Exploring the Potential of Last Mile Transportation as an Enabler for Green Jobs

CUTS International

#2214

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Published by

CUTS International

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Supported by

FRIEDRICH EBERT STIFTUNG

Citation:

CUTS International (2022), Exploring the Potential of Last Mile Transportation as an Enabler for Green Jobs

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This report has been published under the project entitled, 'Exploring the potential of Last Mile Transportation as an Enabler for Green Jobs (GreenJobs III)'.

#2214

Contents

Acknowledgement

This report is a result of the ideas, efforts and support of several people. Involvements in the form of direct inputs, brainstorming sessions, continuous guidance and encouragement and timely reviews have been crucial in developing this report.

First and foremost, CUTS International acknowledges the contribution of all the stakeholders who have provided critical inputs which have shaped the study and the report.

We would like to thank Mandvi Kulshreshtha, Programme Adviser, Future of Work/Social-Ecological Transformation, FES India and Anurag Shanker, Program Manager, Economy of Tomorrow, FES India, for their guidance in shaping the research methodology.

We are immensely grateful to Pradeep S Mehta, Secretary General, CUTS International, Bipul Chatterjee, Executive Director, CUTS International and Ujjwal Kumar, Associate Director, CUTS International, for their continuous guidance and encouragement throughout the course of the study.

We also appreciate the efforts of Madhuri Vasnani for editing, Rajkumar Trivedi and Mukesh Tyagi for preparing the layout of this report. Akshay Sharma deserves special mention for his contribution towards coordinating the information dissemination activities.

Lastly, we are grateful to Friedrich Ebert Stiftung (FES) India, for their valued support of this study.

Finally, any error that may have remained is solely ours.

Abbreviations

ICE	Internal Combustion Engine
EVs	Electric Vehicles
E-3Ws	Electric Three Wheelers
E-2Ws	Electric Two Wheelers
KIIs	Key Informant Interviews
ITIs	Industrial Training Institutes
GHG	Greenhouse Gas
FGDs	Focus Group Discussions
3Ws	Three Wheelers
2Ws	Two Wheelers
MRTS	Mass Rapid Transit System
BRTS	Bus Rapid Transit System
LRTS	Light Rail Transit System
CAGR	Compound Annual Growth Rate
R&D	Research & Development
PUC	Pollution under Control
NCR	National Capital Region
PHEV	Plug-in Hybrid Electric Vehicles
RTO	Regional Transport Office
LMC	Lucknow Municipal corporation

Executive Summary

Creating eco-friendly transportation networks in modern cities requires careful consideration of last-mile transportation, the movement of people and commodities from a central hub to a final destination. This is because the last mile segment, a much smaller segment in the overall road transport sector, presents a low-hanging fruit much easier to decarbonise than the more extensive central public transportation segment. However, it is not without its challenges, largely posed by the variety of routes, the irregular nature and uncertain demand distribution, and unstructured scenarios to meet economies of scale.

Despite these hurdles, last-mile transport is an essential component of urban planning as the lack of it encourages increased reliance on private vehicles resulting in greater traffic congestion, vehicular emissions, and suburban sprawl.

Historically, last-mile connectivity through conventional internal combustion engine (ICE) vehicles has been a part of the mobility ecosystem of several Indian cities. However, with increased environmental concerns and rising awareness, there is a visible shift to cleaner and greener alternatives. Sensing the significance of last-mile connectivity, government and private players have also taken several initiatives to green these fleets. This has resulted in E-2Ws and E-3Ws capturing a significant share of India's electric vehicle (EV) market.

Given this background, the study explore the potential of decarbonisation last-mile connectivity on the local economy and livelihood opportunities. This includes gender and skill inclusivity, reduced environmental pollution, and standard of living from a 'just transition' point of view. The overarching aim was to explore the connectivity practices in two Tier 1 (Delhi & Bengaluru) and two Tier 2 (Jaipur & Lucknow) cities of India and construct a comparative map regarding the preferable modes and strategies for electrification for last-mile delivery and last-mile connectivity of passengers.

From our observations, we noticed that EVs significantly penetrated last-mile connectivity and delivery in all four cities. While Delhi, Jaipur, and Lucknow had E-3Ws dominating last-mile connectivity, Bengaluru had E-2Ws dominating the same. Also, in the case of Bengaluru, we noticed E-carts' presence in the last-mile delivery sector.

The ecosystem around the EVs has been able to absorb and employ thousands of people in all four cities, including several migrant workers, who took up delivery and passenger ferrying as alternative means of livelihood during the pandemic. Besides, people have been employed predominantly in component manufacturing, dealerships, maintenance and repair services, and logistics.

However, the presence of women in the EV ecosystem continues to be low in all four cities. While women are being employed by app-based food and grocery delivery services like Zomato and Swiggy in Tier 1 cities, women's participation in last-mile connectivity was almost negligible. However, this situation is changing as more and more fleet aggregators are looking to employ women as drivers.

Regarding skill inclusivity in all four cities, drivers agree that EVs are easy to drive and require no additional skillset. However, when it comes to becoming an EV technician, training requires various skills, from understanding how the electrical components work to addressing mechanical wear and tear. On this account, industrial training institutes (ITIs) and a few private entities provide vocational training in E-mobility in all four cities.

Coming to the pollution reduction potential of EVs- while zero tailpipe emissions continue to be one of the main selling points of EVs, this has been further substantiated by our GHG emissions avoided calculations for each city. This reveals how even a low percentage of EVs in the last mile segment has the potential to reduce significant vehicular emissions.

Finally, in terms of the standard of living, we noticed that the EV ecosystem was responsible for providing livelihoods to thousands of people, especially during the pandemic. While manufacturers and dealers are undoubtedly enjoying the fruits of being in the business, it is the E-3W drivers as well as E-

2W delivery persons who have gained the most, as EVs are a much cheaper alternative for them compared to their ICE counterparts.

Another noteworthy mention in this context is that of fleet aggregators, who play an essential role in shifting the burden of upfront costs to procure vehicles by delivery partners. This rental model, coupled with affordable pricing, has been quite successful in last-mile logistics, whether for delivering goods/ food or for the daily commute of corporate employees.

With this, we hope that this study will provide some fruitful insights into the economic, social, and environmental aspects of EV inclusion in the last-mile segment. Our suggested roadmap will ensure the sustainability of decarbonisation efforts for creating more green fleets in the coming days.

1 Introduction

Transportation networks globally, especially in the passenger segment, have witnessed a significant transition for the last five to six years. The internal combustion engine ICE-driven automotive market is rapidly transforming into an EV ecosystem. Economies worldwide already have plans to move towards a clean mobility network. Curbing carbon emissions to address climate change can be considered the leading proponent for instigating the EV movement. The market growth of EVs is evident as in 2012, only 120,000 cars were sold worldwide and in 2021, more than that were sold each week. Nearly 10 percent of global car sales were electric in 2021, four times the market share in 2019. This has brought the total number of electric cars on the world's roads to about 16.5 million in 2021, triple the amount in 2018.[1]

India's vision for EVs is well aligned with global aspirations, with a market penetration target of 30 percent for private cars, 70 percent for commercial cars, 40 percent for buses and 80 percent for 2W & 3Ws by 2030. 330,000 EV units were sold in 2021, a 168 percent growth over 2020. As of August 2022, 582,479 EVs have been registered and running on Indian roads. This EV upsurge is most evident in the last-mile connectivity segment, wherein E-3Ws has completely transformed how people traverse intra-city regions. The same implies to E-2W, which is instrumental for last-mile delivery services as service providers aim to go carbon-free. As of September 2022, approx. 0.9 million E3W and 0.6 million E-2W are plying on Indian roads.

Additionally, due to the COVID-19 pandemic, the whole approach toward sustainable transportation has been disturbed. Social distancing norms and periodic lockdowns introduced people to options for reduced or short-distance travel until necessary. It has also shifted the primary preference of people to private transport modes. The rising popularity of work-from-home, online education etc., has prompted a surge in E-commerce orders, fostering

[1] https://www.iea.org/data-and-statistics/data-product/global-ev-outlook-2022

demand for appropriate last-mile transport options for deliveries. However, amidst concerns of congestion, road safety, vehicle quality and regulatory ambiguities, this segment's degree of green transition remains to be seen.

Subsequently, the impact of this transition on existing stakeholders in the last-mile connectivity ecosystem and its potential for creating future livelihood opportunities will be crucial for its sustainability. Thus, a research study was envisaged within this context.

This report presents an in-depth analysis of the potential of the electrification of last-mile transportation in creating better jobs. Further, the potential for promoting social inclusivity through the creation of equal opportunities for women, better standards of living and skill development is also assessed. In addition, this report also analyses the environmental impacts in terms of carbon emissions reductions.

To mainstream the research study, the economic, social and environmental parameters were evaluated across four cities – two cities each from tier-1 and tier-2 categories. The cities were identified based on E-3W sales data across all major tier-1 and tier-2 cities. The criteria were the percentage of E-3Ws in total 3W sales; accordingly, Delhi, Bengaluru, Jaipur and Lucknow were considered for the research.

2 Methodology

The project's objective was to explore the potential of decarbonisation of last-mile connectivity on the local economy and livelihood opportunities, including gender inclusivity, skill inclusivity, reduced environmental pollution and standard of living from a 'just transition' point of view. The overarching aim was to explore the connectivity practices in Tier 1 and Tier 2 cities of India and construct a comparative map regarding the preferable modes and strategies for electrification for last-mile delivery and connectivity of passengers.

To execute the project in a most comprehensive manner, a phase-wise approach was adopted:

Literature Review - Literature linked with decarbonisation and its impacts (In terms of social, economic and environmental) will be analysed with regard to last-mile connectivity. This will be followed by evaluating existing EV policies of various states of India and how it enables last-mile connectivity in those states.

Mapping of Stakeholders and Secondary Data Collection - To understand the city mobility ecosystem, preferred modes of transport and challenges in greening the last mile connectivity, scoping visits were undertaken in the selected cities and relevant stakeholders were mapped. This phase also included collecting data related to local socio-economic development from relevant Government databases and departments.

Primary Data Collection - Key Informant Interviews (KIIs)/Surveys and Focus Group Discussions (FGDs) were conducted with the key stakeholders, namely the consumers, the vendors/vehicle drivers, the transit agencies/aggregators and the government for data collection. The aim was to capture the insights on the economic, social and environmental impacts of transitioning to green mobility in last-mile connectivity. Further, existing challenges and gaps,

according to various stakeholders, were identified, which are hampering the greening of last-mile connectivity.

Data Analysis and Preparation of Outputs - Using an ecosystem approach, qualitative analysis of factors enabling last-mile connectivity were undertaken. Simultaneously, quantitative analysis of social, economic and environmental indicators was undertaken using the relevant statistical methods. Findings from the quantitative and qualitative data analysis were consolidated. Based on these findings, actionable recommendations are suggested in this report, which will act as a roadmap for greening last-mile connectivity.

Economic, Social and Economic Parameters

The project aimed to capture economic impacts with the help of parameters such as the quantum of livelihood opportunities created due to the greening of the last mile and the financial resilience of EV users to withhold any economic shock. Another area of focus was the social impact created as a result of the greening of the last mile. The major indicators identified were inclusivity (economic, gender and disabilities) and human capital development potential of the EV drivers. Under the environmental indicators, the project aimed to quantify the greenhouse gas emissions avoided due to EV adoption.

