15th Urban Mobility India Conference & Expo 2022

Kochi, Kerela 6th November 2021

An Empirical Investigation into Electric Vehicle Adoption in Urban Freight- A Case Study of Delhi

Saloni Gupta, Dr. Sanjay Gupta**

*Research Scholar

** Professor of Transport Planning & Coordinator Centre For Urban Freight Studies (CUFS)



SCHOOL OF PLANNING AND ARCHITECTURE, DELHI, INDIA

Context



- Urban Goods transport account for:-
- a) 10 to 15 % of vehicle equivalent km
- b) 31% of the energy use
- c) 31% of the CO2 emissions respectively (UN Habitat 2013 report)



- There is a need to **decarbonize freight transport** while maintaining its **competitiveness** and **economic strength** and foster **innovation**.
- Few Global projects and experiments related to electrification of urban freight (Jacques Leonardi et. Al 2016)



 The Government of India (GoI) has made an ambitious commitment to creation of demand for EVs through the Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) India Scheme.



- India's **EV market** is poised for **significant growth** in the coming decade.
- Electrification of freight is on the rise.
- Flipkart became the first e-commerce marketplace to commit to 100 percent adoption of EVs by 2030

Small commercial vehicle's electrification is still a challenge in India

Goods Movement Patterns in Indian Cities



Share of destined and through traffic at outer cordon in selected cities





- Freight intensities in Indian cities continue to rise .
- There is **need for decarbonization** of urban freight
- Electrifying urban freight is one of the potential strategy



Profile of Case City – Delhi



Population : 16.7 Million (2011) 20 million (2020) estimated

315 000 goods vehicles registered in Delhi (2019)



Between 2012 and 2017, India's ecommerce market expanded at a compound annual growth rate (CAGR) of





- Estimated E-Commerce deliveries in Delhi -30,59,073 orders/ day
- Estimated E-commerce demand forecast by 2041-200 lakhs orders/day (SPA Delhi Study 2020)

Freight Traffic in Delhi



Goods traffic forms about 10% of the total traffic



Impact of Pollution

- Freight delivery vehicles (both LCVs and HCVs) contribute around 45% of NOx, 41% of PM10 and a large portion of PM2.5 vehicular pollution in Delhi (Source Malik et al, 2019)
- Registered delivery vehicles (three- and four-wheelers) emitted
 0.7 million tons of CO2 in 2019 in Delhi (Source RMI 2021)

Total originating and destined tonnage from Delhi



- Originating tonnage grew at 4% CAGR
- Destined tonnage showed a growth of 9% CAGR
- 1,70,000 goods vehicle move in and out of the city (2022)
- **10 lakh tonnes** of cargo movement (2022)

Stakeholder Survey Design - Transport Operators

Aim - To identify the preferences and barriers related to the adaptation of EV by small commercial vehicle operator

Sample Size – 300 (Small commercial vehicle operators)

Data Collection Method – Face to face interview

Operational Details

- Commodities transported
- Average no. of trips/day
- Average no. dry runs/day
- Average daily vehicle utilization
- Quantity delivered/day
- Daily operation/idling hours
- Daily operation cost/ revenue

General Information

- Type of vehicle
- Ownership of vehicle
- Age of the vehicle

EV Awareness

- Policies
- Subsidies
- Charging Infrastructure

Attitudinal Response

- Barriers
- Solutions/Strategies





Survey Locations and Sample Composition



Composition Based on Ownership



Okhla Groceries and Parcels









Image source – Primary survey

Transport Operation Characteristics - Fruits and Vegetables

Total No. of Samples- 166 (55.5%)

	3-W Loader (CNG)	Vans (CNG)
Ownership Details	%	%
Self	76	90
Rented	9	6
Owned By Company	15	4

	3-W Loader	Vans
Operational Characteristics	(CNG)	(CNG)
Average Trips (Nos/Day)	2.02	2.27
Average Dry Run (Nos./Day)	1.10	1.36
Average Vehicle Utilization (Kms/Day)	57.10	40.91
Average Quantity Transported (Kg/Day)	732.80	110
Average Business Hours (Hours/Day)	10.8	10.09
Average Operational Hours (%)	55.56	72.56
Average Operational Cost (INR/Day)	325.56	138.18
Average Operational Revenue (INR/Day)	790.48	402.73



