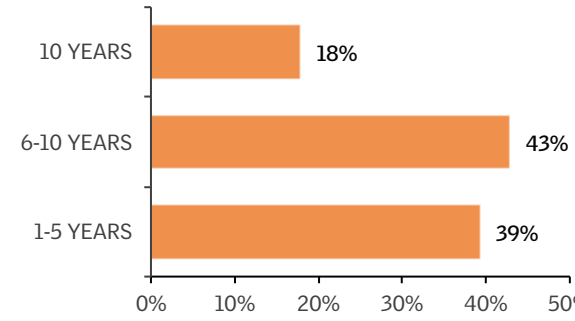
Responses of auto drivers

Profile of auto drivers: Around 64 per cent of auto drivers own their vehicles, and the rest operate rented autos. About 59 per cent of the respondents operate BS IV vehicles; 23 per cent BS III vehicles; and 18 per cent BS II vehicles. There is no clear differentiation in ownership of BS-III and BS-II autos. Around 71 per cent of the respondents are operating vehicles older than eight years.

Graph 13: Age of Vehicle(Auto users)



Graph 14: Years of service(Auto Users)



Source: Primary data collected by CSE

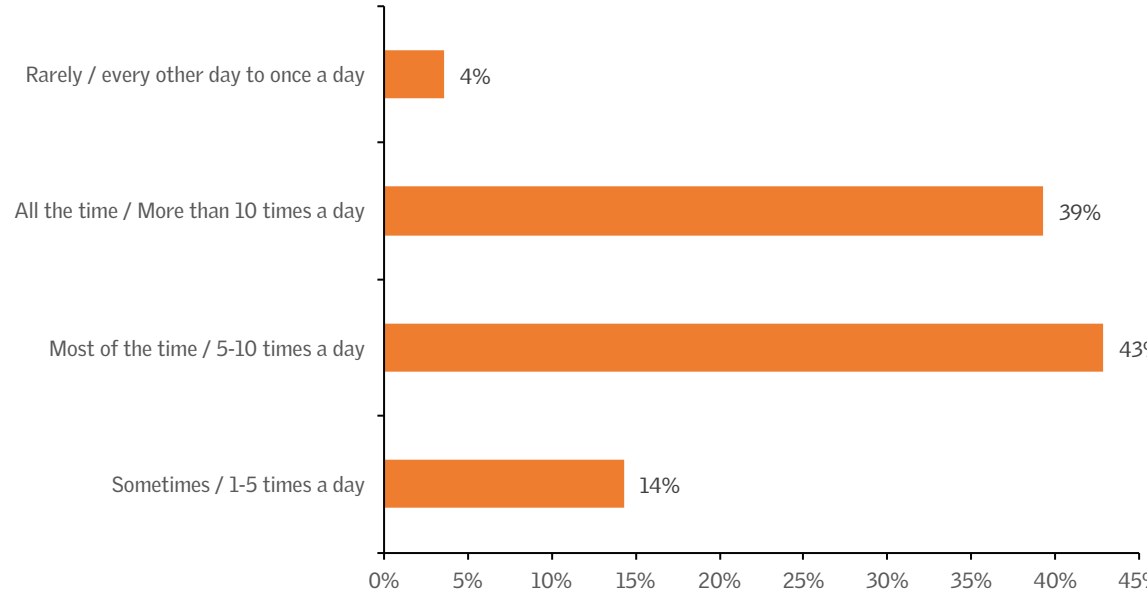
The majority (43 per cent of auto drivers) have been driving autos for more than six (6) years and 39 per cent of auto drivers have been driving auto for 5 years (see *Graph 13: Age of Vehicle(Auto users)* and *Graph 14: Years of service(Auto Users)*).

About 43 per cent of auto drivers serve more than 5 trips in a day and 39 per cent serve more than 10 trips per day (see *Graph 15: Service frequency graph in LEZ area(Auto Users)*).

Across the sample, the operational hours extend between early morning (5 AM) until late night (11 PM). However, the peak operational hours in most cases fall between 8 AM in the morning and 10 PM in the evening (see *Graph 16: Observed auto operations hour within LEZ area*).

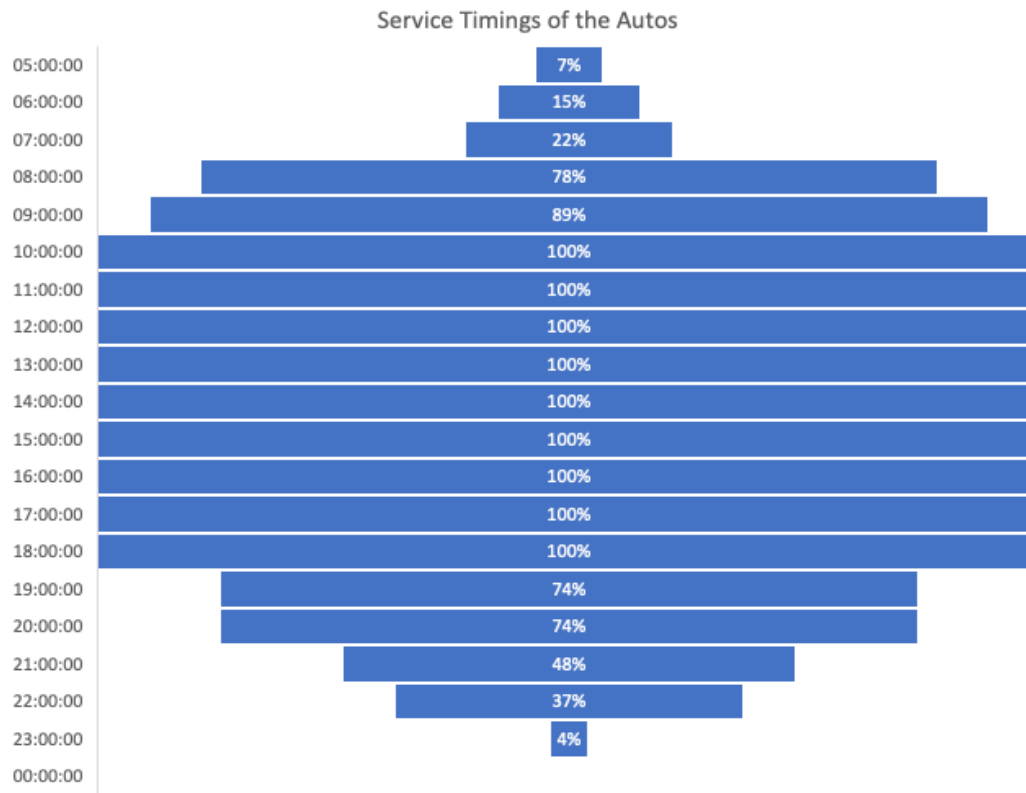
The gross daily earnings of most drivers range between Rs 550 to Rs 1,400 with a median value of Rs 900. Their daily fuel cost ranges between Rs 300 to Rs 600 with a median value of Rs 450. The maintenance cost can be anywhere between Rs 100 to Rs 2,000 per month. The average spending on maintenance is around Rs 1400 per month (see *Graph 17: Financials of auto operations*).

Graph 15: Service Frequency graph in LEZ area(Auto Users)



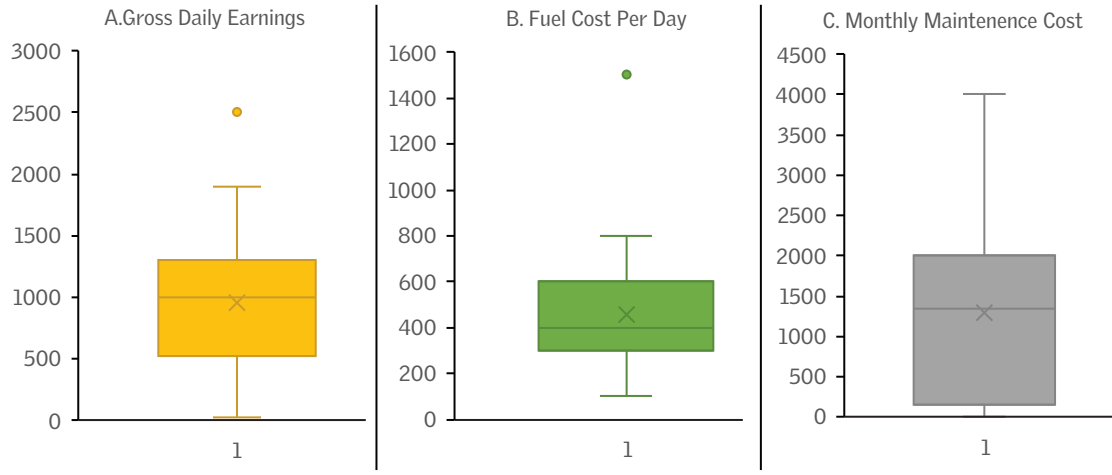
Source: Primary data collected by CSE

Graph 16: Observed auto operations within LEZ area



Source: Primary data collected by CSE

Graph 17: Financials of auto operations



Note: The above representations are box and whisker plots. Box and whisker is used to see the spread of the data. The line splitting the box in two is the median; the dots are outliers in the data; the cross marks the mean value of the data; the vertical lines above and below the box represent the upper and lower limits of the data; and the lines and the box together with the median line divide the data into four quartiles.

Source: Primary data collected by CSE

Impact of complete ban and high penalty on auto drivers

If BS-4 or older vehicles are banned, around 64 per cent of drivers claim they will upgrade their vehicles to compliant modes(Upgrade to EV: 24 per cent; Upgrade to BS VI 40 per cent), while the other 36 per cent will stick to their present vehicle and simply stop their services within LEZ area.

The auto drivers(36 per cent) who have decided not to get a new vehicle are concerned about the financial burden to cate to the requirements of the LEZ operations. Others claim that they can pay the amount to enter the LEZ area.

Among the 64 per cent of drivers willing to get a complaint vehicle, 40 per cent are willing to opt for BS-VI vehicles, and the remaining 24 per cent have indicated a preference for an electric auto.

Few drivers are willing to buy a BS-VI vehicles (65.4 per cent) and have justified this based on pollution reduction.

At the same time, drivers opting for an electric auto have indicated that they need the government to provide them subsidy to buy an electric auto.

Impact of access fee on auto drivers

For the purpose of this study, it was assumed that access fee on IPT vehicles will result in a "cost pass through" – it will be paid by the consumers. Therefore, the IPT users and not drivers have been asked about the critical cost of shift or the extra amount they are willing to pay over the existing fare to enter.

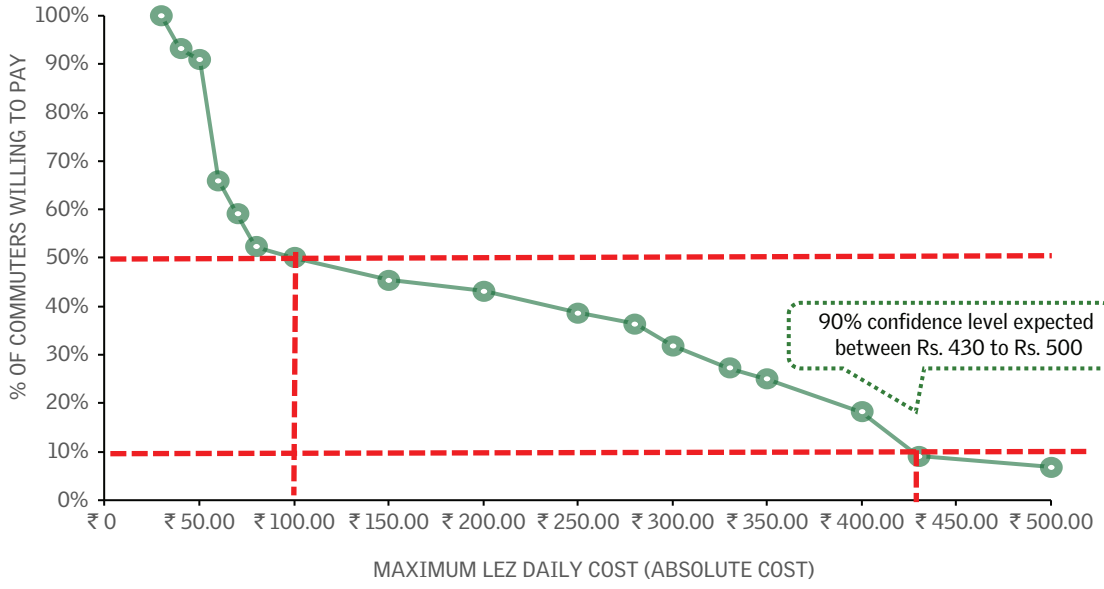
As much as 90 per cent confidence level is between Rs 430 and Rs.500. However, the graph shows that 50% of the respondents are willing to pay Rs.100 (see *Graph 18: Stated critical and mean cost for auto drivers*).

About 44 per cent of auto drivers feel that the LEZ will have an impact on their profits due to the rise in operating costs. And 26 per cent have concerns regarding a decrease in their regular ridership due to the additional costs for the passengers (see *Graph 19: LEZ implementation impact on ridership and profit of auto drivers*).

Around 64 per cent of auto drivers have been shown interest in upgrading their vehicles to compliant vehicles in case an access fee (see *Graph 20: Support needed(as stated by auto riders) during the implementation of LEZ*).

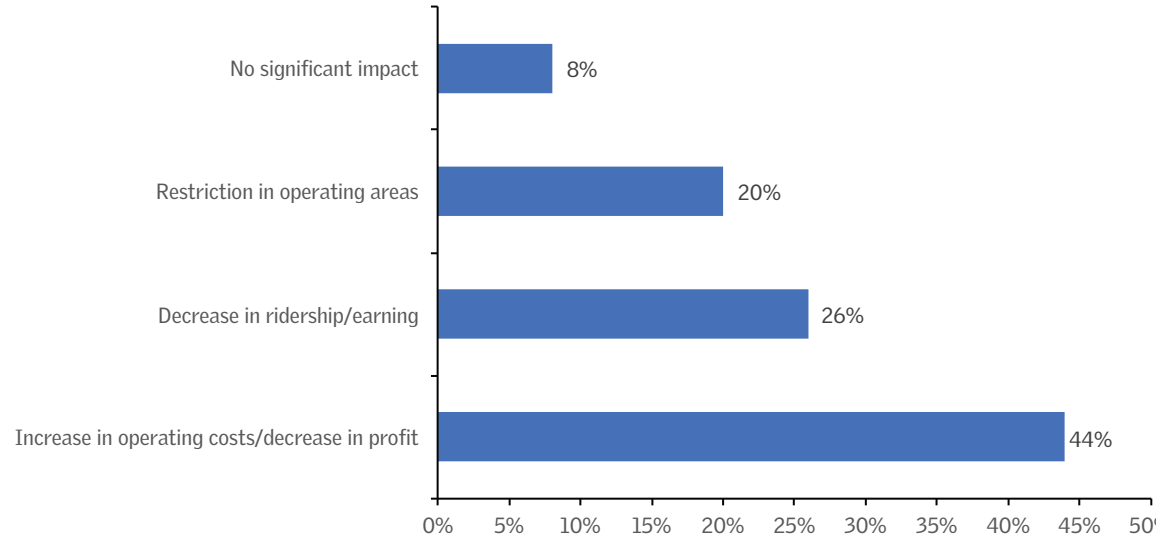
Around 40 per cent of auto drivers claimed that they need financial subsidies for vehicle upgrades. 30 per cent claimed that the leasing arrangements for getting compliant vehicles will be required and a fair scrappage policy will help to upgrade to compliant vehicles.