Table 1: Parameters for Economic, Social and Environmental Indicators

S.No.	Indicators	Parameters	Details
1.	Economic: a. Employment generation b. Financial Resilience	1. Job creation due to E-2W and E3W use for last mile passenger or commercial use 2. Financial and economic benefits	Type, number of jobs linked to the EV ecosystem. Wages/ Change in wages since the shift to E-2W/3W use Savings/Change is savings since shift to E-2W/3W use
2.	Social: a. Inclusivity b. Human Capital Development	1. Economic opportunities/ participation and ease of access/use for women 2. Economic opportunities/ participation and ease of	Quantum of livelihood opportunities for women and differently-abled persons

S.No.	Indicators	Parameters	Details
		access/use for differently-abled persons 3. Potential for skilling and upskilling 4. Improvement is Education 5. Improvement in Health	Types and level of skill development Dynamics of expenditure on health, education, and skill development
3.	Environmental: a. Carbon Footprint b. Noise Pollution	1. Carbon Emission Mitigation 2. Noise Reduction	Emission reduction with reference to the owner of the EV Noise reduction as a result of EV use in last mile connectivity

City Selection Criteria

The selection of tier 1 and tier 2 cities was made based on EV sales data of E-3W provided on the Vahan Dashboard for May 2022. Data for E-2W was excluded as most of these vehicles are purchased for personal use.

Table 2: E-3W Sales Data for Tier 1 Cities

City	E-3Ws	Total 3Ws	E-3Ws as percent of total Sales
Ahmedabad	658	197,088	0.33
Bengaluru	14,043	368,676	3.81
Chennai	4,362	157,367	2.77
Delhi	117,696	439,980	26.75
Mumbai	110	59,502	0.18

Table 3: E-3W Sales Data for Tier 2 Cities

City	E-3Ws	Total 3Ws	E-3Ws as percent of total Sales
Ajmer	623	11,090	5.62
Bhubaneshwar	467	59,170	0.8
Jaipur	24,702	59,312	41.65
Jodhpur	415	22,297	1.86
Kanpur	27,282	85,057	32.08
Lucknow	34,756	56,107	61.95
Nagpur	4,728	30,215	15.65
Nashik	130	26,064	0.5
Patna	13,068	96,572	13.53
Prayagraj	12,628	40,801	30.95
Ranchi	2,874	49,508	0.58
Surat	186	89,344	0.21
Vadodara	305	56,396	0.54
Varanasi	10,978	57,083	19.23

Based on this data, Delhi and Bangalore as Tier 1 & Jaipur and Lucknow as Tier 2 cities, were selected to execute the project.

3 Research Findings

A total of 120 surveys/KII were conducted across the four cities within different categories of stakeholders, including vehicle dealers, manufacturers, consumers, aggregators and E-3W and E-2 W operators. While there were many positive aspects of E-mobility transition, some adverse effects were also observed through these interviews.

Overall, the potential for job growth is immense in the last mile connectivity segment; the same cannot be stated for economic growth. For many E-3W operators who previously earned through other means and shifted to driving E-3W due to job loss during the COVID pandemic, the income levels more or less remained unchanged.

The social impacts varied from city to city, wherein Delhi had the highest ratio of women engaged in last mile connectivity segment, thus, providing additional financial support to the family and increasing the standard of living. The cities of Lucknow and Jaipur did not have the same level of impact, whereas in Bengaluru, it was somewhat neutral on account of fewer E-3Ws as compared to E-2Ws, which prompted more men to take up the job in this segment.

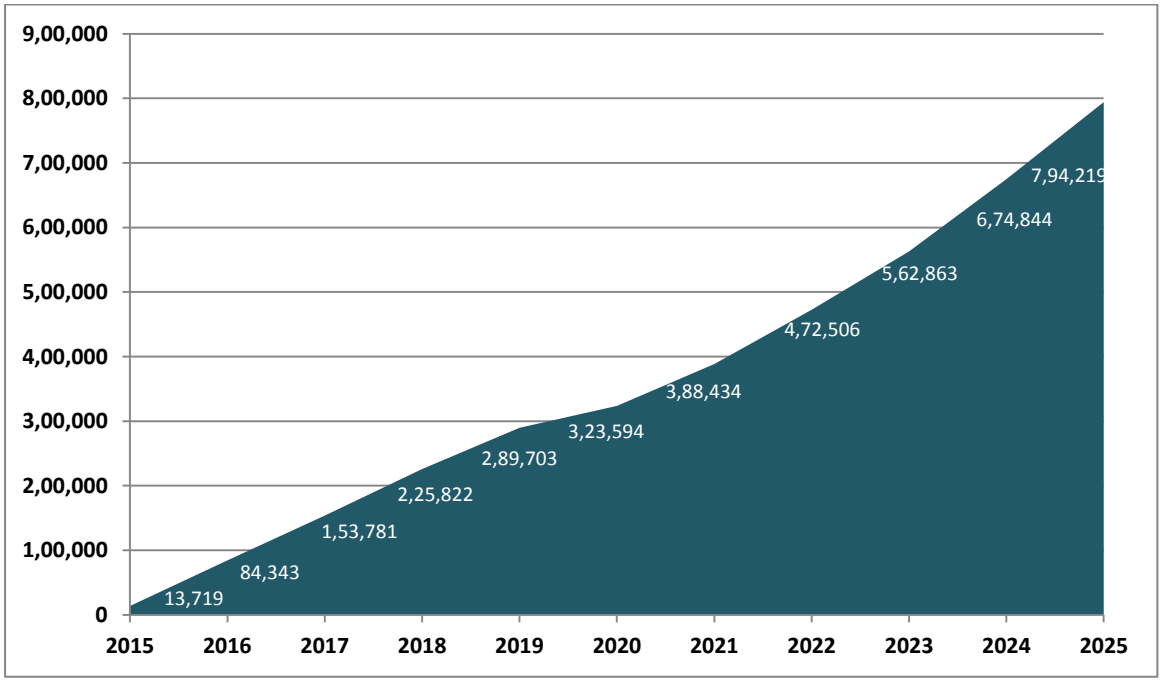
Job Growth

For estimating job growth, cumulative sales data of E-3Ws&2Ws was compiled and extended to 2025 by taking the average growth percentage. Through our secondary literature review and city-wise surveys, it was observed that all E-3Ws could be associated with last mile connectivity segment and, 2.2 jobs (both direct and indirect) per vehicle. For E-2W, 3 percent of total sales with 1.5 jobs per vehicle can be considered.

Table 4: Employment Generation in Electric Last Mile Connectivity

Year	Cumulative E-3W sales	Employment generation due to E-3W	Cumulative E-2 W Sales	Employment generation due to E-2W	Total Employment Generation
2015	6,235	13,717	54	2	13,719
2016	38,336	84,339	83	3	84,343
2017	69,896	1,53,771	205	9	1,53,781
2018	1,02,612	2,25,746	1,331	75	2,25,822
2019	1,31,535	2,89,377	5,302	326	2,89,703
2020	1,46,757	3,22,865	11,319	728	3,23,594
2021	1,75,641	3,86,410	33,398	2,023	3,88,434
2022	2,12,204	4,66,849	98,082	5,657	4,72,506
2023	2,51,632	5,53,590	1,62,401	9,272	5,62,863
2024	3,00,732	6,61,610	2,34,716	13,234	6,74,844
2025	3,52,934	7,76,455	3,199,45	17,764	7,94,219

Figure 1: Job Growth Estimates in Electrification of Last Mile Connectivity



It can be observed that by 2025, close to a million (794,219) jobs will be associated with the electrification of the last-mile connectivity segment.

Skill Inclusivity

Lucknow's last-mile connectivity for goods and people is mainly governed by 3Ws comprising both conventional 3Ws and battery-operated 3Ws. Completely transforming the last mile connectivity to a greener mode of transport will require skill impartment in vehicle driving, vehicle maintenance and vehicle assembling for different stakeholders. This will help in making a robust ecosystem for EVs.

A basic Analysis of the components involved in the E-3W and fossil fuel-powered 3-W can guide us towards the skills to be needed for building the E-3W ecosystem:

Table 5: Skill/ Training Requirement for E-2W & E-3W Segment

S. No.	Sub-systems in a vehicle	Presence of the sub-systems in E-3W	Presence of the sub-systems in a conventional 3W	Training Needed
1	Body/Frame	Yes	Yes	No
2	Wheels	Yes	Yes	No
3	Suspension systems	Yes	Yes	No
4	Wipers and fluid pumps	Yes	Yes	No
5	Mirrors	Yes	Yes	No
6	Interiors	Yes	Yes	No
7	Dashboard	Yes	Yes	No
8	Fuel Tank	No	Yes	No
9	Engine	No	Yes	No
10	Clutch and transmission and associated components	No	Yes	No
11	Electric motor	Yes	No	Yes
12	Motor controller	Yes	No	Yes
13	Battery pack and battery management systems	Yes	No	Yes
14	AC-DC converters	Yes	No	Yes
15	Charging Infrastructure equipment	Yes	No	Yes
16	Steering system	Electric	Hydraulic	Yes
17	Brake systems	Electric	Hydraulic	Yes

From the above table, it can be concluded that there is a need to train the workforce in certain aspects of an EV. Training institutes imparting skills on these sub-systems need to be developed so youth can be absorbed in this segment. These trainings are mostly imparted by private institutes, with some other government institutes offering vocational courses in 3W & 4W EV technology. Still, there is a need for incorporating the whole ecosystem, which includes E-3Ws (E-3Ws), E-carts and E-cycles.

Pollution Reduction

Certain assumptions were factored in for calculating the estimated pollution reduction by electrification of the last-mile connectivity segment.

1. 100 percent of E-3Ws were considered under last mile connectivity segment
2. Three percent of E-2Ws were considered under last-mile connectivity for Delhi, Jaipur and Lucknow
3. Five percent of E-2Ws were considered under last-mile connectivity for Bengaluru owing to the significant presence of micro-mobility start-ups in the E-2W segment
4. Daily distance covered by a conventional 3W was taken at 80 km with mileage of 20 km/litre
5. Daily distance covered by a conventional 2 W was taken at 50 km with mileage of 60 km/litre
6. Total number of operational days were considered as 300

Table 6: Carbon Emissions from Different Fuels[2]

Fuel	Carbon emission in kgCO2/litre
Petrol	2.392
Diesel	2.64
CNG	1.72
LPG	1.15
Petrol/CNG	1.92
Petrol/LPG	1.52

[2] https://shaktifoundation.in/wp-content/uploads/2017/06/WRI-2015-India-Specific-Road-Transport-Emission-Factors.pdf

Since 3Ws in each city were of different fuel types, the weighted average based on the number of vehicles (as of Sep. 2022) was calculated for each city. For 2Ws, petrol was taken as the only fuel type.

Table 7: Carbon Emission Factor for Each City

City	Carbon emission factor for 3W		Carbon emission factor for 2W
	Kg/litre	Kg/km	
Delhi	1.923	0.096	**0.039**
Bengaluru	1.86	0.092	
Jaipur	2.06	0.103	
Lucknow	2..09	0.104	

Table 8: Number of 2W & 3Ws based on Fuel Type

City	E-3W	CNG	DIESEL	LPG	Petrol	Petrol/CNG	Petrol/LPG	Total ICE vehicles
All Cities	204,472	104,499	65,279	2,620	131,286	128,256	238,444	670,384
	E-2W		**E-2W used for delivery**					
	94,337		4,691					

Carbon emissions avoided per day through E-3W – 1,610,744.88 kgCO2

Carbon emissions avoided per day through E-2 W – 187.82 kgCO2

Total carbon emissions avoided per day – 1,610,932.69 kgCO2

Total carbon emission avoided per year – 483,279.81 tonnes kgCO2

4 City wise Data Analysis

Delhi

To ensure connectivity with different transit systems like Mass Rapid Transit System (MRTS), Bus Rapid Transit System (BRTS), and Light Rail Transit System (LRTS), etc. E-3Ws are becoming a preferred mode of transport for passengers.

