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ROAD MAP FOR ELECTRIFICATION OF LAST-MILE URBAN FREIGHT VEHICLES; CASE STUDY OF THREE INDIAN CITIES - AHMEDABAD, DELHI, AND SURAT

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ABSTRACT Urban freight movement is estimated to contribute to about 25% of greenhouse gas emissions and demand 12% of the world's fuel energy. The transition to electric mobility is an opportunity for India to addresses issues like an increase in GHG emissions, deteriorating air quality and dependency on oil imports. However, the transition to electric freight vehicles (EFVs) from conventional ICE vehicles will be challenging considering the market limitations in the supply of electric vehicles (EVs), charging infrastructure, and consumer preference due to the limited operating range and payload of EV batteries. The attempt in this paper is to identify the stakeholders and their choices, and the barriers to electrification. The research is based on the study of urban freight movements linked to textile markets in Ahmedabad and Surat, and the fruit and vegetable (F&V) market in Delhi. A willingness to shift survey of operators has been carried out to identify the impact of various financial and/or infrastructure incentives on the faster transition from ICE vehicles to electric vehicles and its associated economic benefits. The paper also articulates a roadmap for the faster adoption of EFVs.

Keywords: Urban freight; Electric Freight Vehicles; Total Cost of Ownership; Discrete Choice Modelling

1. INTRODUCTION

The Government of India is focused on electrification of urban mobility owing to the Paris agreement, wherein, by 2030, India has committed to reducing the GHG intensity of its GDP by 33-35% below the 2005 levels [1]. In 2017, NITI Aayog released a roadmap for the adoption of EVs and various other policies and schemes have been promogulated by the national and state governments to promote EVs. Most of these initiatives including the FAME scheme are primarily focused on the electrification of public transport (buses), 3-wheelers, taxis, and 2-wheelers. Urban freight vehicles (UFVs), excluding goods 3-wheelers, are largely left out, owing to the complex nature of the sector characterized by its informal operations, small vehicles, limited public sector role, etc. In 2017, in million-plus cities, 2017, Light Commercial Vehicle (LCVs) accounted for 26.9% of the total registered vehicles of which 16.2% were four-wheelers and the remaining 10.7% were 3-wheelers. In India, 17.33 gm/km/year of particulate matter is released by LCVs [2] much higher than passenger vehicles [3]. LCVs, in India are majorly run-on diesel and is a key source of GHG emission. Additionally, difficulties in loading and unloading, navigating traffic to serve last-mile deliveries often contribute to serious environmental challenges. Some nations shifted to CNG as a cleaner fuel, however, CNG still has limitations over resolving the energy security concerns. Globally, the transport sector demands 28% of the energy [4], of which freight vehicles are responsible for 45% and LCVs for almost half of it [5]. In addition to the above, 22 Indian cities are among the top 30 most polluted cities of the world [6], articulating the need for the adoption of EFVs. The transition to EFVs from conventional ICE vehicles will be challenging considering the market limitations in the supply of EFVs, charging infrastructure, and consumer anxiety due to the limited operating range and payload of EV batteries.

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2. AIM AND METHODOLOGY

The paper aims to prepare a roadmap for the electrification of UFVs by conducting feasibility studies in three Indian cities namely Ahmedabad, Delhi, and Surat with a methodology replicable to other cities. The focus was intra-city freight movement of a single critical commodity having the most externalities. Ahmedabad and Surat are hubs for textile production and Gujarat EV policy is in the process of publishing. Delhi EV policy was released in 2019 and the city has high pollution levels, has a growing population with a dependence on the supply of fruits and vegetables. The methodology of the research paper was:

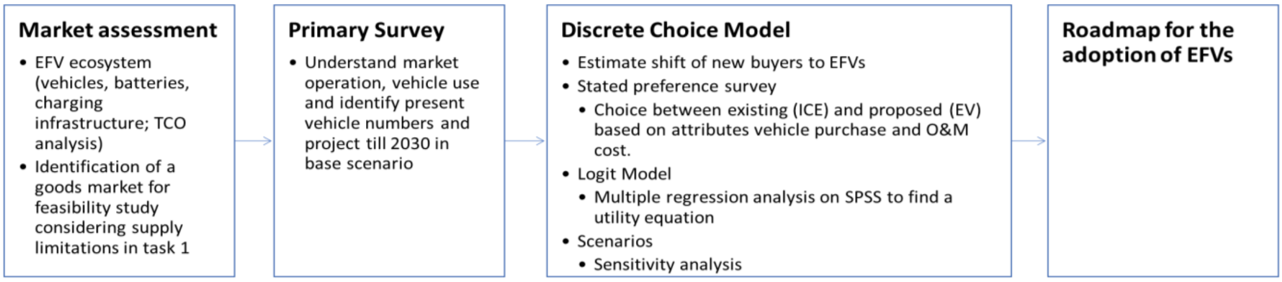

Figure 1. Methodology

3. RESULTS AND DISCUSSION

3.1. Market assessment of EFVs ecosystem

Currently, EFVs, in India, are available majorly across the three-wheeler category and only one model is available in the E-LCV section (0.75-tonne capacity), mainly due to the narrow cost differences of these vehicles with ICE vehicles as the payload is not that high to demand huge batteries responsible for a higher cost of EFV, ease of setting up of charging stations due to use of hub and spoke model by these vehicles, and lastly, high utilization rates in B2B and B2C (40% of all logistic movements). Comparing EFVs to ICEs, for 15 years, at a trip length of 80km/day and CNG priced at Rs 53/Kg, for goods auto, per Km TCO of ICE vehicle is ₹ 14.5 and for EV is ₹ 11.9 i.e. profit/km for an EFV is ₹ 2.6. Similarly, for goods LCV, per Km TCO of ICE vehicle is ₹ 16.6 and for EV is ₹ 15 i.e., profit/km for an EFV is Rs 1.6. With the availability of fiscal incentives on EFVs, the TCO gap between ICE and EV will further increase. However, if the trip lengths are less, the TCO difference between ICE and EV will reduce i.e., EFVs will become expensive.