Graph 18: Stated critical and mean cost for auto drivers



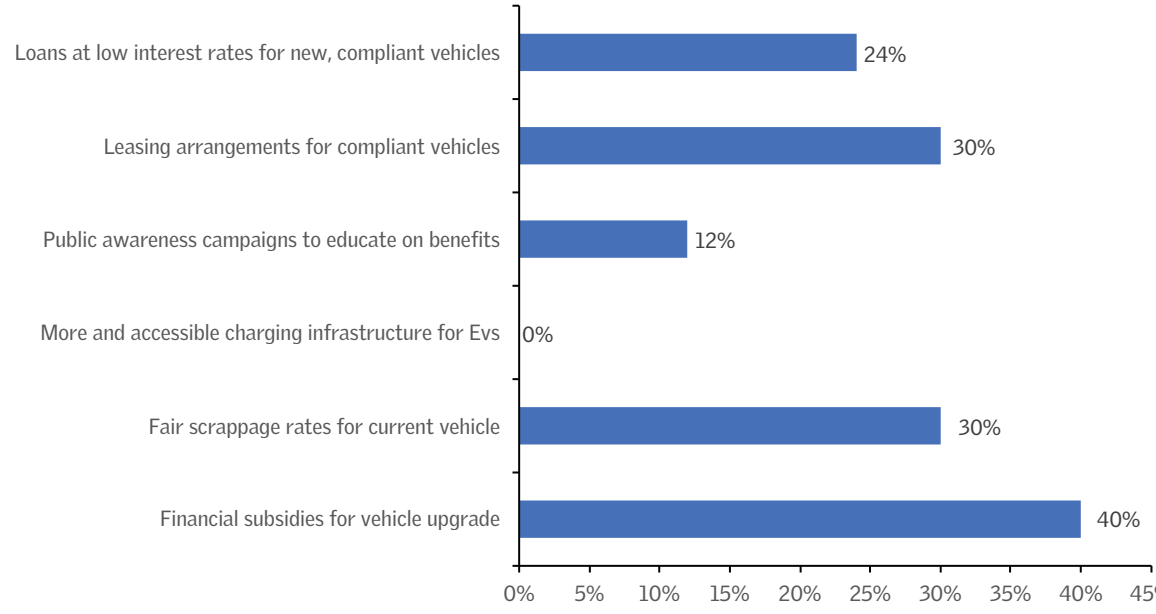
Source: Primary data collected by CSE

Graph 19: LEZ implementation impact on ridership and profit of auto drivers



Source: Primary data collected by CSE

Graph 20: Support needed(as stated by auto riders) during the implementation of LEZ

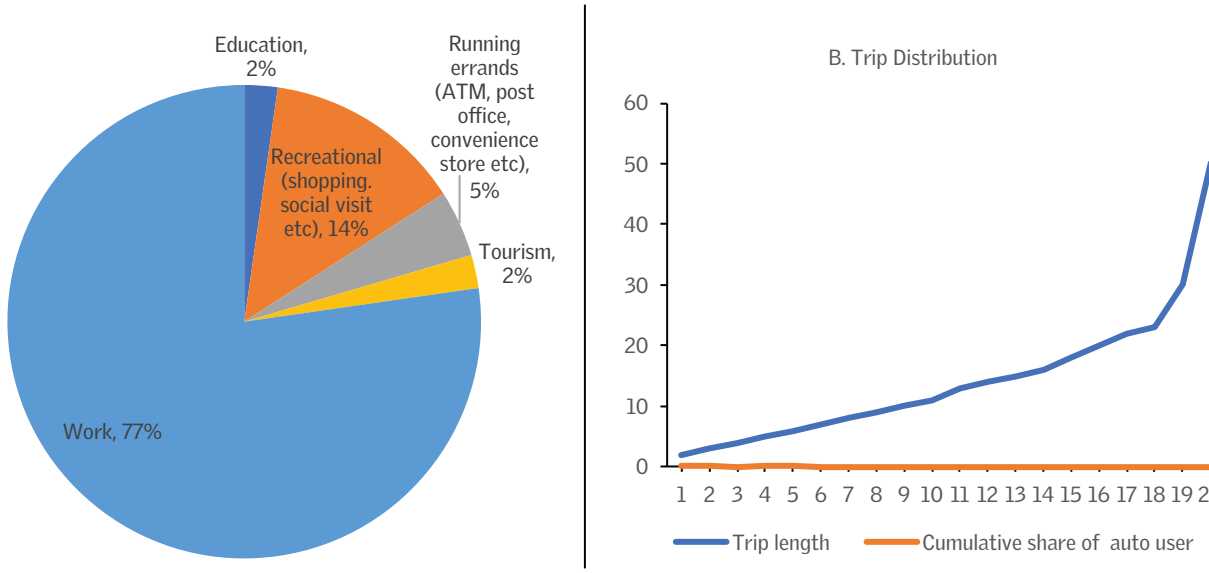


Source: Primary data collected by CSE

Responses of Auto users

Profile of auto users: The gender distribution of auto users is dominated by the male population at 89 per cent. Around 77 per cent of auto users are taking autos for work purposes, followed by recreation (14 per cent). Around 5 per cent of the trips are made for running errands and 2 per cent for education and Tourism. The shortest trip length of 2 km and the longest trip length of 50 km is made by only 2 per cent each. Half of the trips i.e. 50 per cent are short trips of up to 7 km.

Graph 21: Trip purpose and trip distribution of three-wheeler users



Source: Primary data collected by CSE

Impact of complete ban on auto users

If BS-4 or older auto-rickshaws are banned in the LEZ area, 27 per cent of the users have claimed that this will not have any impact; about 27 per cent have claimed that they will reduce their number of trips; and the same percentage of users have opted for sustainable modes. About 14 per cent have claimed that they will choose to shift to compliant auto-rickshaws (see *Table 5: Indirect impact of ban on three-wheeler user*).

Since it has been assumed that access fee will be passed on to the consumer in its entirety, a price elasticity curve of demand was created for auto users visiting the LEZ area using the Gabor-Granger method. The demand curve plots the maximum price amount that the commuters are willing to pay to enter, against the share of commuters.

Table 5: Indirect impact of ban on three-wheeler user

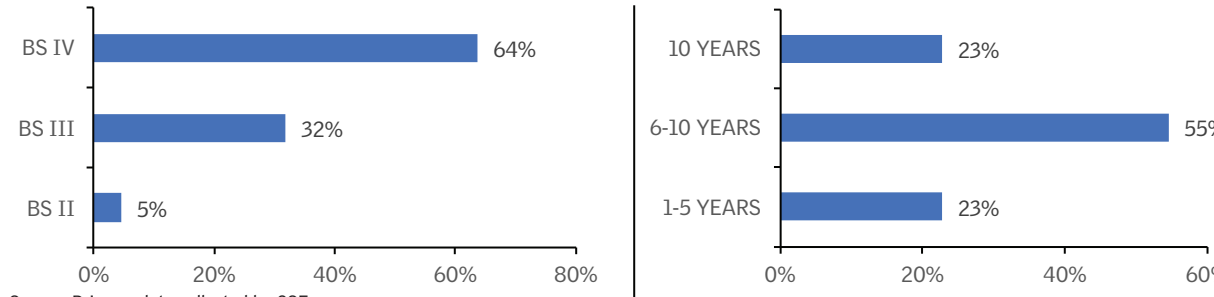
Type of impact	Percentage of Auto user
No significant impact	27%
Use compliant IPT vehicles	5%
Reduce number of trips to LEZ	27%
Shift to private modes (compliant)	14%
Switch to sustainable modes	27%

Source: Primary data collected by CSE

Response of cab drivers

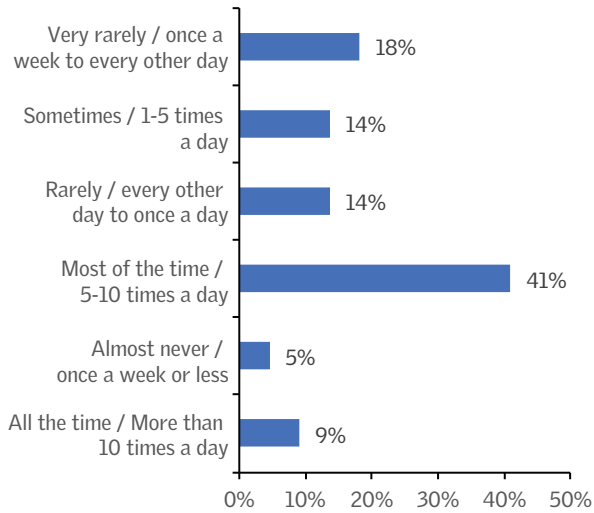
Profile of cab drivers: Around only 46 per cent of cab drivers own their vehicles, and the rest(55 per cent) operate rented cabs. The majority of the respondents (64 per cent) are currently driving BS-4 cabs and around 36 per cent of the sample are operating vehicles older than eight years.

Graph 22: Percentage of cabs under each emission norm and years of service

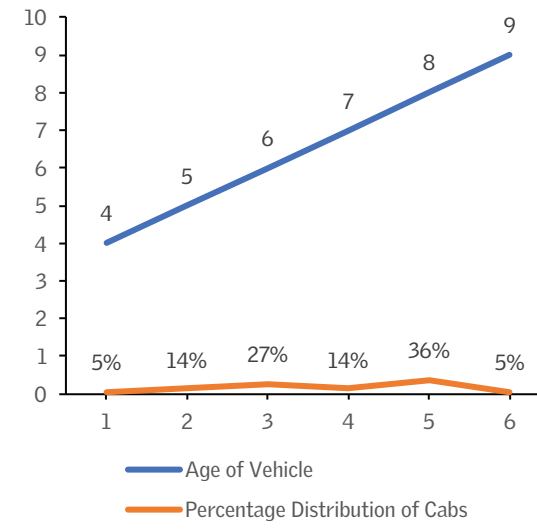


Source: Primary data collected by CSE

Graph 23: Graph representing service frequency of the cab drivers in the study area

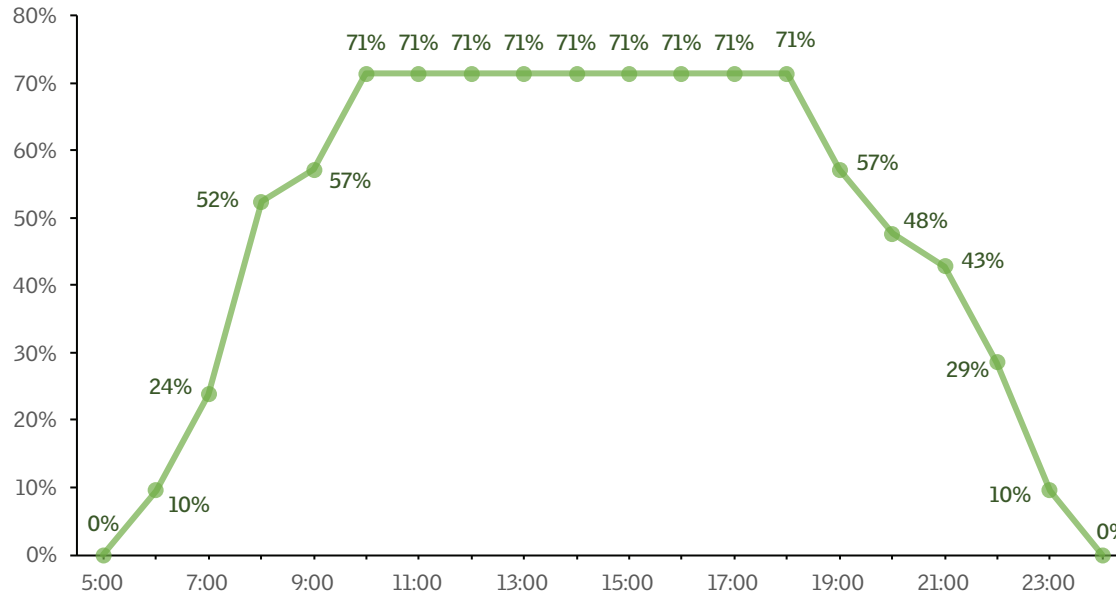


Graph 24: Age of vehicle



Source: Primary data collected by CSE

Graph 25: Graph representing the percentage distribution of service timings of the cab drivers in the study area



Source: Primary data collected by CSE

The majority (55 per cent of cab drivers) have been driving cabs for more than six (6) years. About 79 per cent of cab drivers can more than 5 trips in a day.

The operational hours extend between early morning (7 AM) until late night (11 PM), however, the peak operational hours are 8 AM and 8 PM. (see *Graph 25: Observed auto operations hour within LEZ area*).

The gross daily earnings of most drivers range between Rs1200 to Rs 3,000 with a median value of Rs 2,000. The daily fuel cost of most cab drivers ranges between Rs 600 to Rs 1,200 with a median value of Rs900. The maintenance cost can be anywhere between Rs100 to Rs 4,000 per month (see *Graph 26: Financials of cab drivers*).

Graph 26: Financials of cab drivers

Note: The above representations are box and whisker plots. Box and whisker is used to see the spread of the data. The line splitting the box in two is the median; the dots are outliers in the data; the cross marks the mean value of the data; the vertical lines above and below the box represent the upper and lower limits of the data; and the lines and the box together with the median line divide the data into four quartiles.

Source: Primary data collected by CSE

Impact of complete ban on cab drivers

In an event of complete ban on BS-4 and older vehicles, around 45 per cent of drivers claim that they will upgrade their vehicles to compliant modes and 55 per cent have claimed that they will not upgrade and stop operating in the LEZ area.

Among the 50 per cent drivers willing to get a compliant vehicle, 31 per cent have opted for BS 6 while 14 per cent have opted for electric vehicle.

Majority drivers will not upgrade or stop operating in LEZ area and have not indicated the reasons.

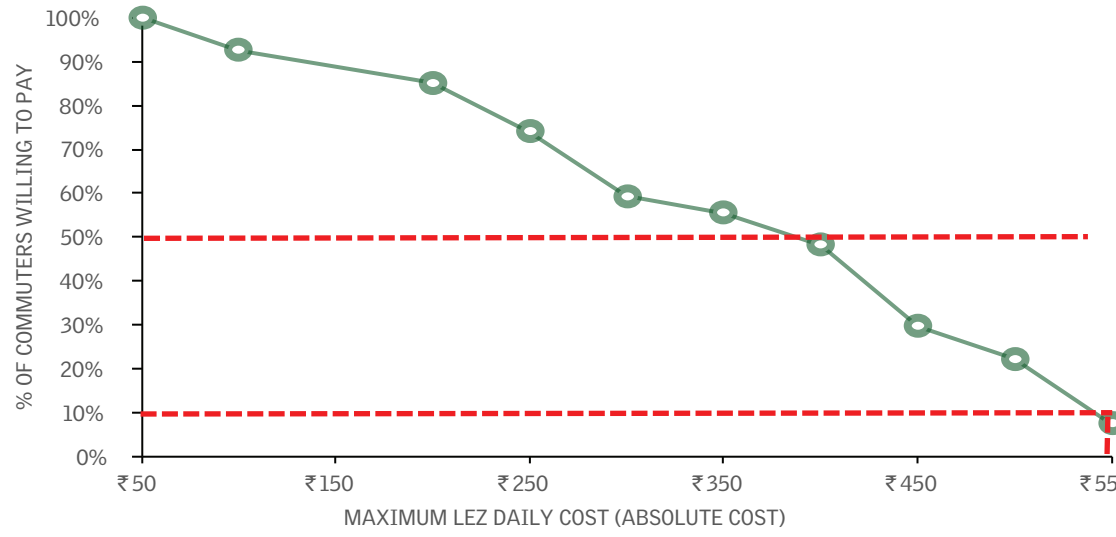
Impact of access change on cab drivers

This scenario will result in a "cost pass through" – to be paid by the consumers. The average indicated critical cost is much higher than the cost required for a more stringent implementation (90 per cent compliance).