As of September 2022, 12,982 E-3Ws comprised more than one-fourth of the total 3Ws sold across Delhi. Due to significant operating cost savings over 3Ws fuelled by fossil fuels, E-3Ws are also being adopted very well in the last-mile delivery market. This is preferred by the small business units whose load requirements are either less or equal to one tonne. This also becomes a sustainable, pollution-free solution in the cargo segment. 2Ws are a preferred choice for delivery in the hyperlocal segment. The use of 2Ws in commercial applications has increased with the rise of the gig economy. In hyperlocal delivery, the courier agent typically uses 2Ws and travels between 5 and 15 kilometres to deliver the product from the vendor to the customer, taking between 2 and 8 hours.

One of the challenges associated with last-mile delivery using 2Ws is related to the cost, as no consolidation of goods is possible here. Here, using EVs brings cost saving to the driver as the operating costs are very low. Zypp electric is a Gurugram-based start-up that provides EVs for last-mile delivery in Delhi or Gurgaon to the companies such as Swiggy, Zomato and Zepto, which are looking for a green fleet solution. To curb the problem of air pollution and accelerate EV adoption in the delivery segment, the Dialogue and Development Commission of Delhi in India has prepared a roadmap for 100 percent electrification of last-mile delivery service fleets by 2030.[3]

Delhi has the highest percentage of E-2W&3W amongst the selected cities, with 26.75 percent of all 3Ws being electric. The after-sales and service market

[3] https://ddc.delhi.gov.in/sites/default/files/multimedia-assets/roadmap_for_100_delivery_electrification_in_delhi.pdf

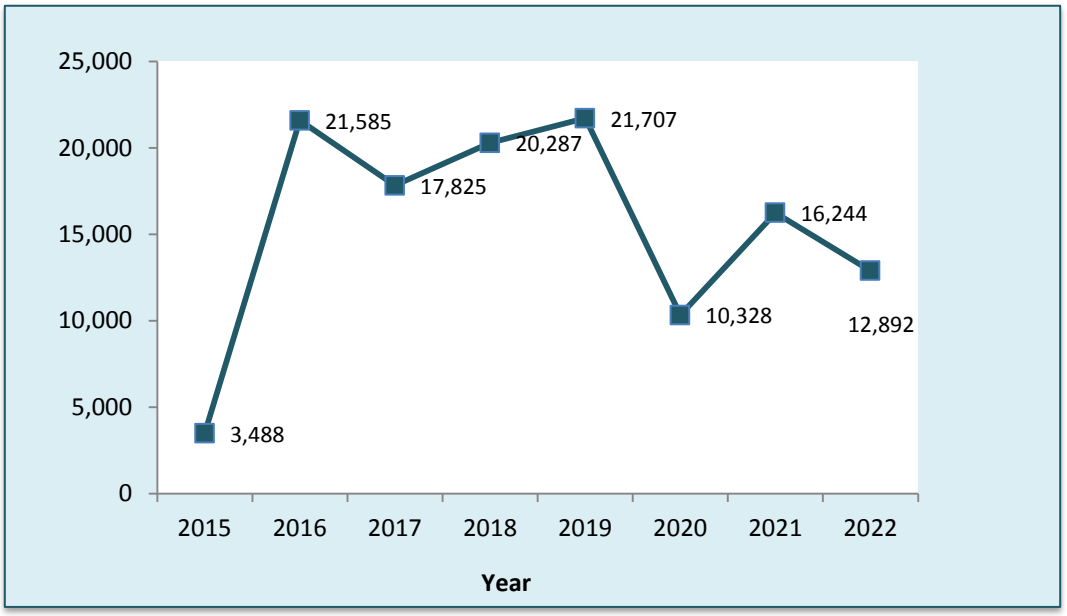
is also quite evolved compared to other cities. A total of 30 stakeholders, including dealers, manufacturers, consumers, aggregators, E-3W operators and delivery agents, were interviewed to assess the economic and social impacts associated with electric mobility.

Table 9: Stakeholders Surveyed in Delhi

City	Stakeholder Category	No. of Stakeholders interviewed
Delhi	Dealers	09
	Manufacturers	01
	Consumers	09
	Demand Aggregators	01
	E-3W Operators	09
	Delivery Agent	01

Sales growth in E-3W in Delhi is among the highest across all cities of India, with a CAGR of 65 percent. Growth trends in towns picked up massively after the COVID pandemic, whereas in Delhi, sales were much higher than in 2015. The dip in sales in 2002-21 can mainly be attributed to nationwide lockdown resulting in a halted economy

Figure 2: Year wise E-3W Sales in Delhi since 2015



Delhi is also the most evolved in terms of technology usage, with lithium-based batteries having a noticeable presence E-3W market which is dominated by lead acid batteries in other cities.

The city fared well on the targeted parameters of economic, social and environmental aspects compared to other cities considered for the project.

Economic

The last-mile connectivity segment has immense potential for job creation and increased income. However, if analysed, different sub-categories emerge which are impacted variably in terms of socio-economic development. There are three categories of E-3W operators.

- Self-owned and self–financed
- Self-owned but market financed
- On rent basis

And four categories of the nature of the job

- First job
- Transition from a different job
- Due to job loss during the COVID pandemic
- Part-time/ additional job

The degree of income levels varies across these sub-categories. While self-owned and self-financed mechanisms provide higher income opportunities, market financed and renting vehicles are not as lucrative. Per day rent of E-3W ranges between INR350-500, which is almost one-third and sometimes half of a day's earning. Additional per day battery charging and vehicle parking costs make driving an E-3W financially unsound. The same applies to market-financed vehicles with high-interest rates, credit unworthiness and late subsidy disbursal discouraging the potential buyer. The need for battery replacement every 8-10 months based on the usage pattern almost eats up whatever savings could have been managed through meagre per day income.

For youth taking up operating E-3W is an attractive idea and rightly so because of few financial responsibilities and our surveys reflected the same. It was also observed

that some of the operators were only driving when there was no other work available in their skill domain. These mostly included house construction workers, electricians, daily wage labourers etc. The juggling of jobs provided a financial cushion when their primary job was suspended.

For E-3W operators who took this profession because of job loss during covid pandemic or found this idea a much better alternate to their existing jobs, the opinions were mixed based on increase or decrease in level income, flexible working hours, and a sense of entrepreneurship or added asset management responsibilities being the guiding factors.

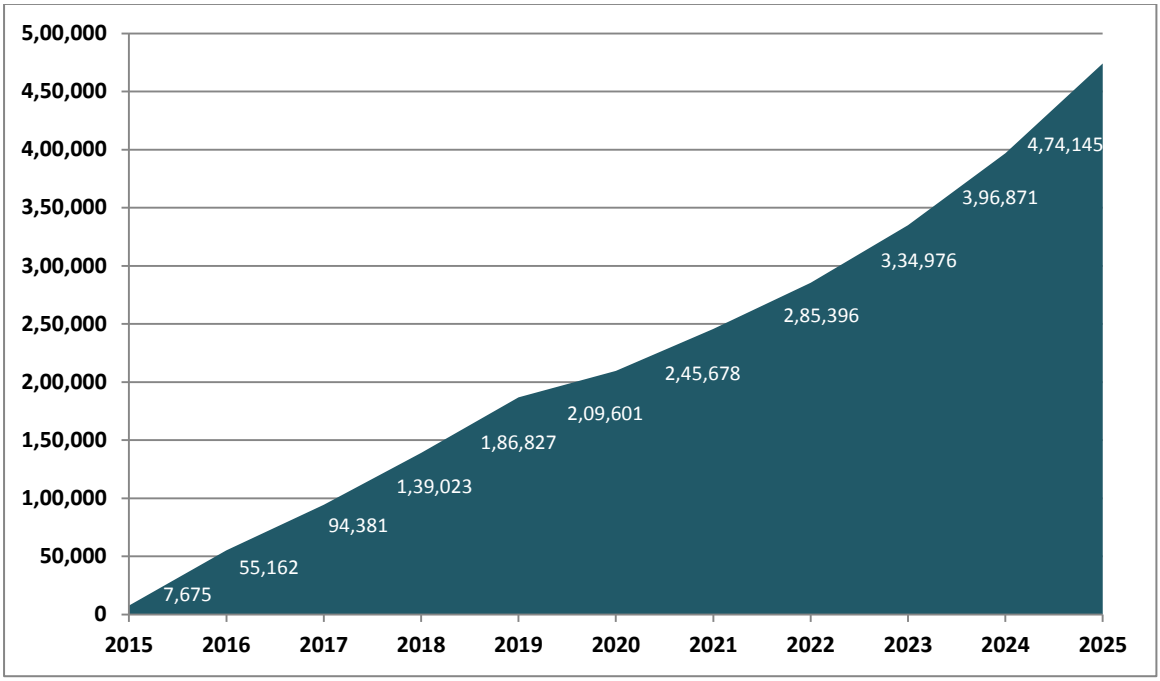
Job Growth

As per the rise in sales of E-3W and 2W & direct and indirect jobs associated with the last mile delivery segment, we estimate close to 474,145 jobs in this sector by 2025.

Table 10: Employment Generation in Delhi in Electric Last Mile Connectivity

Year	Cumulative E-3W sales	Employment generation due to E-3W	Cumulative E-2 W Sales	Employment generation due to E-2W	Total Employment Generation
2015	3,488	7,674	22	1	7,675
2016	25,073	55,161	40	2	55,162
2017	42,898	94,376	109	5	94,381
2018	63,185	1,39,007	365	16	1,39,023
2019	84,892	1,86,762	1,425	64	1,86,827
2020	95,220	2,09,484	2,592	116	2,09,601
2021	1,11,464	2,45,221	10,158	457	2,45,678
2022	1,28,906	2,83,593	40,072	1,803	2,85,396
2023	1,50,708	3,31,558	75,968	3,418	3,34,976
2024	1,77,961	3,91,514	1,19,044	5,357	3,96,871
2025	2,12,028	4,66,462	1,70,736	7,683	4,74,145

Figure 3: Job Growth Estimates for Delhi in Electrification of Last Mile Connectivity



Gender Inclusivity

Delhi performs better in terms of gender inclusivity. It was observed that of every ten E-3W operators, 02 were women. The ratio is quite low but provides a positive outlook for this sector. Women prefer to drive E-3W&2W to offer extra financial support for their families, which in most cases fall under the low-income categories. The flexible time routine and work-when-you-want approach support them in managing family duties and extra earning opportunities. More women would likely adopt a hands-on approach to the E-mobility transition of last-mile connectivity.

Skill Inclusivity

In some states, an E-3W driver trainee must be trained by an individual with at least three years of experience driving and E-3W to obtain the driving permits. This poses certain hurdles as the market itself is new and constantly evolving. Most drivers are relatively new, with only one-two year of driving experience. In contrast, many early starters have transitioned to different jobs or bought more vehicles and started renting them out instead of driving.

The aftersales and service segment has also not grown enough to sustain the rising number of vehicles. There are few mechanics/ spare part dealers outside the

manufacturer network. But as the market grows, we can expect more such interventions in the skill space. Governments at both the central and state level and the industry are taking up the initiatives such as on-the-job training programmes and EV-specific EV courses, which will further strengthen the EV ecosystem and the last-mile connectivity segment.

Pollution Reduction

Delhi is counted as one of the most polluted cities in the world.[4] Despite several interventions by the Delhi government, including installing smog towers across different locations, stricter compliance for pollution under control (PUC) certificates and environmental norms for building construction, the National Capital Region (NCR) has higher pollution levels than any other city in India.

Transport is a major factor which contributes to the ever-rising pollution levels. To curb pollution through transport, the Delhi government, under the National Electric Bus Programme, plans to acquire 3,980 electric buses for public transport. Significant as it may be, the role of the last-mile delivery segment in curbing pollution further is critical to attaining a zero-emission transport network.

Based on the assumptions for carbon reduction, it was observed that Delhi has the maximum carbon reduction by greening the last-mile connectivity segment.