3.2. Primary Survey: Freight Characteristics of Case Cities

A primary survey was done at three identified markets with 100 drivers/transporter each in the textile market of Ahmedabad, Surat and F&V in Delhi as they currently used available segments of EFVs. Concerning the limitations of EFVs, it was observed: Vehicles in all the three markets travelled less than 130 km per day i.e. current battery range of EFVs; Even when the vehicles discharge there is sufficient charging time available during loading/unloading/waiting of goods. Charging infrastructure can be introduced at Gujarat Industrial Development Complex (GIDC) in the case of Ahmedabad, Surat and Agricultural Produce Market Committee (APMC) in Delhi where vehicles mostly pick up the textile/fruits and vegetables from and hence wait for loading/unloading. Home charging is not possible in all three cities due to the living conditions of vehicle owners. There was a negative load on the battery range of vehicles as all the three cities' vehicles had freight vehicles overloaded.

Table 1. Present count and expected growth of freight vehicles

Type	Ahmedabad		Delhi		Surat	
	Goods Auto	LCV	Goods Auto	LCV	Goods Auto	LCV
Registered (2016)	53,130	1,49,463	66,741	1,99,822	40,424	54,045
Growth Rate	4%	2%	3%	5%	5%	4%
% Share in Market	5%	1%	20%	5%	5%	4%
On Road (2030)	2,561	1,023	12,811	9,576	3,448	3,123

Reference CRRI, TNO, TU Delft, 2018; Parivahan, 2020

3.3. Discrete Choice Model: Demand Assessment for Electric Freight Vehicles

The choice of the shift towards EFVs will depend on the choice of vehicle owners and their weighted benefits of EFVs against the use of existing ICE vehicles. Subsidies can be used to attract more EFVs users. Currently, a subsidy of ₹ 40,000 (20% of Vehicle cost) is offered on selected modes of goods auto under FAME II and ₹ 32,000 (15% of Vehicle cost) under Delhi EV Policy. No subsidy is offered at the state level on E-goods auto and E-LCV in Gujarat. For the sensitivity analysis subsidies in a combination of 20 % (only central) and 35% (state and central) are considered for both goods autos and LCVs. A fuel hike with an inflation rate of 10% against the existing 3% was considered to push ICE users to EFVs. Based on the above understanding, three scenarios' classifications were considered against the business-as-usual scenario as summarized in Table 1 from where it can be identified that in absence of any subsidies or fuel hikes, the EVFs in respective markets will account for only 5-10% of the total on-ground vehicles in 2030. However, as per NITI Aayog's target to achieve 30% EVs across all modes by 2030, the government will have to at least provide subsidies to reduce the capital cost of EFVs or rise CNG prices. The economic benefits of EV vehicles are the savings made in the treatment of the vehicular emissions by ICE vehicles, and the savings made by vehicle operators from O&M differences. The cost of the project can be considered as the subsidies being proposed to be provided for the adoption of EFVs. It shall be noted that for all the cities across scenarios the minimum benefits to cost ratio is 1.7 and goes as high as 3.9.

Table 1. Scenario Summary Across Cities

Scenario	Growth	Ahmedabad		Delhi		Surat	
		Auto	LCV	Auto	LCV	Auto	LCV
Business as Usual Scenario	% Shift in 2030	43%	20%	48%	17%	43%	20%
	EFVs on road by 2030 | **% of total vehicles**	335 | 13%	184 | 18%	1220 | 11%	875 | 10%	335 | 11%	184 | 5%
35% Subsidy	% Shift in 2030	54%	50%	79%	44%	93%	50%
	EFVs on road by 2030 | **% of total vehicles**	614 | 24%	338 | 33%	3000 | 31%	2297| 32%	670 | 21%	337 | 10%
20% Subsidy	% Shift in 2030	53%	43%	67%	32%	80%	36%
	EFVs on road by 2030 | **% of total vehicles**	611 | 24%	328 | 32%	2755 | 27%	1750| 22%	651 | 21%	317 | 9%
20% Subsidy + 10% Fuel Hike	% Shift in 2030	54%	49%	73%	35%	86%	44%
	EFVs on road by 2030 | **% of total vehicles**	683 | 27%	562 | 55%	2878 | 29%	1937| 25%	726 | 23%	556 16%

4. CONCLUSION

From Table 1, it can be observed that fiscal incentives alone will not be enough as on-ground EVFs will still not be 30%: NITI Aayog's target across all scenarios in Ahmedabad, Delhi and Surat. The market assessment of the EFVs directs that the EV ecosystem is limited by the supply constraints like range anxiety, payload capacity, price of the vehicle, and the evolving technology. Considering the complex nature of urban freight and the involvement of multiple stakeholders, city-specific additional enabling strategies will have to be taken up under an electrification roadmap with a special focus on information dissemination, competitive market, human perceptions, government subsidies, and policies.

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