The graph presents that 90 per cent confidence level is falling under Rs.550 and 50% of the respondents are willing to pay Rs.375.

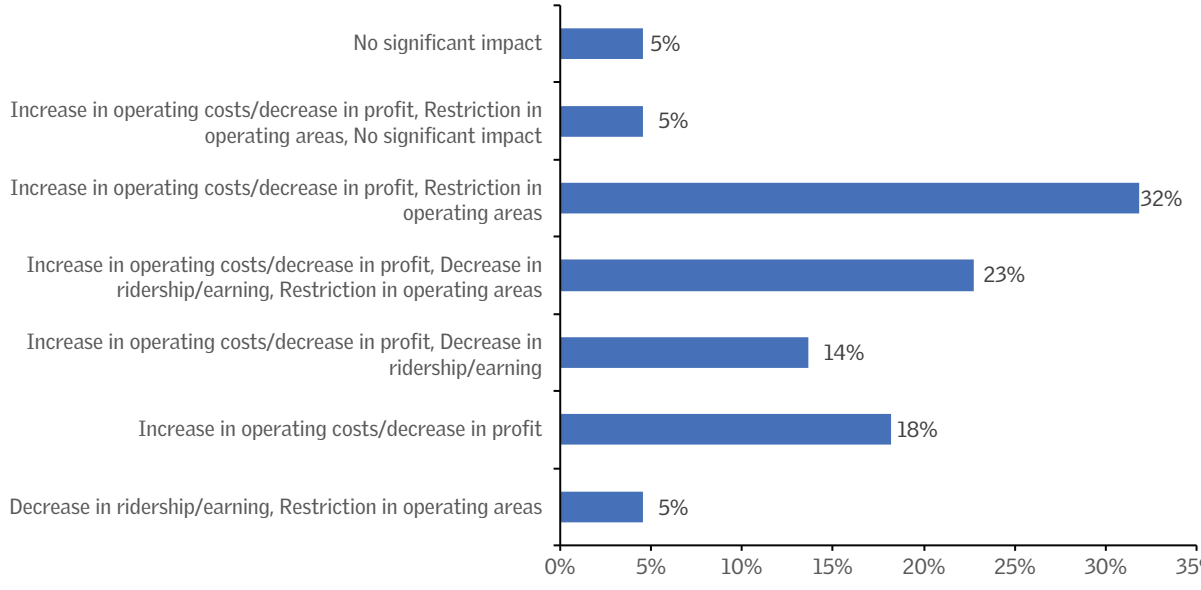
About 32 per cent feel that the LEZ will impact their profits and restrict operating areas. About 23 per cent stated that this will impact both profits and ridership. Around 45 per cent of the drivers have opted for no upgrade and will stop operating in the area (see *Graph 28: Concerns regarding implementation of LEZ*).

Graph 27: Stated critical cost and mean cost for Cab drivers



Source: Primary data collected by CSE

Graph 28: Concerns regarding implementation of LEZ

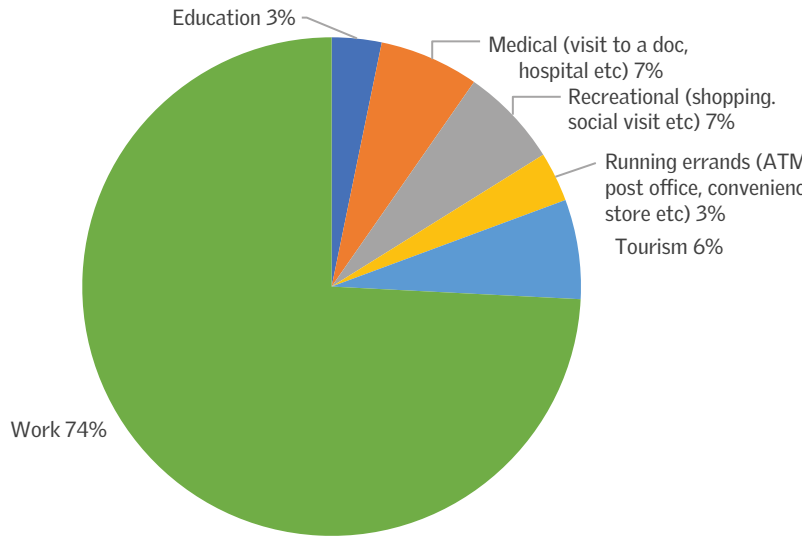


Source: Primary data collected by CSE

Responses of cab users

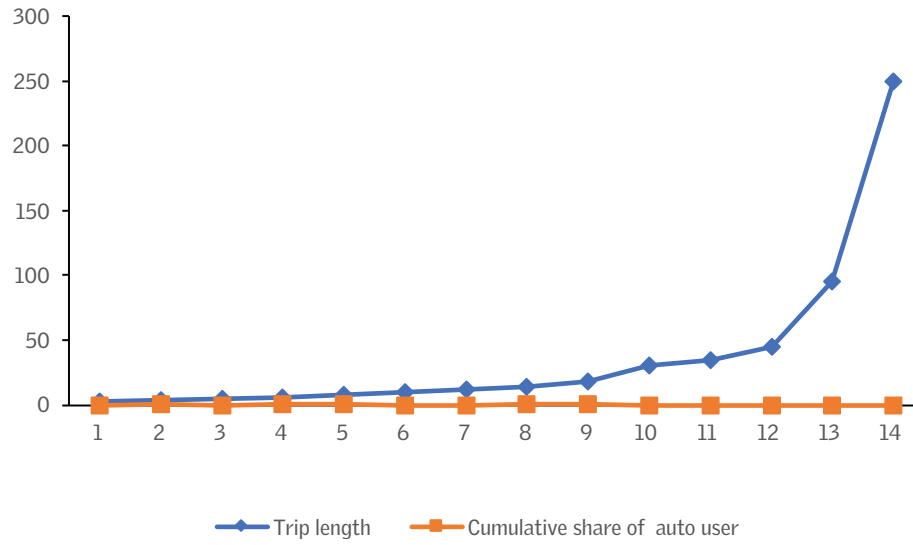
Profile: The majority of the trips made by the sample population in the region are for work purposes (74 per cent). Medical and recreational trips have equal weightage and is also the secnd most stated reason (see *Graph 29: Trip purpose and trip distribution of cab users*).

Graph 29: Trip purpose and trip distribution of cab users



Source: Primary data collected by CSE

Graph 30: Trip length of cab users



Source: Primary data collected by CSE

Impact of complete ban on cab users

If BS-4 or older cab are banned in the LEZ area, most users will switch to sustainable modes(32 per cent) or to complaint private modes (16 per cent). About19 per cent have claimed that they will reduce the number of trips to LEZ area. Interestingly 29 per cent have claimed that there will not be significant impact on them (see *Table 6: Indirect impact of ban on cab users*).

Table 6: Indirect impact of ban on cab user

Type of impact	Percentage of cab user
No significant impact	29%
Use compliant IPT vehicles	3%
Reduce number of trips to LEZ	19%
Shift to private modes (compliant)	16%
Switch to sustainable modes	32%

Source: Primary data collected by CSE

Responses of goods services providers

Profile: Around 83 per cent of respondents operate light-duty commercial vehicles (LDVs), followed by 17 per cent medium-duty commercial vehicles (MDVs), and 5 per cent heavy-duty vehicles (HDVs).

Light duty vehicles visit the LEZ area much more frequently than medium and heavy vehicles; 14 per cent LDVs visit more than 10 times a day, and 17 per cent visit 5-10 times a day. Around 17 per cent of MDVs enter anywhere between 5-10 times a day. There were no Heavy-duty vehicles surveyed.

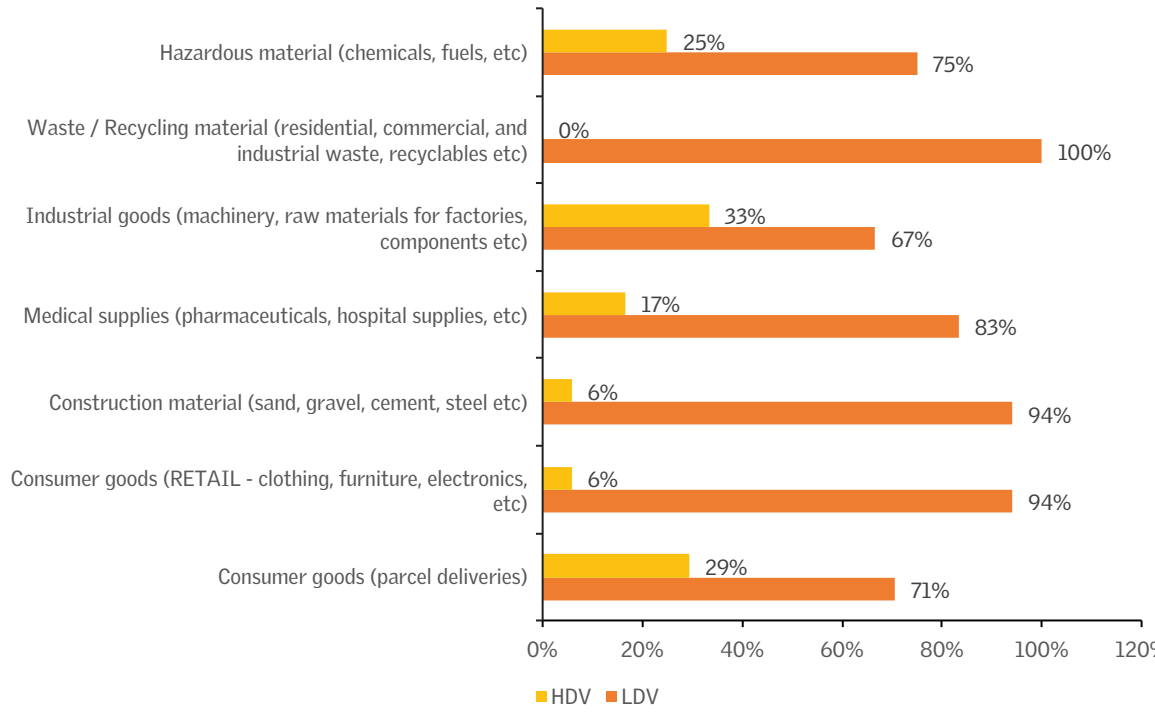
About 82 per cent of total diesel vehicles are LDVs and the 18 per cent are MDVs.

Among the goods carrier operators, most businesses (53.8 per cent) own 1-5 vehicles in their fleet. However, a sizeable share (32.7 per cent) are single vehicle owners.

Most LDVs were found to carry waste/recycling material while most HDVs were found to carry industrial goods(See graph 31:Type of goods delivered within the study(LEZ) area by goods vehicles category).

Most commercial vehicles were seen carrying perishables such as food products and/or groceries to commercial areas. The second largest segment was consumer retail goods carrying vehicles such as clothes, furniture, electronics, and so on. Most

Graph 31: Type of goods delivered within the study (LEZ) area by goods vehicles category



Note: Perishables / Food and beverages = vegetables, fruits, meet, dairy products, grocery etc; Consumer goods = RETAIL - clothing, furniture, electronics, etc; Medical supplies = pharmaceuticals, hospital supplies, etc; Industrial goods = machinery, raw materials for factories, components etc; Construction material = sand, gravel, cement, steel etc; Hazardous material = chemicals, fuels, etc.

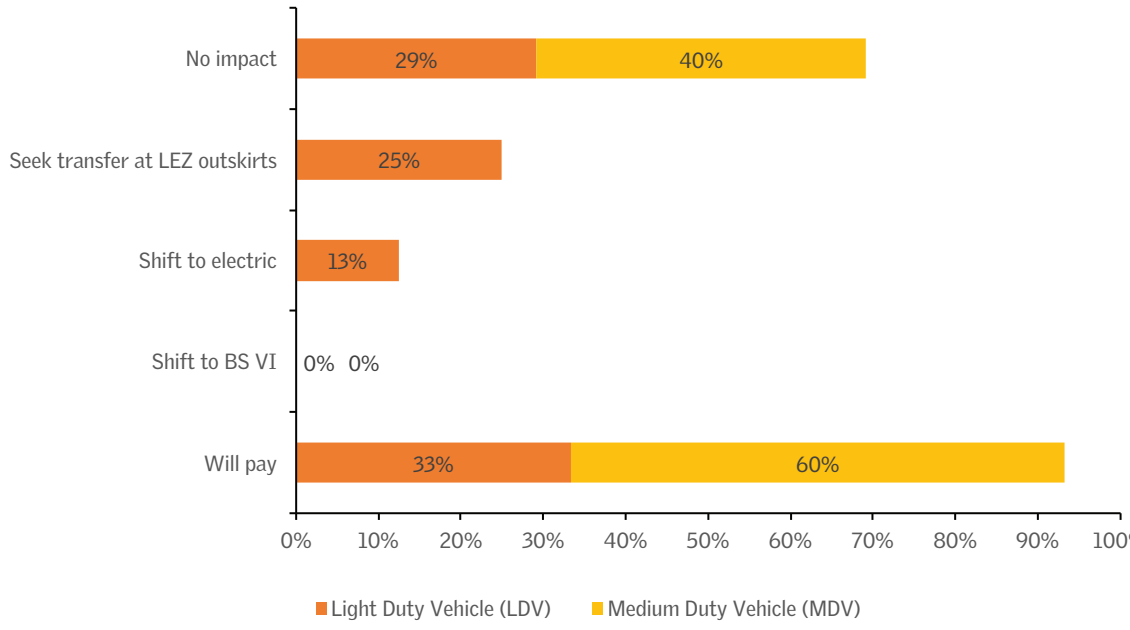
Source: Primary data collected by CSE

HDVs were seen carrying industrial goods which included industrial machinery, raw materials for factories, components etc. LDVs and MDVs were mostly seen carrying perishables.

Impact of complete ban on goods vehicles

In the event of restrictions on all BS IV and older vehicles respondents indicate three options: 1) either switch to a compliant vehicle, 2) discontinue service in the area and look for other areas to work in, or 3) utilise consolidation centres where goods are transferred from high-emission vehicles to compliant vehicles for final delivery.About 29 per cent of LDV operators believe that there will be no impact on them. About 25 per cent have stated that they will move out of LEZ. About 33 per cent of LDV operators have stated that they will not. About 13 per cent have stated that they will shift to electric vehicles. MDV operators were divided between no impact and will be ready to pay if a ban is implemented in the ratio 40 and 60 respectively (see *Graph 32: Impact of scenario-1 on goods service providers*).