Table 11: Number of 2W & 3Ws in Delhi based on Fuel Type

City	E-3W	CNG	DIESEL	LPG	Petrol	Petrol/CNG	Petrol/LPG	Total ICE vehicles
Delhi	123,114	90,522	529	0	71,329	122,107	38,869	323,356
	E-2W		E-2W used for delivery					
	33,917		1,696					

Carbon emissions avoided per day through E-3W - 946,759.47 kgCO2

Carbon emissions avoided per day through E-2 W - 67.60 kgCO2

Total carbon emissions avoided per day - 946,827 kgCO2

Total carbon emission avoided per year – 284,048 tonnes kgCO2

[4] https://www.indiatoday.in/education-today/gk-current-affairs/story/list-of-20-most-polluted-cities-in-thE-world-1990041-2022-08-19

Improved Standard of Living

Despite the apparent benefits of greening last-mile connectivity, the sector faces a critical problem, especially in the case of E-3Ws - speed constraints. E-3Ws, till now, have speed limits of 25-40 kmph, depending on the load. Though the speed is within safe limits, it puts traffic constraints within city limits, wherein 20-30 E-3Ws running on a busy stretch can cause massive congestion issues. All the cities considered for this project had some restrictive mechanism which confined these vehicles to inner city areas or identified designated areas.

In Delhi itself, there was zero availability of EVs near major transport hubs such as Dhaula Kuan or New Delhi Railway Station and passengers had to rely on vehicles operated mostly by CNGs. This temporary problem can be resolved once the market matures and relatively higher-speed EVs are adopted in the last-mile connectivity segment.

Within the inner city regions of each city, E-3Ws do pose a traffic congestion problem but are quite economical, easy to access and provide better rise comfort than overcrowded city buses.

Overall, the standard of living for both the consumer and the service provider, including goods delivery, can be assumed to have improved but still has some rough edges that need to be polished.

Bengaluru

Even though E-3Ws sales comprised only 4 percent of the total 3Ws sold, Bengaluru ranked second among the tier 1 cities in adopting E-3W as the last mile connectivity option. With the recent announcement by the city municipality to expand the Metro line, the market for E-3W sales is bound to increase. Again, the surge in online shopping, especially after the pandemic, will compel the business owner to look for cheaper alternatives where they do not have to spend much on operating costs.

Here, the use of E-3W as a delivery option can also be explored, considering increased consumer preference towards online shopping. Along with this, with a strong policy focus on EV ecosystem development by the Karnataka government, Bengaluru has the potential to lead in EV manufacturing and its adoption in the last-mile connectivity segment. Bangalore is also actively transitioning to E-2Ws in the last-mile deliveries segment. Many start-ups are working in the delivery market and

are planning to deploy EVs in their fleet. For example, Swiggy plans to cover 8 lakh km per day using EVs by 2025 of which most of the distance covered will be through E-2Ws. Bangalore-based Welectric is also working towards electric mobility in last-mile connectivity.

Karnataka has been the frontrunner in promoting E-mobility in India by introducing the EV and Energy Storage Policy in 2017 to encourage EV adoption while creating EV charging facilities. Not only the State EV policy aims to convert 50 percent of its public transport fleet into EVs by 2030, but it has also made a strong mandate of transforming Bengaluru into the EV capital of India.

However, with an EV policy that puts a greater focus on attracting investment, research & development (R&D) and no direct subsidy for EV owners (except road tax and registration fee exemption) - Karnataka has become a hub of EV manufacturing, housing 47 start-ups working in the EV sector[5], including leading players such as Mahindra Electric, Ather Energy, Ola Electric, Bosch and Sun Mobility. In addition to this, several EV-based micro-mobility and bike-sharing start-ups such as Yulu, Evo, Faebikes, Vogo, and Bounce have also sprung up in Bengaluru in recent years to provide greener alternatives to people and relieve the overburdened and congested transport system of the city.

Besides these, app-based E-grocery platforms such as Bigbasket and logistic companies like DHL are using E-carts (E3W-based carts), while food delivery services like Zomato and Swiggy are shifting to E-bikes (E-2W) for intra-city deliveries.

In a bid to further promote the adoption of greener alternatives in the last-mile delivery segment, the Bengaluru Postal department partnered with Yulu and undertook a pilot project to use their E-bikes to deliver letters and parcels across the city.[6] While the initiative was launched at the JP Nagar sub-post office in October 2021, it was largely motivated by rising fuel costs and was a first of its kind in the country.

Bengaluru is a major manufacturing and R&D hub of electric mobility in the country, with all major players in the industry headquartered at various locations in the city.

[5] https://economictimes.indiatimes.com/industry/renewables/karnataka-tweaks-ev-policy-to-offer-15-capital-subsidy-to-investors/articleshow/83007932.cms?from=mdr

[6] https://www.newindianexpress.com/cities/bengaluru/2022/apr/01/duE-to-high-cost-bengaluru-postal-div-drops-plan-to-usE-yulu-bikes-for-deliveries-2436506.html (Picture taken from Yulu's twitter handle https://twitter.com/YuluBike/status/1448933458982555648/photo/3)

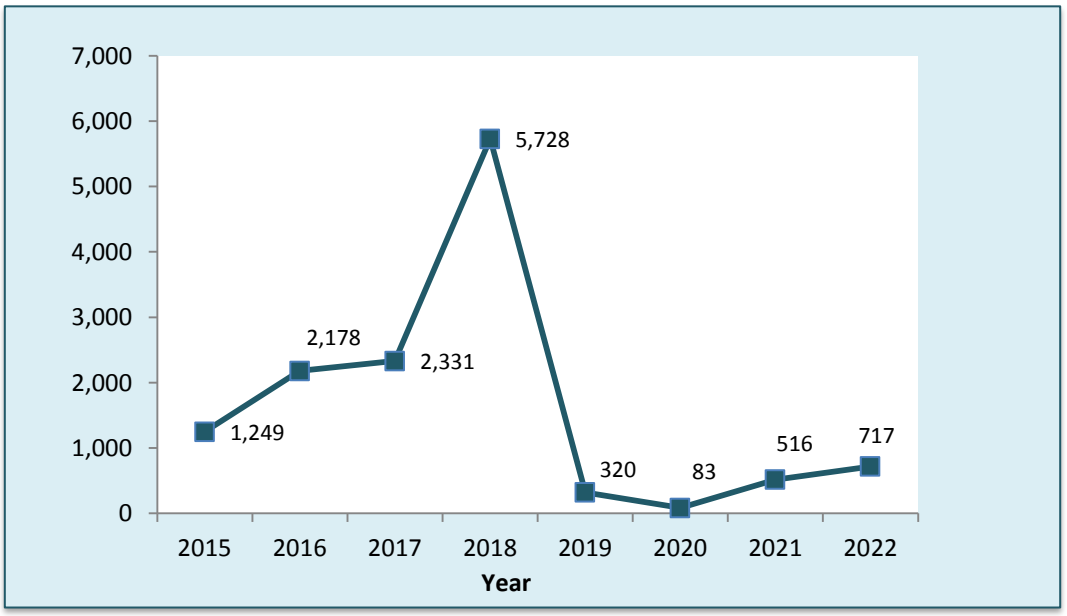
Besides manufacturers, there are a large number of fleet aggregators such as Lithium Urban Technologies, SainikPod, Yulu, Faebikes, and so on who provide E-cab and E-bike rental services to corporates as well as the general population, especially those who work on flexi-time schedules since public transport with no last-mile connectivity is not an option for them.

Thus, to understand the social, economic, and environmental impacts of EV integration in the last-mile segment, we divided out surveys amongst the major stakeholders in the EV scene of the city- Manufacturers and Fleet aggregators, EV Users, and Dealers. The details and insights from the qualitative surveys undertaken have been presented below.

Table 12: Stakeholders Surveyed in Bengaluru

City	Stakeholder Category	No. of Stakeholders interviewed
Bengaluru	Dealers	10
	Manufacturers	06
	Consumers	04
	Demand Aggregators	04
	E-3W Operators	03
	Delivery Agent	03

Figure 4: Year wise E-3W Sales in Bengaluru since 2015



It can be observed that the growth of E-3Ws has been rather dismal with registered sales recording a negative CAGR of approximately 0.07 percent. While E-3Ws recorded a steady growth up to 2018, it suddenly recorded a fall of about 94.4 percent in 2019. This was followed by another blow to E-3W sales in 2020 owing to the COVID-19 pandemic. Since then, sales in this segment have improved, albeit rather slowly and in line with the Indian economy, which is gradually opening up post-pandemic.

However, unlike other cities, the rise in demand for E-2Ws is fast rising in Bengaluru, which was further confirmed by dealers we interviewed, who largely attributed this rise to the central subsidies provided by the Indian government as well as the pandemic, which pushed people to invest in affordable private vehicles owing to covid protocols like maintaining a safe distance in public spaces, including public transport. Also, during this time, many people, including migrant labourers from different states, started taking up delivery work as a stopgap measure or an alternative means of livelihood, which in turn gave a boost to micro-mobility aggregators like Yulu. With the fuel price hikes, renting electric bikes without any ownership costs proved to be a game-changer for such gig workers.

Job growth

Several corporates and start-ups are making huge investments in the growing E-mobility industry in Bangalore; Indian EV start-ups are expected to reach $15,397 billion by 2027[7]. In India, where vehicular pollution is a major concern for climate change and rising temperatures, alternative clean mobility is expected to play a crucial role in improved environmental outcomes. The leading start-ups instrumental in providing sustainable transport solutions in and around Bangalore are Ather Energy, Altigreen, BOLT, Pi Beam, Baaz Bikes, and so on.

As the government promotes the indigenisation of EV and its components manufacturing, this sector's associated employment generation potential is also increasing gradually. The entire spectrum of the EV industry has several segments that can generate employment, albeit with requirements of specific skill sets. According to a study, the Indian EV sector will be a US$206bn opportunity by 2030,[8] indicating a significant rise in employment.

[7] https://www.mordorintelligence.com/industry-reports/india-electric-vehiclE-market
[8] https://www.thehindu.com/business/indias-ev-sector-to-offer-206-bn-opportunity-by-2030-study/article33282411.ece

In the last mile segment in Bangalore, EVs are used as passenger vehicles and in moving medium and large-size shipments with a significant operating cost advantage. Therefore, the future of urban freight movement also lies in electrifying last-mile mobility. Going by the traffic forecast in the last mile segment, the logistics players in and around Bangalore have started exploring alternative modes of transportation at different scales to reduce the carbon footprints of inter and intracity logistics.

As a result of the changing pattern of purchase mediums, the demand for last-mile delivery may result in approximately 36 percent more delivery vehicles in the top 100 global suburbs by 2030, according to a study by the World Economic Forum[9]. This indicates ever-increasing traffic on the road resulting in a higher level of vehicular pollution if appropriate actions are not taken by the authorities concerned.

As a convenience, delivery speed, and efficiency continue to be crucial parameters for ensuring customer satisfaction, we are witnessing a steady upward trend in the use of EVS, especially in the last-mile operations segment in Bangalore. With an increasing demand for dynamic, app-based 'on-demand' services, E-commerce giants including Amazon, Flipkart, and Big Basket have started emphasising embracing a transition towards sustainable energy consumption through measures like rapid adoption of battery-operated electric delivery vans for their last-mile deliveries.

Although owing to limitations like lack of adequate charging infrastructure, the general preference has been for the Plug-in Hybrid Electric Vehicles (PHEVs) that have both an internal combustion engine and electric motor, running partially on fuel and electricity. However, this trend is gradually shifting towards EVs, at least in the last mile segment, with the emergence of players like fleet aggregators.

Fleet aggregators also play an important role in shifting the burden of upfront costs to procure vehicles by delivery partners. This rental model, coupled with affordable pricing, has been quite successful in last-mile logistics, whether for delivering goods/ food or for the daily commute of corporate employees. According to Vogo, a 2W rental start-up, only 8 percent of the total demand they catered to was from the delivery executives and front-line workers in 2020 in Bengaluru; however, this increased to 54 percent by April 2021.