Graph 32: Impact of scenario-1 on goods service providers



Source: Primary data collected by CSE

Close to half of the MDV and LDV operators stated that they will switch to a BS-6 vehicle while another 3 to 10 percent has said about switching to electric.

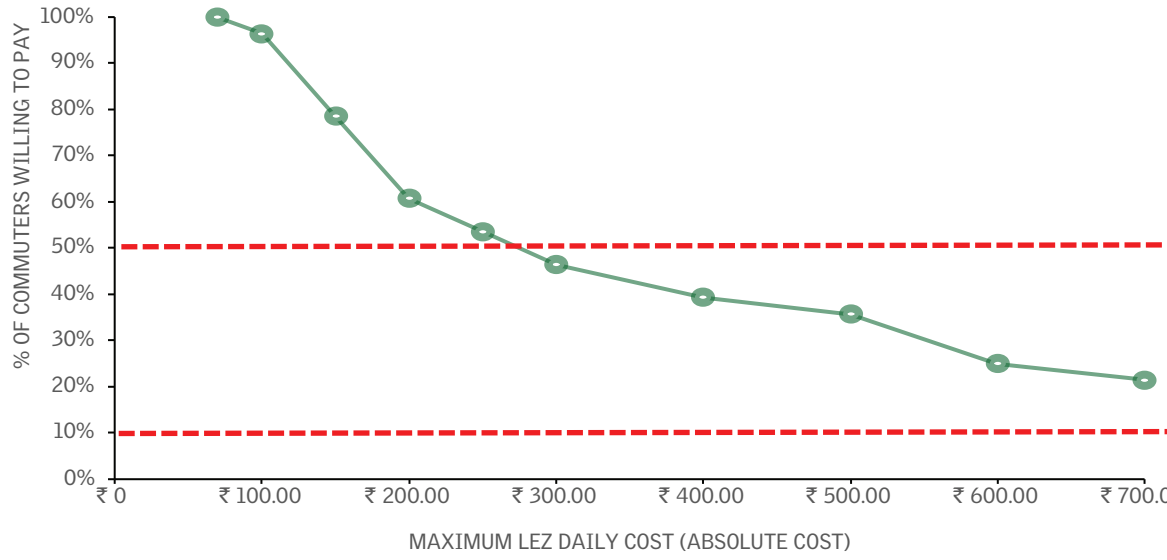
Interestingly, HDV operators have also shown their interest in switching to an electric vehicle (if possible). However, 60 per cent of them have said that the ban will not impact them severely.

Impact of access fee on goods vehicles

In the case of access charges, irrespective of vehicle category, around 40 to 48 per cent goods operators including LDV, MDV and HDV, want to shift to compliant modes (preferably BS-6 or EV). Around 15 to 23 per cent operators have stated that access charge will impact their business in terms of reduced business due to reduced number of entries. A dominant share (i.e., 40 per cent) of HDV operators have shown rigidness in not changing the vehicles and are ready to pay the entry price.

This scenario will result in a "Cost Pass Through" – to be paid by the consumers. The average indicated critical cost is much higher than the cost required for a more stringent implementation (90 per cent confidence level).

Graph 33: Stated critical and mean cost for Goods carriers



Source: Primary data collected by CSE

No confidence level slots could be inferred from the responses received. However, 50% of the respondents expressed that they are willing to pay up to Rs 280 to enter the LEZ area.

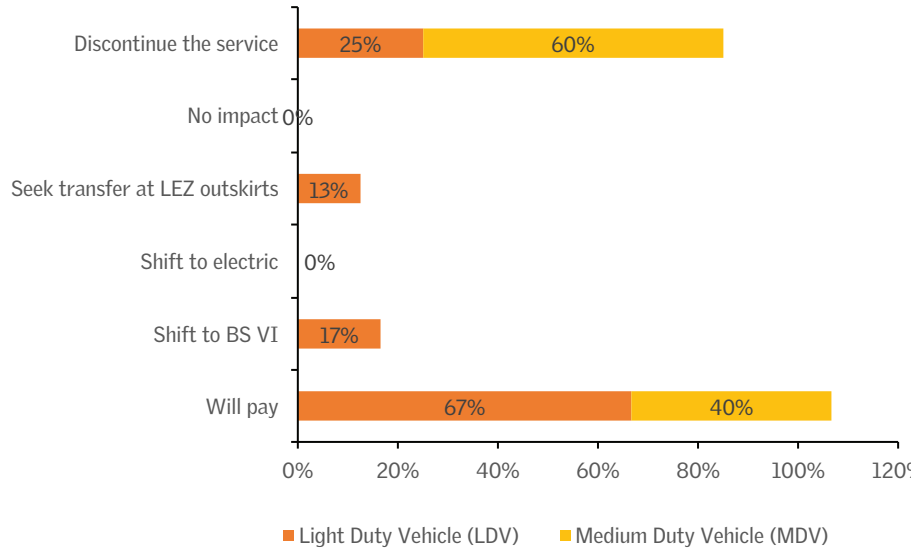
About 67 per cent of the LDV operators stated that they would pay access fees. About 25 per cent have stated that they will discontinue the service. Amongst MDV operators, 60 per cent will discontinue the service and 40 per cent will pay (see *Graph 34: Impact of scenario-2 by Vehicle category*).

None of the operators have stated that there will not be any impact due to this scenario.

The current business of most operators is not yet ready for an LEZ, as most(46 per cent) LDV operators and 13 per cent of MDV operators claim that they do not have any plans to upgrade their vehicles yet. About 38 per cent either have plans to procure an electric vehicle or already have BS-VI vehicles in their fleet. No LDV operator claimed they have electric vehicles (see *Graph 35: Stated preferences of choices of fleet upgradation*).

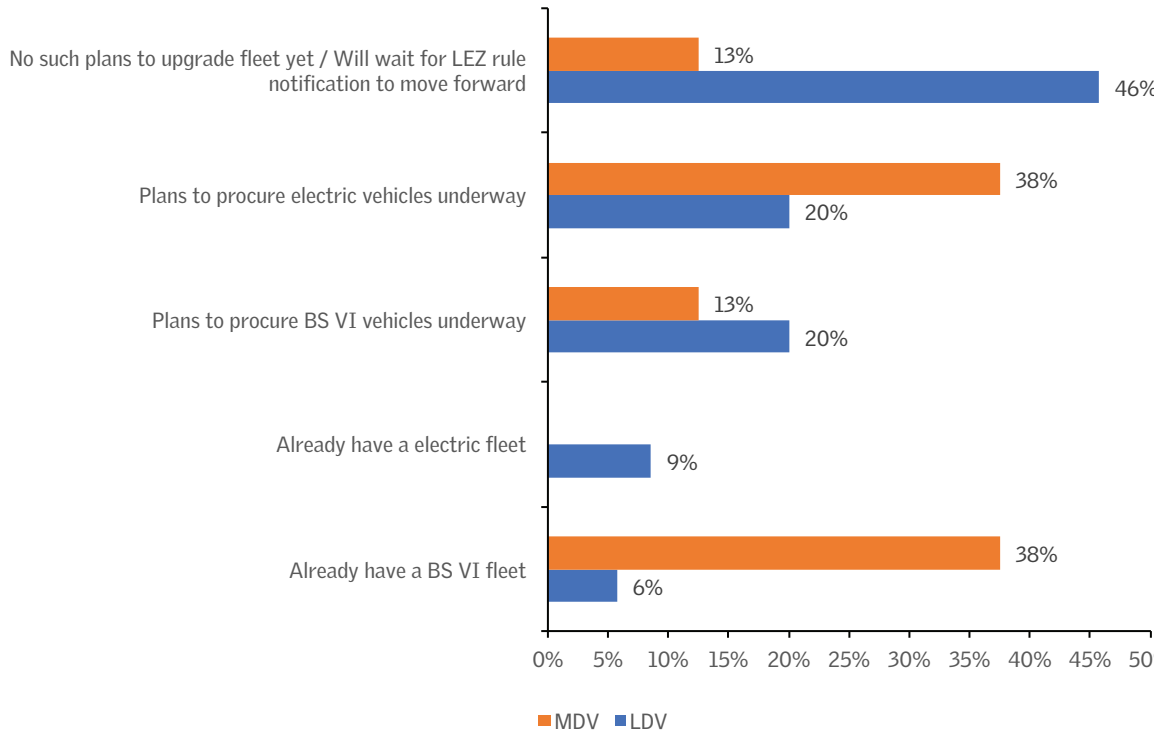
Most MDV operators demand financial incentives, such as subsidies, tax breaks, and low-interest loans to help upgrade to compliant vehicles. As the vehicle load capacity increases from LDVs to HDVs, the share of operators asking for financial support also increases. However, the scenario here is different as most LDV

Graph 34: Impact of scenario-2 by Vehicle category



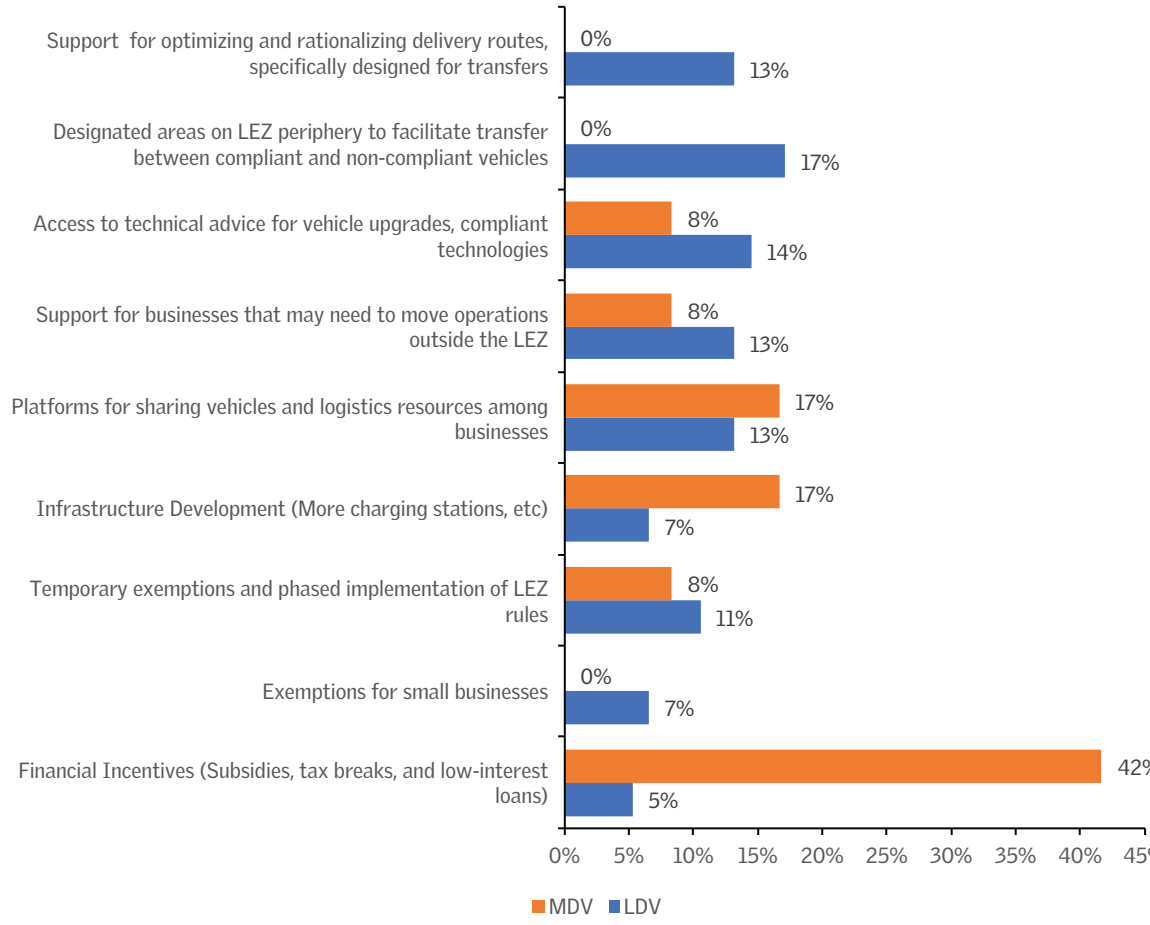
Source: Primary data collected by CSE

Graph 35: Stated preferences of choices of fleet upgradation



Source: Primary data collected by CSE

Graph 36: Stated preferences support and demands for LEZ implementation



Source: Primary data collected by CSE

operators are seeking designated areas at LEZ periphery to facilitate transfer of goods, access to technical advice to upgrade to compliant vehicles, support for businesses and vehicle sharing programs (see *Graph 36: Stated preferences support and demands for LEZ implementation*).

Another important support measure highly requested is exemptions for small businesses and phased implementation of the LEZ restrictions, with ample grace period to either switch their vehicles, or for choosing new business areas. Infrastructure development is highlighted as a priority, by MDV operators.

Perception of public transport service users

Intermediate public transport (Auto and Cab) users:
Around 90 per cent of cab users use a cab for their entire journey while 86 per cent of two-wheelers use it for the entire journey (see *Graph 37: Use of Various modes at different leg of the journey*).

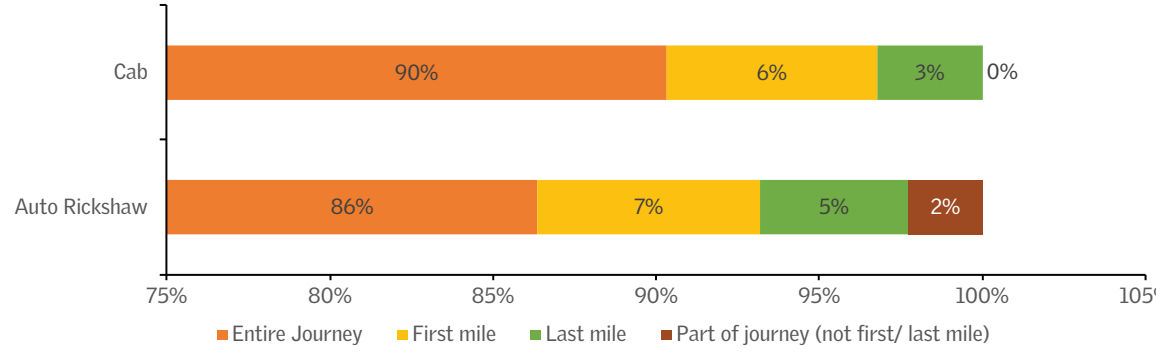
About 7 percent of auto user and 6 percent of cab users use these modes for first mile journey. Only 2 per cent of auto user use this mode for part of their journey.

Among auto users, 77 per cent prefer using an electric auto if an option is given to use, and 14 per cent say there are no such preferences as long as the need is being met. A higher number of cab users are neutral towards the choice, with 26 per cent having no preference (see *Graph 38: Preferences of EV*).

The primary challenge reported by auto-rickshaw drivers is the issue of high or unfair fares, largely due to the absence of a standardized fare system that allows drivers to charge arbitrary rates for trips. Additional challenges identified by most auto-rickshaw users include reckless driving, high waiting times or difficulty in finding rides during peak hours, and refusals by drivers to take passengers.