[9] https://auto.economictimes.indiatimes.com/news/aftermarket/growth-of-urban-last-milE-delivery-will-add-36-morE-vehicles-globally-by-2030/73580524

According to studies, 46 percent of this 54 percent rise was from the delivery executives in the last-mile food and goods segment. This certainly highlights the rise in employment due to better E-mobility networks, especially in the last-mile segment. Post-pandemic, the fleet aggregators also diversified their profiles to cater to different sections of stakeholders and came up with provisions for customised packages. With the gradual indigenisation of EV technology, the overall E-mobility network in the IT Capital of India is expected to become more convenient and economically viable.

On this note, a case worth mentioning is that of the start-up MotherPod Innovations Private Limited, a shared mobility solutions provider, and Electrodrive Powertrain Solutions Private Limited (Electra EV), which collectively launched the 'SainikPod Sit & Go' mobility service in Bengaluru in 2021.[10] It is an ex-servicemen-driven initiative and was started to provide dignified employment to ex-servicemen (Sainiks) and their families.

As a popular trend in Bangalore, start-ups working in the E-mobility space often tie up with large-scale EV manufacturers – e.g., Bykemania - a company that operates across Bengaluru, Delhi, Bhubaneshwar, and Kolkata, collaborated with Hero Electric for delivering 5,000 EVs from its City-Speed category. In such collaborations, the manufacturer generally provides service support through its dealer network and an electric mobility solution ecosystem through an all-inclusive leasing solution.

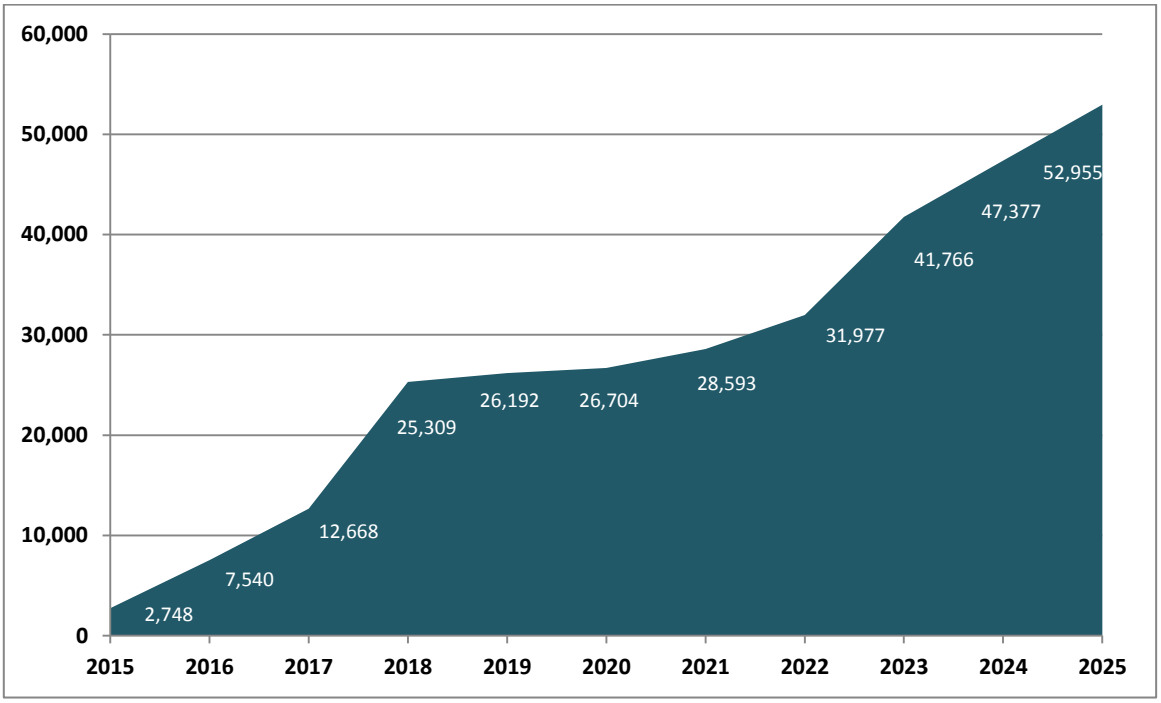
It is important to note that due to the low running and maintenance costs of EVs, it automatically becomes a cheaper yet less-polluting alternative to a traditional vehicle in the long run. The fuel cost incurred by an ICE vehicle's owner, when compared with the monthly rental charge of electricity, is significantly higher, especially with the recent rise in conventional fuel prices. While cost implication, in the long run, has been one of the major reasons behind people's preference for EVs over ICE vehicles in Bengaluru, its proximity to Hosur, the automobile manufacturing hub of Tamil Nadu, has further contributed to the growing EV market in the former location fuelled by Government policies and incentives.

[10] https://www.financialexpress.com/auto/electric-vehicles/bengaluru-new-electric-taxi-servicE-ex-servicemen-sainikpod-sit-go-electric-cars-tata-nano-range/2179611/

Table 13: Employment Generation in Bengaluru in Electric Last Mile Connectivity

Year	Cumulative E-3W sales	Employment generation due to E-3W	Cumulative E-2 W Sales	Employment generation due to E-2W	Total Employment Generation
2015	1,249	2,748	1	-	2,748
2016	3,427	7,539	3	-	7,540
2017	5,758	12,668	4	-	12,668
2018	11,486	25,269	528	39	25,309
2019	11,806	25,973	2,923	219	26,192
2020	11,889	26,156	7,314	548	26,704
2021	12,405	27,291	17,355	1,301	28,593
2022	13,122	28,868	41,446	3,108	31,977
2023	16,752	36,854	65,484	4,911	41,766
2024	18,499	40,698	89,058	6,679	47,377
2025	20,245	44,539	1,12,213	8,415	52,955

Figure 5: Job Growth Estimates for Bengaluru in Electrification of Last Mile Connectivity



Gender Inclusivity

In a recent survey done by CIEL HR Services, it has been seen that Bengaluru leads as a hub for EV-related opportunities, housing almost 62 percent of EV-related jobs in the city[11]. A significant portion of these newly emerging jobs are from the last mile logistics and these are expected to grow further in the coming years. As announced by the company's Chairman, Ola's Future factory will be run completely by an all-woman workforce with a capacity of 10,000 female employees.

From our field surveys, we also found that several app-based E-commerce platforms like Zomato, Swiggy, and Dunzo have started engaging women as delivery executives and EV dealers who have women in sales and marketing departments. However, the number of women in on-field operations requiring technical know-how is still low, as most manufacturers reported having women only in managerial and administrative roles. In the case of fleet aggregators, most reported having hired female drivers in the past but owing to long and unpredictable work hours, and they backed out after a few months. They added that this trend of women drivers leaving the workforce during the pandemic was especially prominent as caregiving responsibilities at home burdened them.

Another major move from the aggregator perspective is to draw in more crowds, especially women passengers and to make them feel safe, start-ups like Lithium Urban and Sainik Pod have additional features in their EVs, such as a tamper-proof GPS to monitor the movement of the vehicle and panic buttons, which can be used to alert family and friends in case of any emergency. Besides these, all cars are equipped with a live dashboard connected to the company's server at all times.[12] These features have been specially included in a bid to make EVs more reliable as a major customer base for these aggregators are corporates and their employees. Most of them have flexible timings and night shifts, making

Skill Inclusivity

Over the last few years, Bengaluru has become the R&D and entrepreneurship capital for E-mobility, creating many employment opportunities for the youth. The incubation facilities offered by various academic institutions in Karnataka and its neighbouring state Tamil Nadu (including IIT-Madras) have been crucial for the

[11] https://www.cielhr.com/wp-content/uploads/2022/05/Latest-Employment-Trends-in-EV-Sector-2022-Report-2.pdf

[12] https://www.deccanherald.com/content/490100/electric-cab-servicE-gets-high.html

emergence of successful start-ups in this domain, many of whom are investing in technology and business models for the last mile logistics.

On the other hand, Bangalore Electricity Supply Company Limited (BESCOM), the nodal agency to promote EV growth, has played an instrumental role in setting up EV charging stations in more than 70 locations. Such proactive measures from the government have escalated the growth of EVs in the city, making the transport sector cleaner, providing the mass with sustainable mobility options, and simultaneously addressing the demands for jobs. The ITIs and other private entities such as SkillDzire provide vocational training in E-Mobility, E-2W and E-3W repairing, EV charging Station installation, etc. On the successful completion of their training, the trained workers can later be absorbed by the fleet Aggregator and other EV entities working in the EV industry in various capacities, including drivers, technicians, and charging station workers.

Pollution Reduction

With its population increasing every year owing to the growing opportunities resulting from a rapidly growing IT industry, Bengaluru draws in a significant population from different parts of the country. This growth has also increased demand for public transportation and private vehicle ownership, resulting in more vehicles on the road than their capacity. This has led to traffic congestion leading to people spending longer hours stuck in traffic jams increasing the time spent commuting.

Besides this, the rise in the number of vehicles plying the road has also been accompanied by the rise in the volume of vehicular carbon emissions and deteriorating air quality. To tackle this issue- the Karnataka state government has been rather instrumental in promoting EVs in the state, to the extent that it is the first state in India to come up with an EV policy in 2017. Besides that, the state government is keen on making Karnataka a hub of EV manufacturing and R&D since its EV policy is more geared towards attracting manufacturers with its capital and production-linked subsidies.

As a result, Bengaluru currently is home to about 47 EV start-ups which include all major players in the EV space like Ather, Sun Mobility, Mahindra Electric, and Ola Electric, along with several ridE-sharing fleet aggregators, which also include micro-mobility start-ups like Yulu, Faebikes, Vogo, and Lithium Urban and so on.

Table 14: Number of 2W & 3Ws in Bengaluru based on Fuel Type

City	E-3W	CNG	DIESEL	LPG	Petrol	Petrol/CNG	Petrol/LPG	Total ICE vehicles
Bengaluru	14,392	2,871	41,391	1,580	57,876	1,757	1,84,537	2,90,012
	E-2W		**E-2W used for delivery**					
	43,778		2,169					

Carbon emissions avoided per day through E-3W – 106,930.94 kgCO2

Carbon emissions avoided per day through E-2 W - 87.26 kgCO2

Total carbon emissions avoided per day – 107,018.21 kgCO2

Total carbon emission avoided per year – 32,105.46 tonnes kgCO2

Improved standard of living

EVs have successfully improved the standards of living of all the stakeholders involved, starting from manufacturers, dealers, fleet aggregators, and users. While manufacturers are getting all the help from the Karnataka government in terms of infrastructure, capital subsidies, and a host of other incentives such as stamp duty exemption and a 0.1 percent registration fee, dealers are also benefitting from the increased demand for high sales. The medium to small dealers we interviewed reported a minimum of two weeks for E-2W and E3Ws, while industry leaders like Ather reported a waiting time between 6-7 months for an E-2W.

From the perspective of fleet aggregators, the business has been booming, with start-ups like Yulu and Lithium Urban securing hefty investments and capturing a significant market share through corporates and gig workers.

Jaipur

Through its EV Policy, the state has subsidised E-2W& 3Ws based on the battery capacity. This subsidy component, coupled with the central government incentive, has resulted in increased adoption of E-3W in the city for both passenger use and goods delivery. As of September 2022, E-3Ws comprised roughly 40 percent of the total 3Ws sold, the second highest among all tier 2 cities. Jaipur has a robust road network system compared to Metro transit, which is at a nascent stage. With the ongoing efforts by the governments towards infrastructure development, the city has the potential to increase its share of EVs shortly.

Jaipur is bestowed with various transport services such as city buses, metro rail and cabs. The E- 3Ws, auto 3Ws and cycle 3Ws in the city facilitate feeder to the mass transport services for both tourists and long-term residents. According to Ola mobility institute's Ease of moving index, Jaipur's transport system is efficient, but the last mile connectivity is a big challenge.[13] The last-mile connectivity of the city is primarily dependent on auto 3Ws and E-3Ws sprawled throughout the city. Though E-3Ws are relatively new, they have become the masses' preferred mode of last-mile connectivity.

The drivers generally own the E-3Ws in Jaipur city, or they are rented to the drivers daily by a contractor. The major population driving the E-3W belongs to the BPL segment that migrated to Jaipur. The contractor system provides opportunities for the migrated people to earn their livelihood and daily wages. Earlier, there were no financing options available. But with, the registration of E-3W by the government has led to the development of financing facilities. As a result, a large increment could be seen in the registration of E-3W in Jaipur city.

The application of E-3W in the city of Jaipur has been observed since 2012. The recent statistics from the Rajasthan Transport portal show a growth of more than 200 percent per year with the capability to phase in more than 12000 E-3Ws, employing more than 17000 registered E-3W drivers in the city of Jaipur. This also contributes to the increment in the number of E-3W dealers in Jaipur city above 65.

With the growing concerns of pollution and population, concerns regarding the mode of transport are also growing. Earlier before 2014, the battery-operated E-3Ws did not come under the ambit of the Motor Vehicles Act, of 1988 and were not licensed. This led to the absence of government rules governing the actions of battery-operated 3Ws; hence, the driver will not be prosecuted by the Traffic Police. As such, these vehicles were considered and deemed to be unsafe. As per the report prepared by TERI, 80 percent of passengers felt unsafe in an E-3W.

This, in turn, led to the regularisation and registration of E-3Ws, as the government authorities held hands in 2015. From a socio-economic point of view, the registration and regularisation of these vehicles led to the development of financing options in the form of government and private authorities.

[13] https://olawebcdn.com/ola-institute/easE-of-moving.pdf

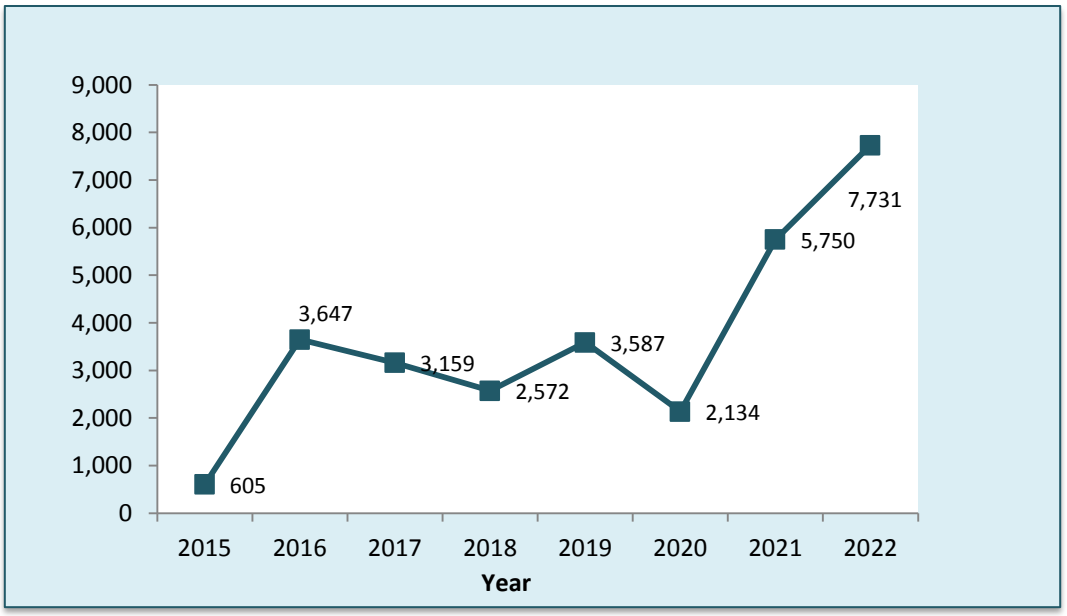
We surveyed the key city stakeholders to assess the social, economic, and environmental effects of the E-3W. There are a lot of dealerships of E-3Ws in the city, even though there are no major manufacturers here. Since Jaipur is near NCR, which boasts a manufacturing hub, it is one reason for having many dealerships here. We covered 10 Dealers, and the users' perspectives and E-3W drivers were also considered. The Survey details are given below:

Table 15: Stakeholders Surveyed in Jaipur

City	Stakeholder Category	No. of Stakeholders interviewed
Jaipur	Dealers	10
	Consumers	10
	E-3W Operators	10

- The Regularisation and registration of E-3Ws in Jaipur started in 2015
- There was a surge in the number of e-3Ws in the year 2016
- Number of E-3Ws dropped due to the pandemic and lockdown imposed by the governments
- There was again an increase in the no. of E-3Ws in 2021, which can be attributed to the fact that due to the pandemic, many people lost their job and turned to E-3Ws for employment

Figure 6: Year wise E-3W Sales in Jaipur since 2015



Job growth

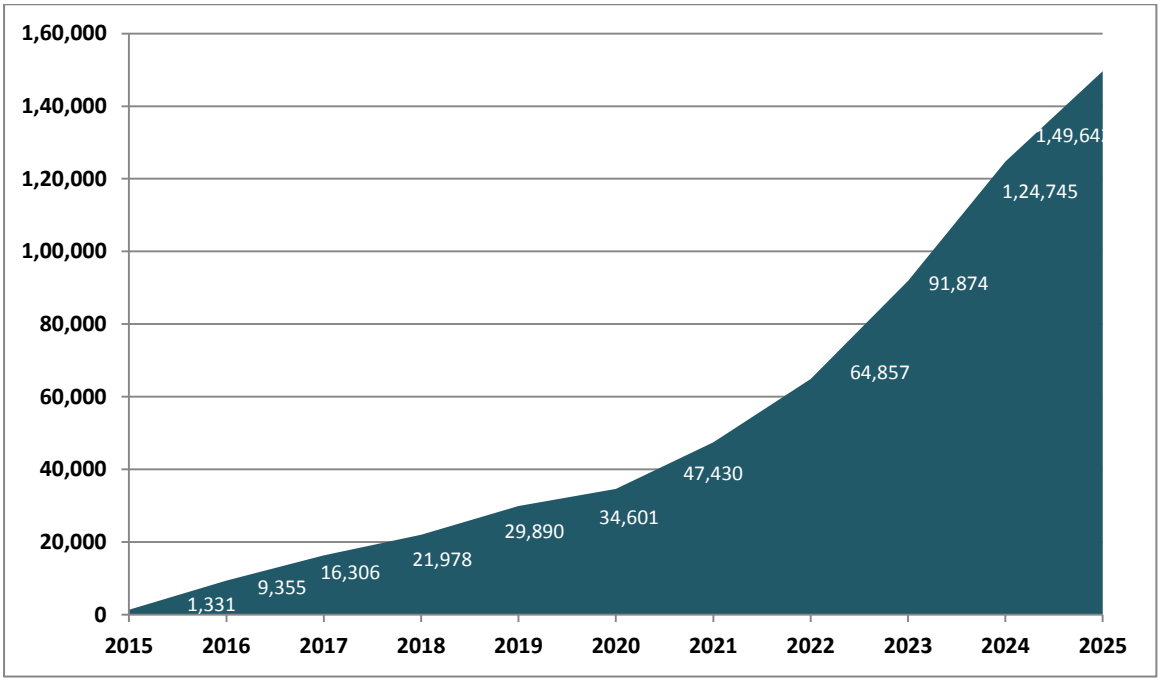
The E-3Ws in Jaipur has proven to be a better alternative over cycle 3Ws and auto 3Ws. It has helped a range of city dwellers, including migrant workers and people employed in different sectors previously that had lost their job due to the COVID-19 pandemic, to find employment with a decent wage. We also found through this study that most E-3W drivers were previously unemployed or 3W pullers. This has created an era where people have started to develop earnings and employment for their livelihood. Other respondents were previously factory workers and daily wage labourers, who registered a growth in their incomes. This has also provided people with an extra earning opportunity as many of the E-3W drivers were doing this as a secondary job.

The E-3W ecosystem has enabled the city to employ thousands of people. The majority of the jobs for the people have been in E-3W component manufacture, dealerships, maintenance, logistics, and driving. The E-3W ecosystem has enabled the city to employ thousands of people. The majority of the jobs for the people have been in E-3W component manufacture, dealerships, maintenance, logistics, and driving. The following data shows the cumulative no. of E-3Ws and E-2Ws as of 21st September 2022. The graph follows a linear trend indicating the number of jobs through electric 3Ws and 2Ws will increase significantly.

Table 16: Employment Generation in Jaipur in Electric Last Mile Connectivity

Year	Cumulative E-3W sales	Employment generation due to E-3W	Cumulative E-2 W Sales	Employment generation due to E-2W	Total Employment Generation
2015	605	1,331	1	-	1,331
2016	4,252	9,354	5	-	9,355
2017	7,411	16,304	42	2	16,306
2018	9,983	21,963	336	15	21,978
2019	13,570	29,854	799	36	29,890
2020	15,704	34,549	1,162	52	34,601
2021	21,454	47,199	5,133	231	47,430
2022	29,185	64,207	14,439	650	64,857
2023	41,359	90,990	19,643	884	91,874
2024	56,244	1,23,737	22,410	1,008	1,24,745
2025	67,419	1,48,322	29,335	1,320	1,49,642

Figure 7: Job Growth Estimates for Jaipur in Electrification of Last Mile Connectivity



Introduction of E-3Ws has also helped in mainstreaming petty criminals

Through the primary survey in Jaipur, we also found that petty crimes have reduced drastically after the induction of E-3Ws. Due to a lack of economic opportunities, petty crimes often increase. Now when an easy source of income is available, it is helping in the mainstreaming of the persons involved in petty crimes. Though the exact figures for the petty crime rate reduction are missing, the drivers and passengers confirmed this fact during the primary survey. This trend is predominantly visible in the periphery of the city.

Gender Inclusivity

Electric 3Ws give substantial savings for women drivers as there is a potential of earning up to INR18,000-20,000 per month for women from poor and marginalised communities, leading to improvement in their lives and livelihoods. Though women drivers are comparatively low in numbers compared to their male counterparts, with most of them driving mainly near Badi Chaupad and areas surrounding Hawa Mahal, the socio-economic impact of the involvement of women is quite encouraging.

For example, we spoke to Nirmala (E-3W woman driver), who has successfully pulled her family out of poverty by driving an E-3W. She also managed to bear all the marriage expenses of her daughter and bought one E-3W for her drunkard husband,

ensuring a healthy and prosperous life. This was one of the examples of women empowerment through e 3W throughout the city. Women E-3W owner-drivers frequently discover that owning an E-3W transforms their lives; they feel more autonomous and have increased self-esteem due to earning good pay. Another advantage is that female drivers make female passengers feel safer.

Skill Inclusivity

Given that EVs have far fewer moving parts than ICE vehicles, there are bound to be losses in certain jobs exclusive to the ICE vehicles value chain, like manufacturing fuel injectors, transmission systems, etc. RE-skilling and training existing and new workers are one way to mitigate the potential job losses resulting from the transition. The technological transformations brought in by the E-mobility transition will require adaptive skill up-gradation in professionals across the automotive ecosystem to overcome redundancy.

Like Lucknow, Jaipur has a few private institutes providing youth skill training. Still, there is a need to include these skill courses in Industrial training institutes, which should focus on up-skilling youth on basic technology, troubleshooting skills and capability.

Pollution Reduction

Jaipur is considered one of the most polluted cities in India and was ranked 70 In the IQAir report of the most polluted cities in the world. [14]The main reasons for this are fossil fuel-powered infrastructural development, industries, transport, waste burning and construction activity. Electrification of transport in cities like Jaipur can help control air pollution in these cities. As E-3Ws run on battery and not on petrol or diesel, they prevent and save smoke emissions while functioning. It is also a safer and eco-friendly option to use.