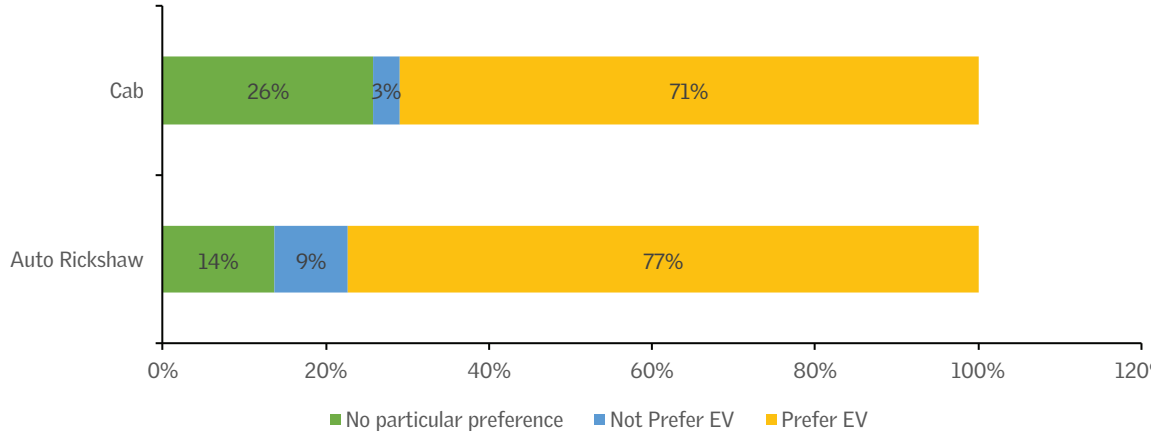
For cab users, the most significant problem is high unfair fares, delays and cancellations. Almost all cab users surveyed were using app-based cab rental services and reported that high wait times, refusals and cancellations especially during peak times. Additionally, cab users highlighted surge pricing during peak hours as a major challenge (see *Graph 39: Issues and problems faced by Auto and Cab users*).

Graph 37: Use of various modes at different leg of the journey



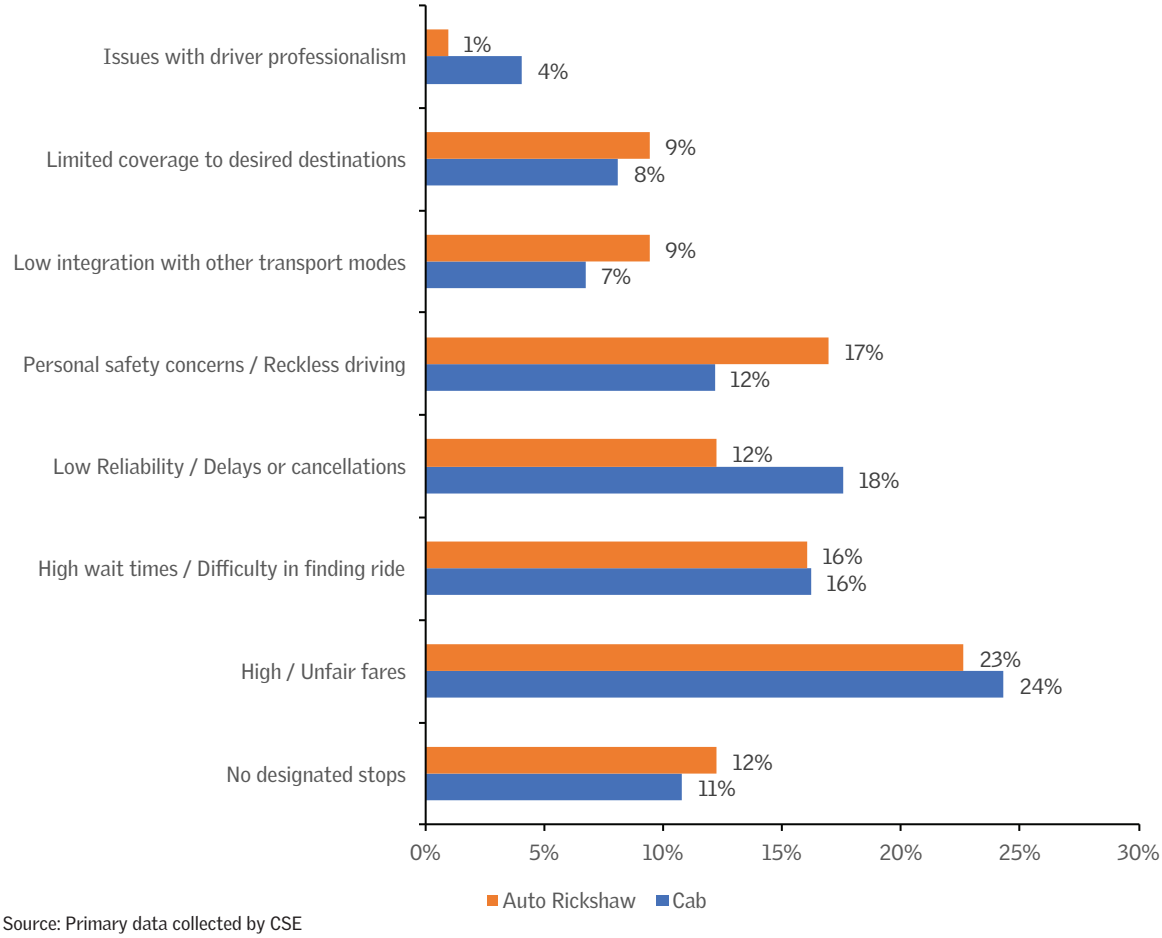
*Part of journey does not include first/last mile.
Source: Primary data collected by CSE

Graph 38: Preferences of EV



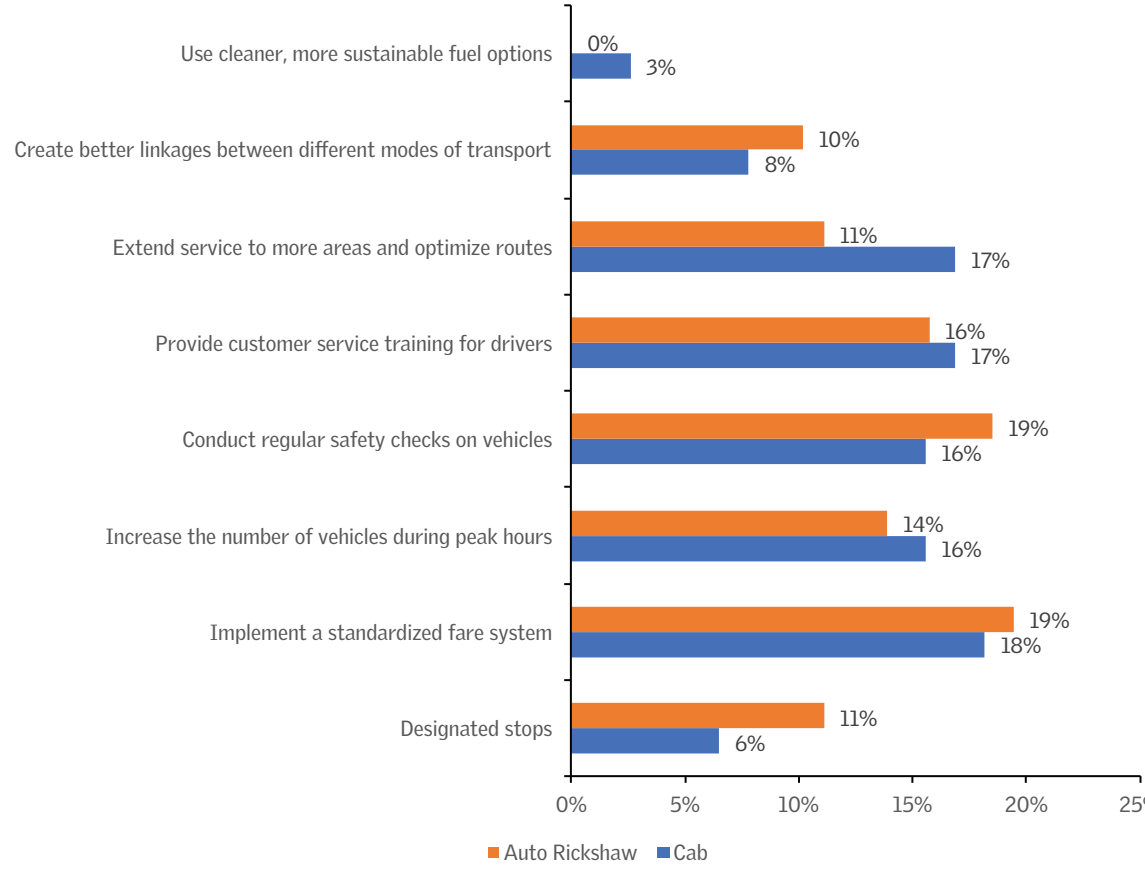
Prefer EV: If option given, will prefer EV; Prefer not EV: If option given, will prefer EV; No particular preference: Do not have a preference as long as the need is met
Source: Primary data collected by CSE

Graph 39: Issues and problems faced by Auto and Cab users



Source: Primary data collected by CSE

Graph 40: Needs/requirements of auto and cab users



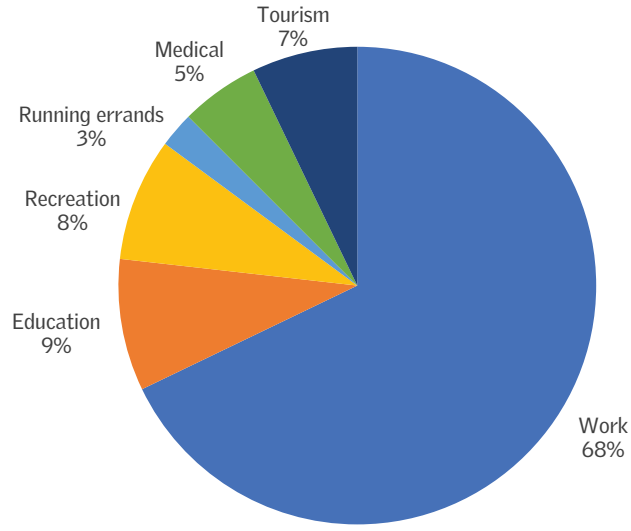
Source: Primary data collected by CSE

There is a strong demand for the implementation of a standardized fare system, with 19 per cent of auto-rickshaw users and 18 per cent of cab users supporting this measure. Both groups expressed an urgent need for more vehicles to be available during peak hours to reduce wait times and delays apart from conducting regular safety checks as one of the major concerns. There is also a clear call for providing customer service trainings and creating better linkages between different modes (see *Graph 40: Needs/requirements of auto and cab users*).

Public transport (metro and bus) users

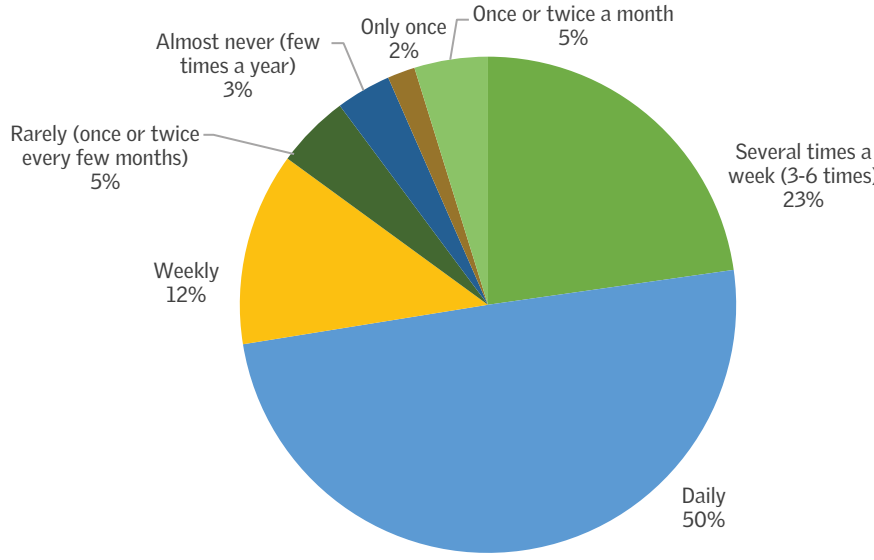
The largest share of the public transport user sample, at 68 per cent, is for office/ business/ work/ service purposes, indicating that more than half of the PT trips are work-related. Social/recreational trips comprise 8 per cent, showing significant use of PT for leisure activities as well (see *Graph 41: Purpose of travel by PT users*).

Graph 41: Purpose of travel by PT users



Source: Primary data collected by CSE

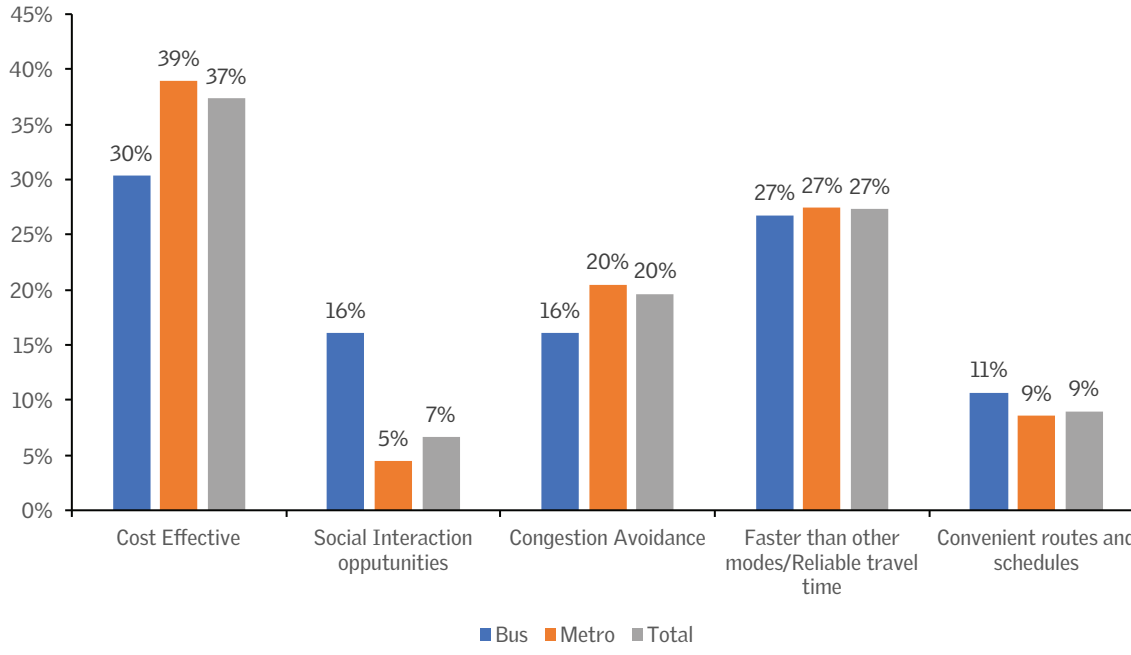
Graph 42: Frequency of journey by PT users



Source: Primary data collected by CSE

About 50 per cent of public transport users travel daily. 23 per cent use it several times a week, while 5 per cent travel monthly. Weekly users account for 12 per cent, and 5 per cent use public transport rarely. This indicates a high daily and frequent usage among PT users at 50 per cent (see *Graph 42: Frequency of journey by PT users*).