Besides being cheaper and having a high economic impact, E-3Ws also have a positive environmental benefit with zero tailpipe emissions. Additionally, the average energy consumption of electric 3W is 53.76 KJ/passenger/km, which is one of the most efficient forms of motorised transport.[15]

[14] https://www.iqair.com/in-en/world-most-polluted-cities

[15] Ramachandra TV, Shwetmala. Emissions from India's transport sector: state wise synthesis

Table 17: Number of 2W & 3Ws in Jaipur based on Fuel Type

City	E-3W	CNG	DIESEL	LPG	Petrol	Petrol/CNG	Petrol/LPG	Total ICE vehicles
Jaipur	29,269	1,823	16,681	1,039	436	504	14,945	35,428
	E-2W		**E-2W used for delivery**					
	14,439		716					

Carbon emissions avoided per day through E-3W – 241,650.33 kgCO2

Carbon emissions avoided per day through E-2 W – 28.55 kgCO2

Total carbon emissions avoided per day – 273,784.35 kgCO2

Total carbon emission avoided per year – 72,503.67 tonnes kgCO2

Improved standard of living

- We found through our survey that most E-3W drivers operate mainly throughout the day. This is because lead-acid battery power the majority of E-3Ws. Therefore, the vehicle gets charged at night and is ready to operate during the day. This has given them a decent standard of living as they can spend quality time with their family members, and also, they can use this spare time for other productive work.
- An electric 3W generates quite a good income at low operational expenses. We spoke about how an E-3W has helped them solidify their monthly income to a great deal, which has helped them save money for their children's education and future purposes.
- Many cycle 3W drivers are also switching to E-3Ws as it provides them with a better social status, more revenue and less strenuous work. Cycle 3Ws require much energy and hard work to earn a meagre amount of money, and this was a major reason for cycle 3W drivers to shift towards e 3W.

Division of Routes for E-3Ws in Jaipur

Since 2016, the city has witnessed a tremendous surge in E-3Ws. These 3Ws have often been blamed for slowing down traffic and operating without clear guidelines. One of the many complaints is that E-3Ws often swarm a particular point, leading to

traffic chaos. To curb this, in 2019, the RTO divided the city into eight zones to fix the routes of E-3Ws.[16]

These zones have helped ease traffic and distributed the routes of E-3Ws in the city uniformly. Though its long-term impact has not yet been established but E-3W drivers were satisfied with this since the zoning has helped them increase their daily earnings as only some E-3Ws use certain routes.

Lucknow

Uttar Pradesh had notified its EV policy as early as 2019 to promote investments in the EV sector and increase its adoption in the state. The state, in its policy, has clearly stated that it is going to phase out all conventional commercial fleets and logistics vehicles and achieve 50 percent EV mobility in goods transportation in identified 10 EV cities by 2024 and all cities by 2030. The state plans to roll out 1 million EVs across all segments by 2024 and set up 2 lakh slow and fast charging stations by 2024.

As a result, Uttar Pradesh's cities are seeing accelerated EV adoption. Lucknow has approximately 62 percent of 3W as electric, making it top among the tier 2 cities. Considering its young demographic and developmental works going around, the city can become 100 percent electric in 3W segment in years to come.

In August 2015, the state cabinet of Uttar Pradesh approved a budget of INR 372 crore for distribution of 27,000 E-3Ws in the first phase of the scheme to improve the pedal condition 3W puller and last mile connectivity in the city. This scheme generated interest among many and the number of E-3W started to increase gradually in Lucknow.

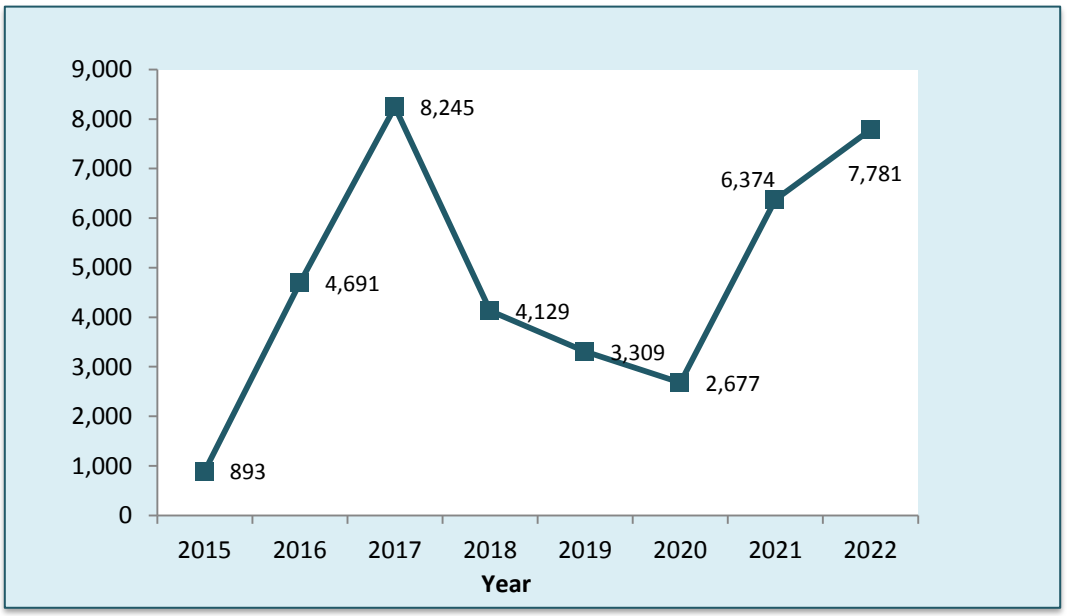
To measure the social, economic and environmental impacts of the E-3W, we conducted KIIs with the major stakeholders in the city. Lucknow is not a manufacturing hub of E-3W, and however, its vicinity with manufacturing hubs in the NCR region has led to the opening of several dealerships in the city. This was the reason for including 09 dealers from the city with one manufacturer/ assembler. The perspective of E-3W drivers and the users were also taken to get a comprehensive understanding of the situation. The details of the surveys are presented below.

[16] https://www.bhaskar.com/rajasthan/jaipur/news/E-3W-will-bE-divided-into-8-zones-in-jaipur-5-thousand-E-3Ws-in-every-zonE-01573067.html

Table 18: Stakeholders Surveyed in Lucknow

City	Stakeholder Category	No. of Stakeholders interviewed
Lucknow	Dealers	09
	Manufacturers	01
	Consumers	10
	E-3W Operators	10

Figure 8: Year wise E-3W Sales in Lucknow since 2015



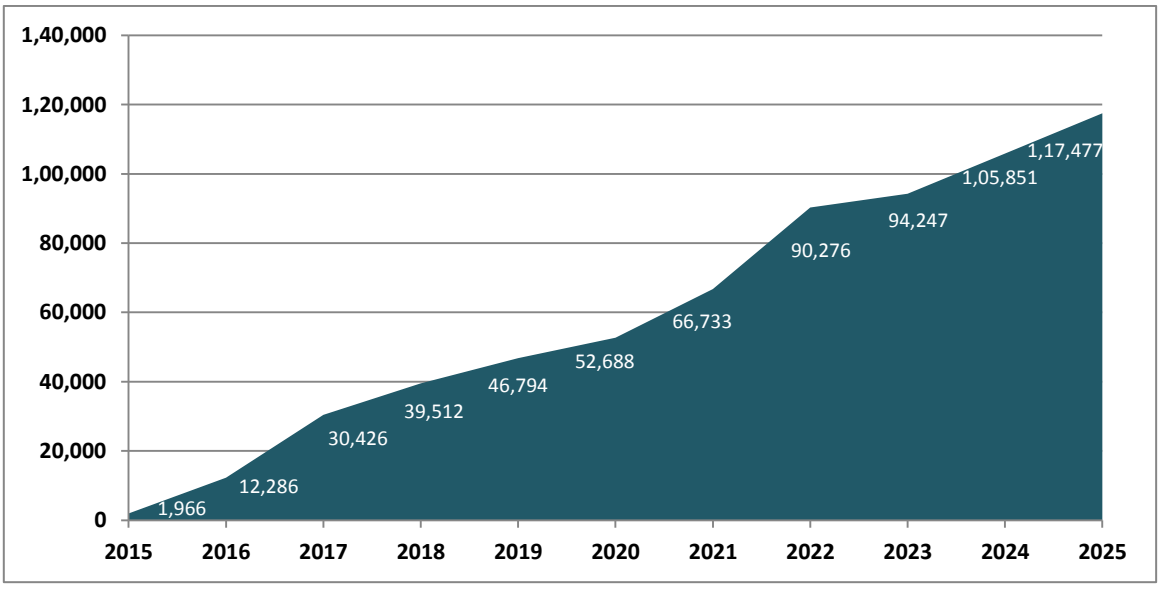
- The number of E-3Ws saw tremendous growth till 2017, with a CAGR of more than 200 percent.
- Year 2018 and 2019 saw a decline in E-3W registrations, which can be traced back to the news of the E-3W ban in the city by the Senior Police Commissioner.
- Year 2020 saw a dip in the E-3W registration owing to the lockdowns imposed in the state by the governments.
- Year 2021 again saw a three-time jump in the E-3W registrations. The possible explanation for this can be attributed to the job losses of the migrant workers caused due to the Pandemic. These migrant workers who came back to their hometowns found E-3W to be an easy source of income owing to the low skill requirement for driving E-3W and thus, numbers shoot up in 2021.

Job growth

The ecosystem around the E-3W has employed thousands of people in the city, and the people have been employed predominantly in the component manufacturing, dealerships, maintenance, logistics and driving of the E-3Ws. The following graph shows the city's cumulative no. of E-3Ws and 2Ws.

Year	Cumulative E-3W sales	Employment generation due to E-3W	Cumulative E-2 W Sales	Employment generation due to E-2W	Total Employment Generation
2015	893	1,965	30	1	1,966
2016	5,584	12,285	35	1	12,286
2017	13,829	30,424	50	2	30,426
2018	17,958	39,508	102	4	39,512
2019	21,267	46,787	155	7	46,794
2020	23,944	52,677	251	11	52,688
2021	30,318	66,700	752	34	66,733
2022	40,991	90,180	2,125	95	90,276
2023	42,813	94,189	1,306	59	94,247
2024	48,028	1,05,662	4,204	189	1,05,851
2025	53,242	1,17,132	7,661	345	1,17,477

Figure 9: Job Growth Estimates for Lucknow in Electrification of Last Mile Connectivity



While the numbers of E-3Ws are growing linearly, the E-2W is following an exponential trend line. As per the trends, the E-3W and E-2W will touch a figure of 53,242 and 7661, respectively in 2025, which is impressive. Based on the job assumptions, 117,477 jobs will be created in this segment by 2025.

While the segment of the society employed by this ecosystem varied widely, some notable segments employed were:

1. **E-3W and retired professionals:** Driving an E-3W provides control over one's life with a decent earning. Retired professionals from private/public (lower category) jobs find this value proposition attractive and are motivated to drive this eco-friendly vehicle.
2. **E-3W and petty criminals:** E-3W has become a medium for mainstreaming some pickpockets in the city. Since, the skill requirement for driving an E-3W is relatively lower; they are finding this as a decent source of employment where they can earn an average of amount of INR300-400 per day even if they do not own an E-3W.
3. **E-3W and migrant laborers:** Lucknow, being the state capital, is the hub of intra-migration from the adjacent districts. As per the dealers surveyed, people migrate from their hometown to this city because there is a lack of employment opportunities in their home town. Most of these migrants are from rural areas and their level of skills is low. Therefore, E-3W driving becomes a convenient source of employment for them.