Graph 43: Reason for using PT over private mobility options



Source: Primary data collected by CSE

A significant portion of both bus (30 per cent) and metro (39 per cent) users consider cost-effectiveness a major factor for using public transport. Similarly, 27 per cent of bus and metro users consider PT faster than other modes. Implementation of LEZ might push more people to use public transport due to potential restrictions or increased costs associated with private vehicle usage in the zone. With more people likely to opt for public transport, there could be an increased demand for buses and metro services (see *Graph 43: Reason for using PT over private mobility options*).

Metro's speed and reliability are highlighted by users. An LEZ could further enhance metro usage as private vehicles face restrictions, leading to an increase in demand for faster and reliable transport options like the metro. Since 20 per cent of metro users appreciate its ability to avoid congestion, these features may become more attractive post LEZ implementation, making metro a preferable option over buses.

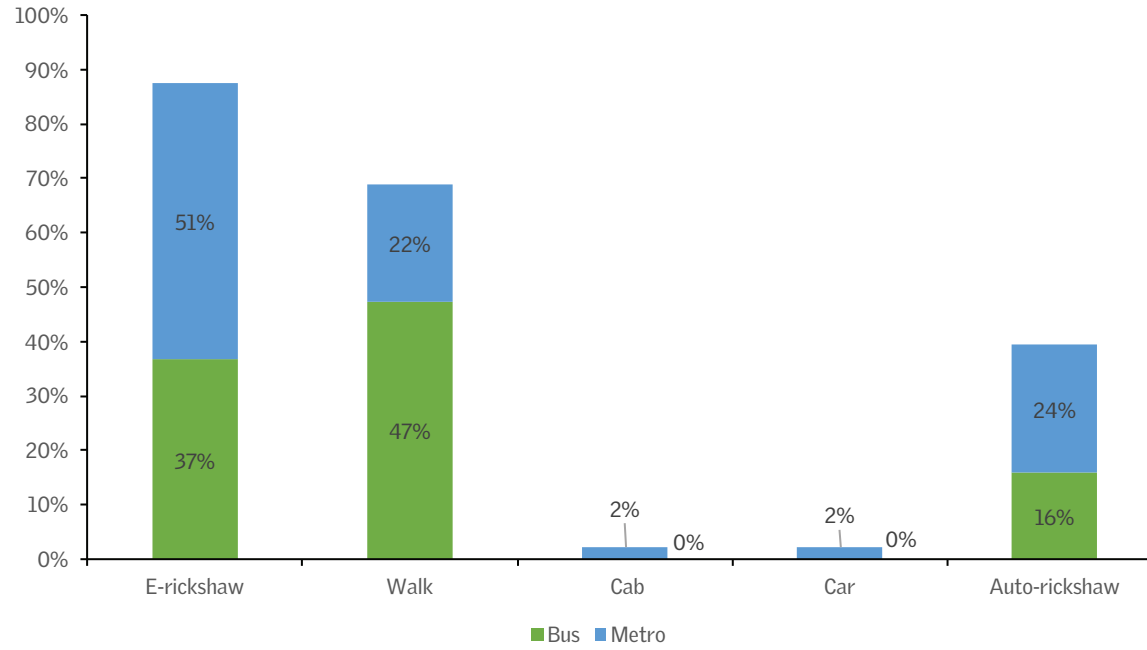
About 37 per cent of bus users and 51 per cent of metro users stated that they use E-rickshaw to commute to the LEZ area. A significant portion (47 per cent) of bus users walk and 22 per cent of metro users use walking as an alternative mode.

A significant proportion of bus users (47 per cent) already consider walking as an alternative mode, which suggests that improved pedestrian infrastructure could further encourage walking. However, only 22 per cent of metro users consider walking, indicating room for improvement in pedestrian connectivity to metro stations (see *Graph 44: Alternate modes to travel to LEZ area by PT users*).

The implementation of LEZ in the heritage area is likely to lead to a shift in commuter behaviour towards increased use of public transport and non-motorized modes like walking and cycling. To maximize the benefits and address current challenges, it is crucial to improve last-mile connectivity, enhance pedestrian infrastructure, integrate multi-modal transport solutions, and promote non-motorized transport.

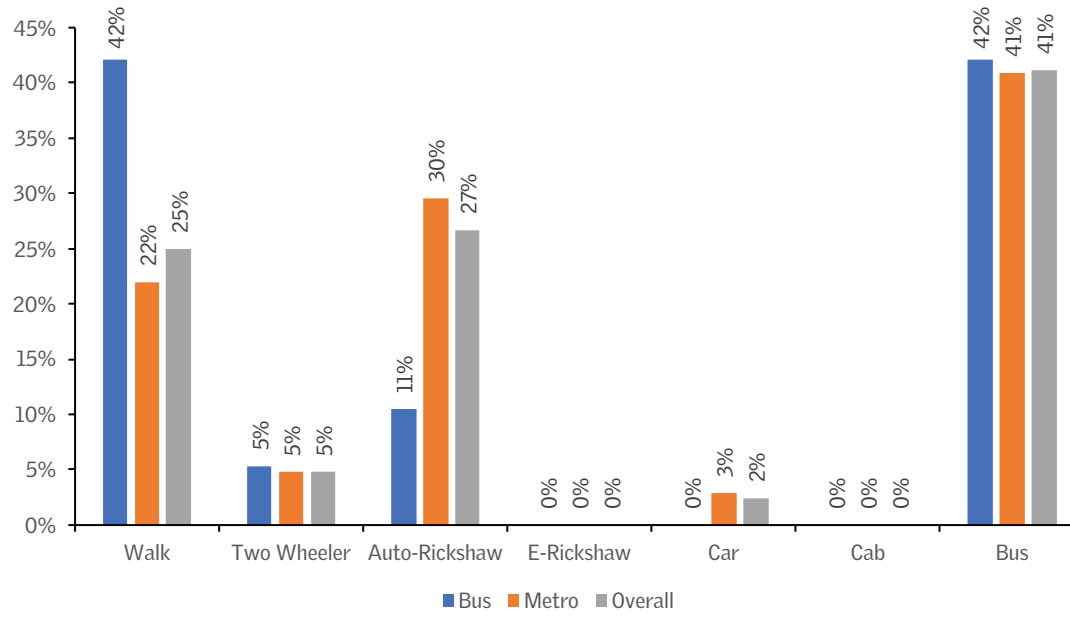
Public transport is also required to be integrated with reliable last-mile and first-mile connectivity options to ensure compliance with LEZ implementation. Users have indicated that walking is the most common mode used for first/last mile connectivity, with 25 per cent of total respondents (42 per cent of bus users and 22 per cent of metro users) choosing this option (see *Graph 45: Use of various modes at first and last mile of the journey*).

Graph 44: Alternate modes to travel to LEZ area by PT Users



Source: Primary data collected by CSE

Graph 45: Use of various modes at first and last mile of the journey



Note: Bus was chosen as last mile/first-mile mode by metro users.
Source: Primary data collected by CSE

Buses are used by 41 per cent of the respondents (42 per cent bus users and 41 per cent metro users), showing a moderate preference for this mode, particularly among metro users.

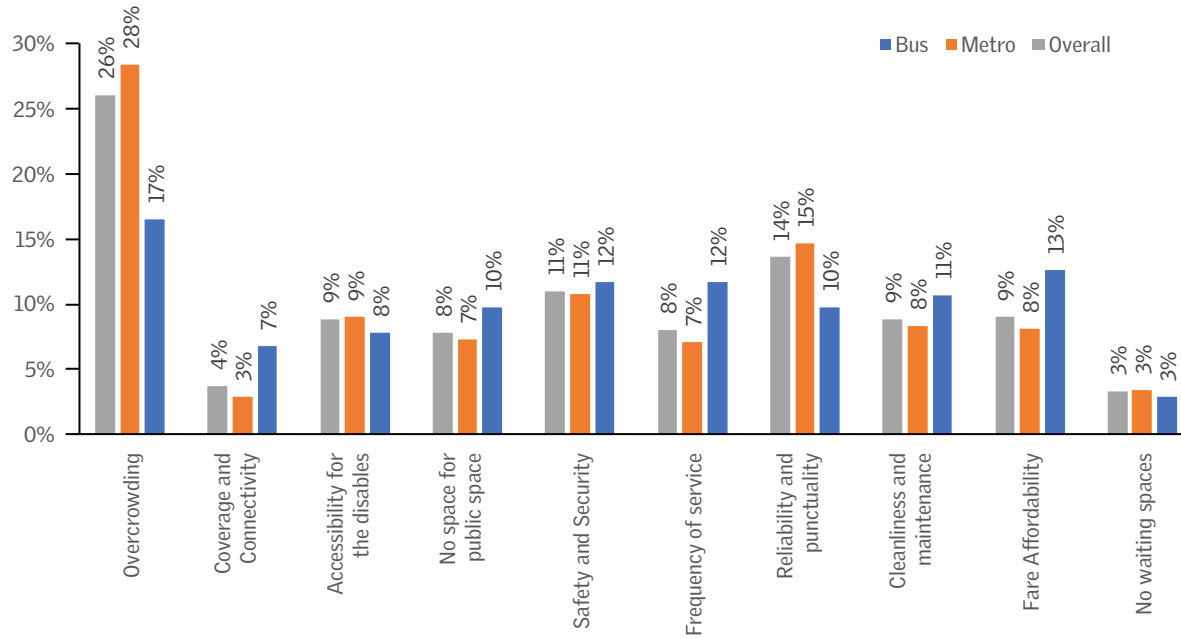
Auto-rickshaws are used by 27 per cent of respondents (11 per cent of bus users and 30 per cent of metro users), indicating a significant dependence on this mode for short first-mile/last-mile trips within the LEZ area, especially by metro users.

Cabs are not used by any of the respondents captured in the surveys.

Cars and two-wheelers are less commonly used.

Bicycles do not appear as an option for last mile connectivity. Given the high percentage of people walking, improving sidewalks, pedestrian crossings, and ensuring safe walking paths could further encourage this mode, making it safer and more attractive. Also, since auto-rickshaws are widely used, there could be initiatives to integrate them more effectively with public transport hubs, ensuring easy availability and regulated fares. The low usage of bicycles suggests potential for growth. Implementing dedicated cycling lanes, bike-sharing programs, and secure parking can promote cycling as a viable first/last mile option.

Graph 46: Issues with PT as stated by its users



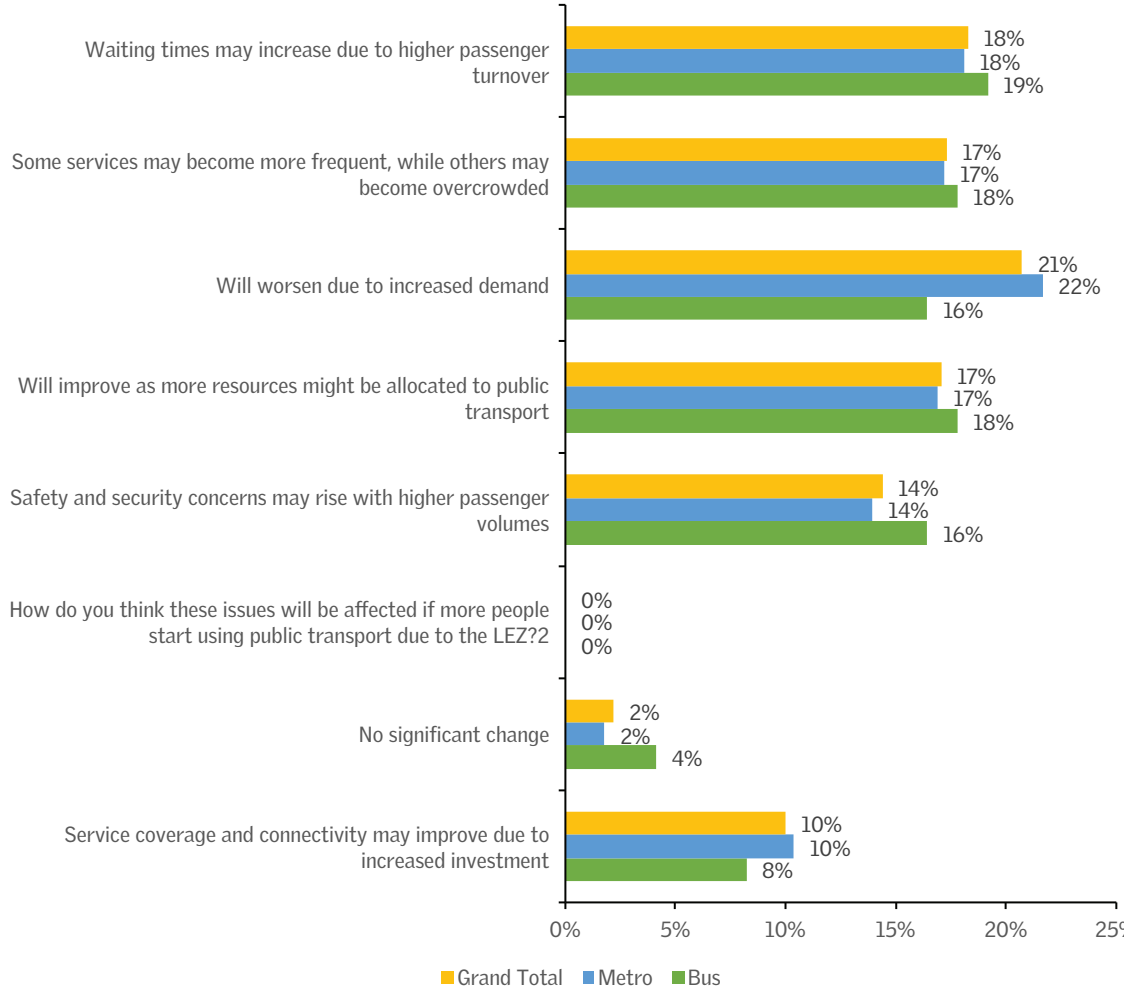
Source: Primary data collected by CSE

Almost all public transport users cited overcrowding as a major concern with the current service. About 13 per cent of bus users indicated that the fares and 12 per cent of bus users indicated the frequency of service of buses ad of major concerns. For metro users, the concern is around15 per cent waiting time (see *Graph 46: Issues with PT as stated by its users*).

More metro users feel that fare affordability is an issue. The same goes for coverage and connectivity of the service.

About 22 per cent of metro users fear that the service will deteriorate after LEZ implementation due to increased demand. About 21 per cent of bus users have shared similar concerns. A large number of metro users (18 per cent) also stated that LEZ can cause an increase in waiting times due to increased passenger turnover. On the other hand, only 10 per cent of metro and bus users are optimistic, as increased demand and ridership for them can mean increased efforts towards service improvement (see *Graph 47: Impact of LEZ implementation on PT as stated by PT users*).

Graph 47: Impact of LEZ implementation on PT as stated by PT users



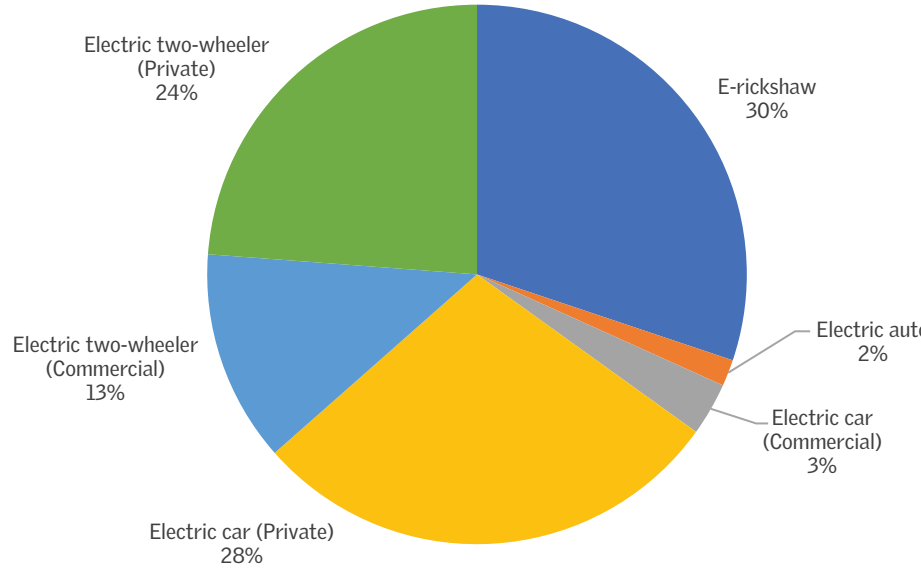
Source: Primary data collected by CSE

Private electric vehicle (two-wheeler and car) owners

Among electric vehicle owners, 28 per cent of the respondents are car owners and 13 per cent are two-wheeler owners (see *Graph 48: Ownership of various vehicle types*).

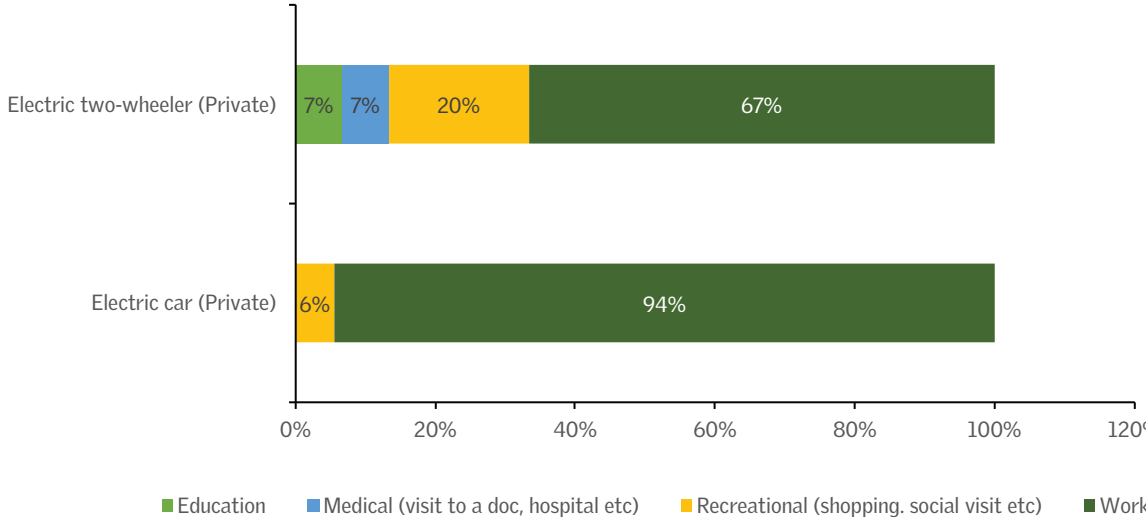
About 67 per cent of electric two-wheelers and 94 per cent of electric cars are used for work trips. The share of recreational trips in the sample in also high for both the segments, considering the nature of the study area (see *Graph 49: Trip Purpose*).

Graph 48: Ownership of various vehicle types



Source: Primary data collected by CSE

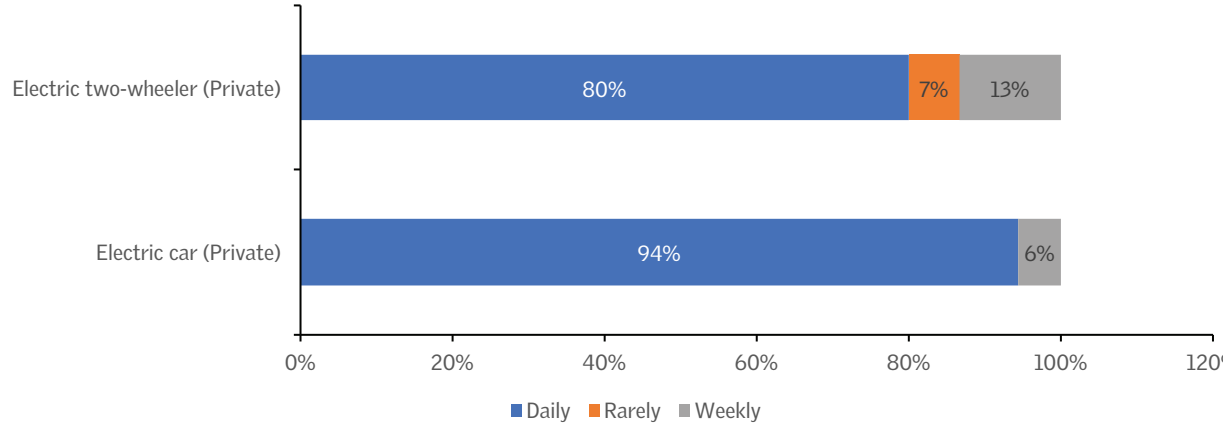
Graph 49: Trip purpose



Source: Primary data collected by CSE

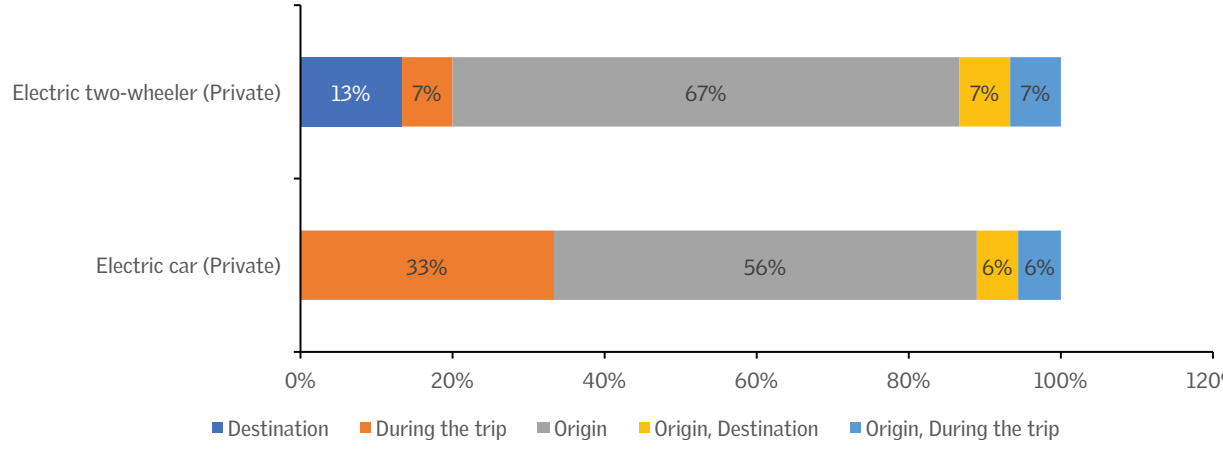
About 67 per cent of two-wheelers and 56 per cent of cars charge their vehicles at the origin, while 33 per cent of car charge their vehicle during the trip (see *Graph 51: Charging locations based on the leg of the journey*).

Graph 50: Frequency of visit to LEZ area



Source: Primary data collected by CSE

Graph 51: Charging locations based on the leg of the journey

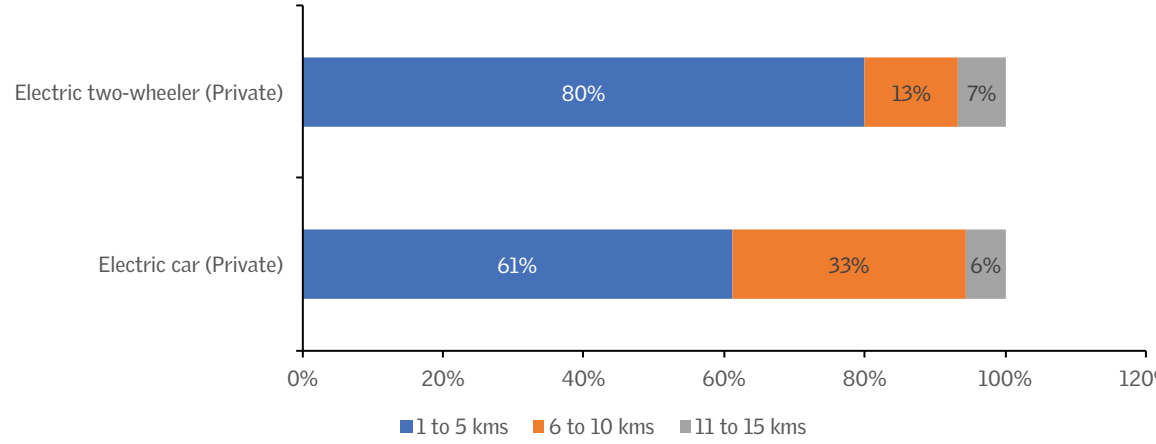


Source: Primary data collected by CSE

80 per cent of two-wheeler and 61 per cent of car users travel 1 to 5 km while 13 per cent of two-wheeler users and 33 per cent travel at the distance of 6 to 10 kms (see *Graph 52: Travel distance*).

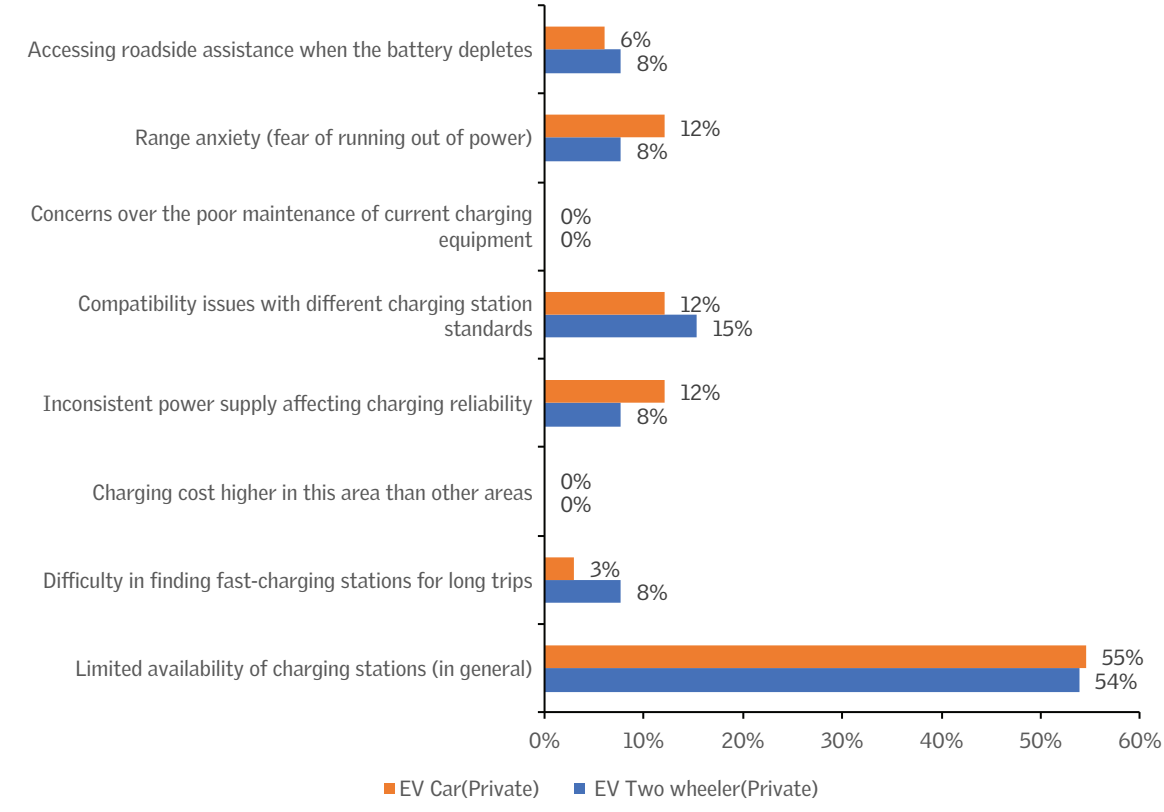
Among car owners, limited availability of charging stations is more prevalent as a challenge of driving their vehicle for both car and two-wheeler users. Range anxiety appears to be second major concern for EV car owners (see *Graph 53: Concerns of using EV(Private cars and two-wheelers*).