Gender inclusivity

Due to its terrible lifestyle, driving has not been associated with a great profession in the Indian context. And if the driver is a woman, they face the strange look of the people passing by, derogatory remarks and vulgar jibes from fellow drivers. However, these stereotypes have been put to rest as women in Lucknow have taken the driving seat of E-3Ws. This has made them successfully break several genders and economic disparity barriers by becoming financially independent and establishing their own identity.

Presently, the fleet of women E-3W drivers consists majorly of brave, tenacious and aspirational ladies who want to have a better life for their children, who want to get rid of the violence and torture perpetrated by their husbands, who want to have a certain sense of independence, who are widowed and want a source of income for feeding their family.

However, to encourage more women to participate in driving, E-3W will need basic amenities such as toilets at regular intervals for women and charging facilities so that they do not get panicked if they have to travel back home. Their charging has been exhausted, a GPS that will provide the location details of the E-3W to the nearby police station, easy processing and instalment of loans, better training facilities and many others. Women passengers, too, find riding with a women E-3W driver comfortable as this guarantees a certain level of safety for them.

Skill inclusivity

Lucknow's last-mile connectivity for goods and people is mainly governed by 3Ws comprising both conventional 3Ws and battery-operated 3Ws. To completely transform the last mile connectivity to a greener mode of transport will require skill impartment in vehicle driving, vehicle maintenance and vehicle assembling for different stakeholders. This will help in making a robust ecosystem for EVs.

In Lucknow, training institutes imparting skills on these sub-systems must be developed so youths will be absorbed in this EV segment. Currently, these trainings are mostly imparted by private institutes. Still, there is a need to incorporate E-3W and E-bike-related trainings in the courses of Industrial training institutes and other skill imparting organisations.

Pollution reduction

In the IQAir report of top 50 polluted cities of the world 2021, Lucknow was ranked 16 among all. The major reasons for this could be traced back to vehicular emissions, power generation, industrial waste, biomass combustion for cooking, the construction sector and events like crop burning. The main repercussion of this translates in terms of increasing health expenditure by the population living in the city.

One of the ways to reduce the pollution level is by the use of EVs (E-3Ws). E-3Ws are said to be a vehicle with zero tailpipe emissions. An E-3W does not use gasoline or diesel; instead, it runs on batteries. They are relatively environmentally-friendly and safer because they do not release greenhouse gases. To quantify the environmental benefits of the E-3Ws, guidelines for calculating the GHG emissions were followed to know the amount of CO2 avoided due to replacing a fossil fuel-powered 3Ws. The following assumptions were made while calculating GHG emissions.

Table 19: Number of 2W & 3Ws in Lucknow based on Fuel Type

City	E-3W	CNG	DIESEL	LPG	Petrol	Petrol/CNG	Petrol/LPG	Total ICE vehicles
Lucknow	37,697	9,283	6,678	1	1,645	3,888	93	21,588
	E-2W		E-2W used for delivery					
	2,203		110					

Carbon emissions avoided per day through E-3W – 315,404.16 kgCO2

Carbon emissions avoided per day through E-2 W – 315,408.55 kgCO2

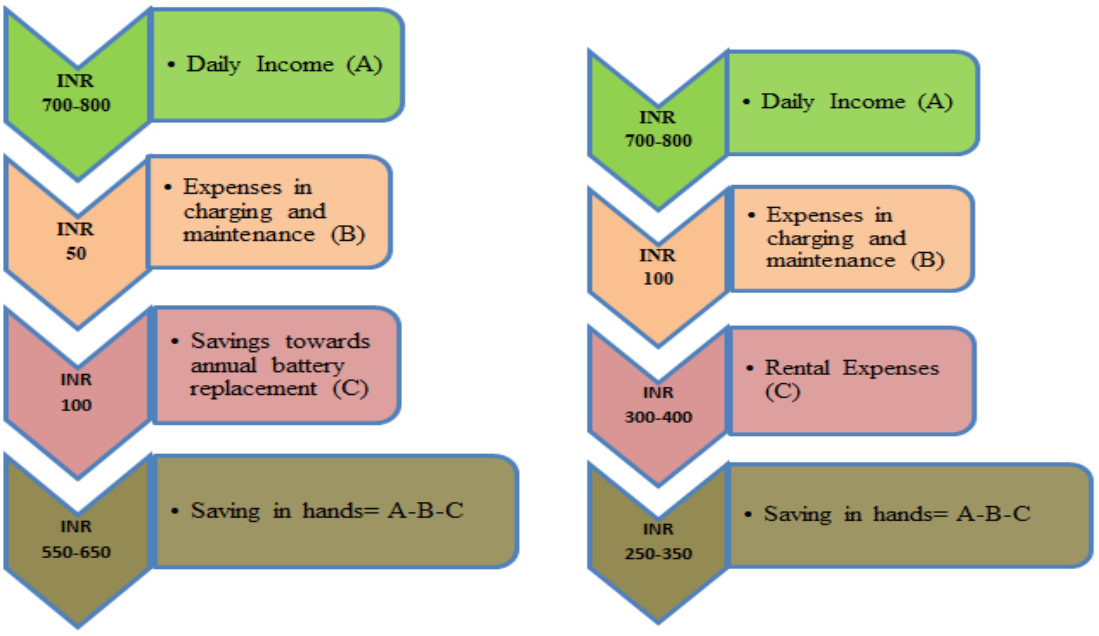
Total carbon emissions avoided per day – 273,784.35 kgCO2

Total carbon emission avoided per year – 94,622.57 tonnes kgCO2

Improved standard of living

E-3W has successfully improved the standards of living of all the stakeholders involved, from manufacturers and dealers to E-3W operators. While manufacturers and dealers are certainly enjoying the fruits of being in the business, it is the E-3W drivers that a closer look tells a different story. The E-3W has built a component of financial resilience for those who own the vehicle. But, drivers who do not own the vehicle, are vulnerable to financial shocks.

Figure 10: Economic Comparison - Self Owned vs Rented vehicles



E-3W driver who own their vehicle **Drivers who do not own the vehicle**

E-3W Drivers with their own vehicle

This has surely improved people's standard of living for the drivers who own these vehicles. This has been explained in the adjacent diagram. As per the survey conducted, the daily earnings from these vehicles is in the range of INR 700-800. The daily charging cost of the vehicle is in the range of INR 25-30. To take account of some minor maintenance, a total of INR 50 has been kept aside, covering both charging and minor maintenance. INR 100 has been set aside towards the annual replacement of batteries. Therefore, after subtracting the expenses from the daily income, daily savings of INR 550-650 is achieved in the case of E-3W drivers who have their vehicle**.** This saving can give a decent standard of living to the E-3W drivers as they can meet their other expenses and provide an excellent living to their families.

E-3W Drivers who don't own the vehicle

For drivers who do not own E-3W, if the daily income is kept the same, the rental expenses of the order of INR 300-400 come into the picture. Again, most of these drivers do not have a charging facility; therefore, they must pay an additional amount of INR 100 to charge the vehicle. These expenses bring down the saving to INR 250-350 per day, making life challenging for E-3W drivers.

Recent Developments in E-3W Ecosystem

Bans/Restrictions in the plight of E-3Ws

In its notification dated 12.05.2022, Lucknow Municipal Corporation banned E-3Ws in 11 routes citing the reason for air pollution, traffic congestion and public safety. This has been done by revising the guidelines using provisions under section 15 of the Motor Vehicle Act 1988 and section 178 of Uttar Pradesh Motor Vehicle Rules 1998. The details of the 11 routes have been indicated below:

The Regional Transport Office (RTO) has been instructed by the Lucknow Municipal Corporation (LMC) not to register E-3Ws without receiving a no objection certificate (NOC). Additionally, E-3W operators that wish to operate within municipal limits must obtain permission by paying the appropriate charge to the LMC.

Impact of the ban on E-3Ws

The national and local media extensively covered the impact, citing this as a bizarre and unthoughtful step. While the issue of traffic congestion is genuine and will need a serious planning by the LMC, these reactionary steps of reducing the number of E-3W on the road will also impact the daily income of the E-3W drivers.

So, the need of the hour is to have a thoughtful plan as to how the numbers of E-3Ws can be added/removed from the city roads so that an optimal number of E-3Ws will be there in the city. This calls for end-of-life management of the vehicle, development of small depos and speedy development of metros, which are described in the following section.

5 Way Forward

Short to medium-term focus

Definition of life of E-3W and strict compliance

With consultations from relevant stakeholders, the life of E-3W should be defined. This will serve two purposes. Firstly, regulating the number of E-3Ws will help in rightsizing the number of 3Ws on the city's roads. Secondly, according to the city survey, E-3W operators complained that they could not earn the same amount as they used to earn 2-3 years back. When asked about the reason for this change, they mentioned that the number of E-3Ws has grown tremendously on the roads. Therefore, defining life and regulating the number of E-3W will ensure an optimum income level for the E-3W drivers and improve the social and economic status of the people in this business.

More emphasis should be given to skill training for different sections of the workforce required in the EV industry, especially in the last-mile segment. Curriculums should be designed in such a way that encourages women to get enrolled and explore job opportunities.

The lack of shared mobility service facilities, such as shared E-autos and feeder bus services, is an issue. Promoting and legalising shared E-vehicles is crucial to reduce heavy reliance on private vehicles and singlE-ride autos. With the increasing traffic and vehicle load on the road infrastructure, switching to public & shared modes of transportation has become necessary.

Another concern is the lack of parking spaces for rental operators/fleet aggregators to provide EV services. Better parking space management is required, especially for EVs, and such parking spaces can be co-utilised as charging stations.

With the growing emphasis on the indigenisation of EV component manufacturing and technology in India, the market is expected to surge. However, quality checks and standardisation are crucial to ensure safety and security, especially for 2Ws and 3Ws plying in the last-mile segment.

More private players and government organisations should be encouraged to switch to zero-emission electric cars for their employee commute, following the corporate giants, including Google, Wipro, Accenture, and so on.

The state government has been quite proactive in providing electric bus services, which have been quite successful even in the last-mile segment. However, the frequency should be more, especially between the prominent locations, including the metro station, to encourage people to use the same. Also, the routes are to be rationalised while increasing these buses' distance/area coverage.

Development of E-3W Depots

Along the lines of bus depos, E-3W depos should be planned by the municipal corporation to decongest the traffic caused by the E-3Ws**.** Municipalities should earmark the places for the development of mini-depos, which will have charging and parking facilities. These places could be near metro stations, near circles, bus stops, near railway stations or outside the city where provision for electricity connection is well placed. These mini-depos will be managed through fleet management system software which will have the data of no. of vehicles and charging stations available for the day, real-time traffic data, and available charging points for allocating it to different 3Ws and well-placed communication and navigation system for handling the traffic in a coordinated manner. The fleet management software should also have the detail of the vehicle's life so that the vehicle can be retired on time. The diagram shows the structural components of E-3W-based mini depots.

Long term Focus

Government organisations such as Municipality/Metro Rail Corporation should consider holding consultation meetings with various stakeholder groups, including the Residents Welfare Associations in various constituencies. This is crucial for designing the last-mile connectivity options in an environment-friendly way which is convenient and financially viable.

Fleet aggregators, mostly owned by private entities, should look into providing EV shuttle services within defined routes and can also be incentivised to function on a pilot scale basis in select constituencies to see the acceptance and success rate.

Speedy development of Metro networks

The Metro Rail System is the most effective regarding energy use, space occupancy, and the number of passengers transported. Other metro system benefits include reduced air and noise pollution compared to road-based systems. In Lucknow, metro is a mass transit system with 22.87 kms of functional network and 11.90 kms of proposed network for development. The speed of development of the metro transit system should be fastened to better connectivity across all major points in the city. Parallelly, Municipal Corporations should develop mini-depos to facilitate hassle-free last-mile connectivity for the people.

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