Graph 52: Travel distance



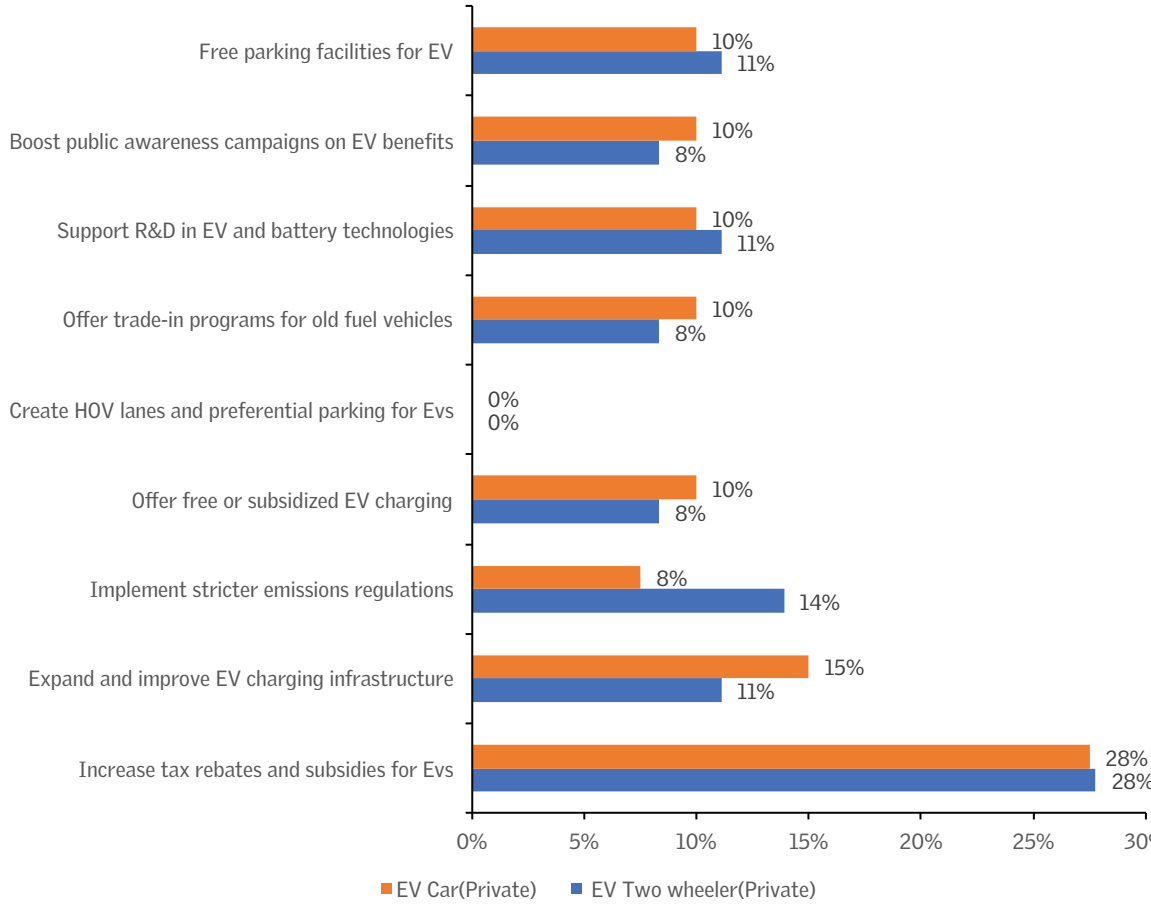
Source: Primary data collected by CSE

Graph 53: Concerns of using EV(private cars and two wheelers)



Source: Primary data collected by CSE

Graph 54: Support needed from the government for LEZ implementation



Source: Primary data collected by CSE

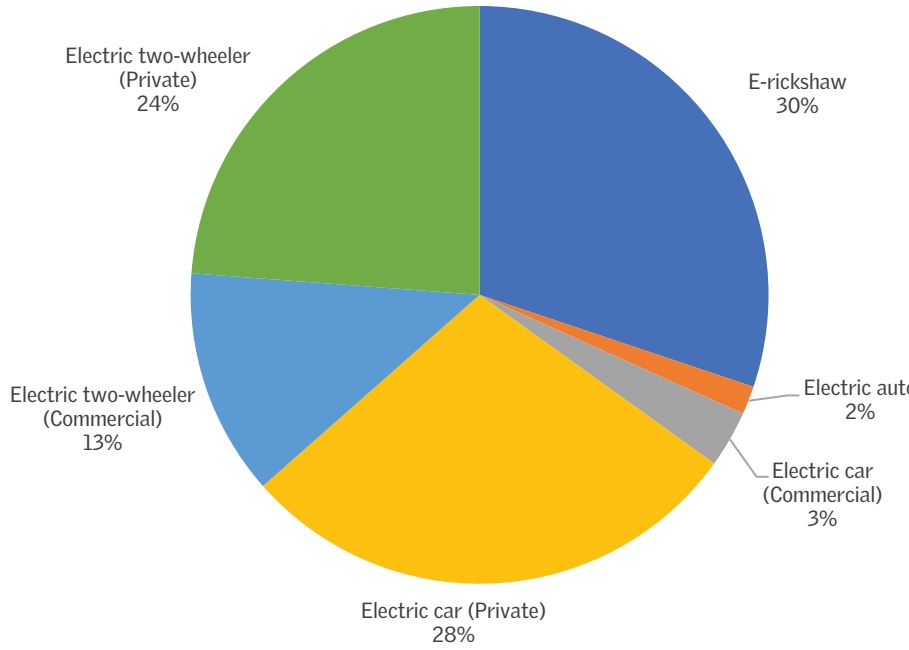
Other prominent concerns of owning an electric vehicle in Jaipur were difficulty in finding a fast-charging station for longer trips, uncertainty about battery life and longer charging times compared to refuelling.

The two-wheeler users expect fiscal support in terms of purchase incentives, free parking facilities, expansion of charging network, and boosting awareness and research in battery technologies. Aside from the aforementioned support tools, car owners have also given priority to subsidised charging and preferential parking (see *Graph 54: Support needed from the government for LEZ implementation*).

Commercial electric vehicle (two-wheeler, auto and cab) users

Even though the sample size is very small – about 48 vehicles - more than half of

Graph 55: Vehicle type break-up of Commercial electric vehicles



Source: Primary data collected by CSE

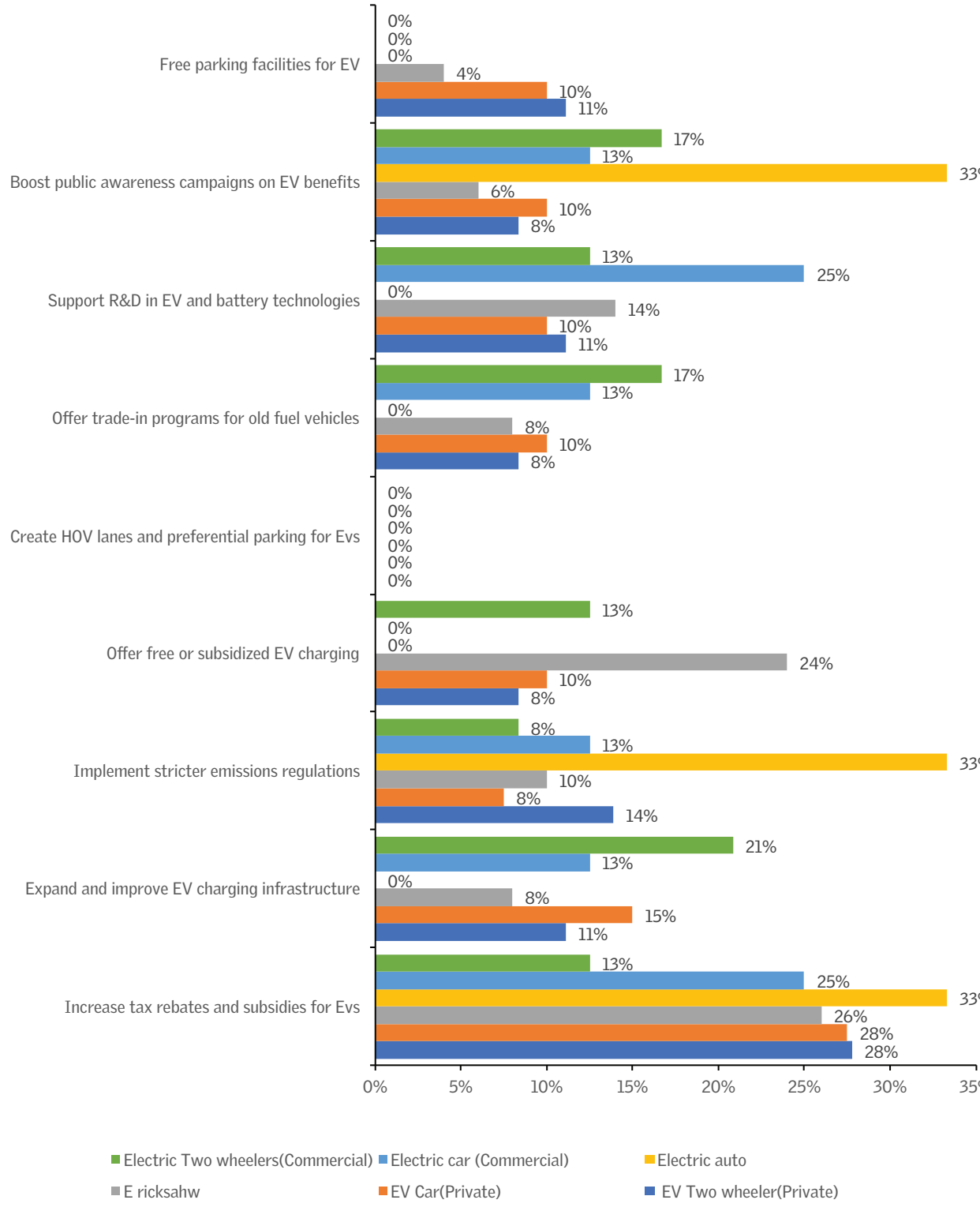
the electric vehicles (2w + car) are used for a private commute and 48 per cent of electric vehicles are used for commercial purposes in the study area. Out of private vehicles, the e-cars are 28 per cent and e-two-wheelers are 24 per cent. The commercial electric vehicle sample is divided into two-wheelers (13 per cent), cabs (3 per cent), e- rickshaws (30 per cent) and electric auto-rickshaws (2 per cent) (see *Graph 55: Vehicle type breakup of commercial electric vehicles*).

Among surveyed commercial electric two-wheeler segment, 100 per cent of the sample are delivery personnel.

Among cabs, 50 per cent used their vehicle for delivery services and 50 per cent for passenger service.

About 33 per cent of electric autos have asked for public awareness, stricter emission regulations and increased tax rebates and subsidies for EVs. The e-rickshaws have asked for increased tax rebates and free or subsidised EV charging (see *Graph 56: Needs/requirements for better uptake of EV by commercial EV users*).

Graph 56: Needs/requirements for better uptake of EV by commercial EV users



Source: Primary data collected by CSE

SECTION 4: The way forward

LEZ is an important enabler to connect policies with ground implementation of mobility and electrification strategies. Several mobility and fleet electrification policies have evolved but these require an integrated and aligned approach to transform the urban spaces. This strategy has direct bearing on the commuters and communities in targeted zones.

While solutions related to technology, transportation and design are possible, their adoption within given socio economic context is challenging. As its effectiveness depend on the wider acceptance by the community it is necessary to understand the disproportionate impacts on different socio-economic groups to identify the appropriate mitigation and support action.

The assessment brings out that potentially LEZs can influence technology and commuting choices, but this will have to be enabled at individual and community levels.

Harsher restrictions, including an outright ban on entry of older vehicle technologies, can have stronger impacts on choices as such measures do not provide options. But this may be more politically difficult to push through. This may also be the cause of public resistance jeopardizing the entire strategy. As the city of Jaipur may not be ready for the measures.

There is also a sizeable inelastic section among the personal vehicle users who despite the harsher measures on entry and exit from the LEZ may continue to stay on with their vehicle usage and also resist change. This requires community-oriented inclusive strategies.

Take steps

Identify key strategies that require city-wide implementation to precede the LEZ implementation: Identification of common strategies for city wide implementation to cover all wards and neighbourhoods is necessary to enable LEZ approach. As the city is already mandated to phase out old vehicles that needs to be fully implemented. Alongside, reform and scale up public transport strategy for intensification of bus and metro service and well-designed last mile connectivity. Moreover, as per the Jodhpur High Court order proof of parking is to be

implemented across the city. This needs to be done along with the implementation of parking management are plans and variable parking pricing across all wards and neigbourhoods. Augment and implement the city-wide electric vehicle policy and programme along with the charging infrastructure.

Delineation of area for implementation of LEZ: The Nagar Nigam, Heritage Jaipur (Municipal corporation) may identify the ward-wise zones that can implement LEZ. To lead the process, it is possible to identify the heritage area of Pink City-Jaipur that has several locational advantages to start the LEZ programme.

The study area falls under the jurisdiction of Nagar Nigam, Heritage Jaipur (Municipal corporation). The Nagar Nigam, Heritage Jaipur (Municipal corporation) may delineate the area for implementation of LEZ along with the parking management area plan.

Notify LEZ policy and regulatory framework for implementation: It is necessary to frame and notify the LEZ policy along with the strategy for implementation. This needs to outline the guidance framework for the implementing agencies.

Phase in LEZ implementation for the targeted zone:

- **Phase 1**: All area management plans need to converge for implementation. Combine implementation of the parking management area plans (PMAP) along with variable parking pricing policy across all neighbourhoods of the zone; initiate pedestrianization of key commercial areas; introduce access based charges for entry of pre-BSIV vehicles; ban BS I and BS 2 vehicles; make entry of electric vehicles free, charge a nominal entry fee for BSVI vehicles that may increase after BSVII vehicles come into effect. Eliminate end-of-life vehicles from the zone. Simultaneously, enhance public transport services and accessibility of the zone.

- **Phase 2**: In the second phase while all the provisions of the phase one will continue, the strategy will be ramped up by restricting pre-BS-IV vehicles. Introduce more direct fiscal and non-fiscal incentives for promoting electric vehicles and apply polluter pay principle. Scale up electric vehicle charging infrastructure in the zone.

Addressing differentiated impacts on income groups: Moderate to high economic impacts on different income groups are expected in personal vehicle segments. This is particularly so in the policy scenario one that aims to ban entry

of pre-BSIV vehicles, scale up electric vehicle requirements to be in the zone and encourage use of public transport.

It is evident from the survey that the economically vulnerable groups like old people and small-income self-employed categories may require some fiscal support for the shifts to cleaner technology.

The overall assumption for the general category of owners of personal vehicles is that they need to move to public transport for primary trips and mobilise their own investments if purchase of new vehicles is required. However, a targeted and purposeful fiscal incentive can be considered if old vehicles are encouraged to be replaced with electric vehicles.

Commercial vehicle need interest subvention, fiscal incentives - co-join with fiscal incentive for electric vehicles.

Recalibrate the policies for fleet renewal, scrappage and electric vehicles to incentivize the special efforts in LEZ and support lower income groups: Already the state government and the city government are mandated to implement the old vehicle phase out, vehicle scrappage policy, and electric vehicle policy. These schemes can be designed to include special incentives for the lower income categories for targeted electrification of the fleet that can be leveraged for the LEZ areas.

Creation of dedicated funds for local area development: Dedicated fund from parking management area plans and the access fees to enter the LEZ can help to fund the cost of transition, and the fiscal strategy to help people to tide over to adjust to the LEZ requirements.

Earmark revenue for local area improvement and to regenerate infrastructure, connectivity and improve the service levels.

Augment public transport accessibility and service level of LEZ: This needs to be supported by enhance safe walking and cycling access in the targeted zone.

Public campaigns and awareness on the benefits of LEZ will be a critical entry point.

The advantage of the LEZ approach is that it can integrate multiple strategies to achieve both vehicle technology transformation and mobility transition. This can

combine fleet renewal for quicker adoption of clean, energy efficient, and zero emissions electric vehicles. At the same time it can enable scalable, integrated, connected and reliable public transport system and services; upscaled network of walking and cycling infrastructure and efficient last mile connectivity; reduce automobility; promote compact urban form to keep jobs and home close; reduce distances, demand for travel and vehicle usage; improve infrastructure for sustainable mobility; integrate the needs of urban poor and vulnerable groups and improve liveability of neighbourhoods.

All cities (Tier I, II and III) require to upscale sustainable mobility options and accelerate adoption of clean and zero-emission vehicles to meet the clean air benchmark and accelerate low-carbon pathways. Cities need to adopt, on a priority basis, an integrated framework of low-emission-zones approach for combined and aligned implementation of enhanced and integrated public transport services along with walking and cycling infrastructure and vehicle-restraint measures while adopting fiscal incentives and regulatory measures to promote use of only clean and zero-emission vehicles in the zones. This can enable community-wide adoption while catalysing city-wide cascading effects for a fast fast-paced transition.

This report, through a mix of perception surveys and policy scenario analysis, provides a nuanced understanding of how LEZs can be strategically implemented in an equitable way to promote clean and low-carbon pathways in Jaipur.

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