3-W Loader (CNG)



Source- Analysis by authors (2022)

Transport Operations Characteristics - Groceries and Parcels

Total No. of Samples- 134 (44.5%)

	Category	Average Trips (Nos/Day)	Average Vehicle Utilization (Kms/Day)	Average Quantity Transported (Kg/Day)
Vehicle Type				
3-W	Loader (CNG)	10.2	68.34	487
2	-W (Petrol)	14.67	57.21	14.3
	EV-3W	8.35	47.59	338
	EV-2W	10.56	49.63	13.34
Commodity Type				
	Groceries	12.7	59.8	324
	Parcels	9.8 43.2		153
Other Details	5		Average Age of Vehic	le
Ownership	Owned by	Company	EV (2-W & 3 W)	1.2 years
Operational Area	Within 22 km radius of the warehouse		3-W Loader (CNG)	4.3 Years
Compensation Drivers work on salary basis – (12,000 -14,000 INR/month)		2-W (Petrol) Source- Analysis by authors (20	6.8 years	

Stakeholder's Response about EVs

Are you aware about E-Vehicles used for Urban Goods Movement		Where wo	uld you li	ike the	e charging l	nfrastructure?	
Response Yes	Fruits and Vegetables (%) 88.3	Groceries and Parcels (%) 94.4	Respo	nse	Fri Vege	uits and tables (%)	Groceries and Parcels (%)
No	11.7	5.6	At wareh	iouses		29.7	30.8
	If Yes.		Near (D/D		51.3	58
	★		At public	parking		18.9	11.2
	Are you aware of the subsi	dies for EVs?					
Response	Fruits and Vegetables (%)	Groceries and Parcels (%)					
Yes	69.4	73.0					
No	30.6	27.0		4			
	Rate your knowledge about	these subsidies					
Response	e Fruits and Vegetables (%)	Groceries and Parcels (%)	G				
Somewha familiar	t 10.8	52.8					
heard abo it	ut 89.2	47.2	ELECTRIC SCOOTERS AND MOTORCYCLES	alysis by autho	ors (2022	ELECTRIC LIGHT TRUCKS	

AHP Weights of Criteria and Barriers

Criteria	Self/Rented	Owned by	Electric
	vehicle *	Company*	Vehicles
Infrastructural	35.8	33.9	33.4
Economical	22.5	11.6	11.6
Technological	29.5	39.0	41.2
Social	12.2	15.5	13.8

Technological Barriers				
Barrier Self/Rente Owned by E			Electric	
	d vehicle*	Company*	Vehicles	
Less electric range/charge	67	68	74	
Less battery life	30	18	22.2	
Few EV models	3.6	14	4	

Social Barriers				
Barrier Self/Rente Owned by Electric				
	d vehicle*	Company*	Vehicles	
Poor Awareness	27	33	31	
Anxiety related to reliability	62	62	65	
& performance				
Lack of knowledge on EV's	11	5	4	
ability to reduce emissions				

Economical Barriers				
Barrier	Self/Rente	Owned by	Electric	
	d vehicle*	Company*	Vehicles	
High cost of vehicle	56.6	11.9	12.7	
High battery replacement	27.5	29.7	19.3	
cost				
Limited financing options	4.7	17.5	16.2	
High price on charging	11.2	40.9	51.7	

Infrastructural Barriers				
Barrier	Self/Rente d vehicle*	Owned by Company*	Electric Vehicles	
Inadequate Charging	77.9	14	9.5	
Infrastructure				
Less Repair and	14.3	33.3	25	
Maintenance shops				
Absence of Battery	7.9	52.8	65.5	
Swapping Facility				

All Values in Percentage * Fuel Type – Petrol/ CNG

Global Weights of Barriers in EV adoption



AHP Weights for Potential Solutions and Strategies

	St			
Solutions & Strategies	Self/Rented vehicles (CNG /Petrol) (%)	Owned by Company (CNG/ Petrol) (%)	Electric Vehicles (%)	Global Weights
Extensive EV Charging Infrastructure	56.6	66.8	62.1	62
Awareness Campaigns for logistics providers	31.8	13.7	22.2	21
Financing from public banks	9.2	11	9.4	10
More Subsidies	5.5	6.8	6.2	7

Total Cost of Ownership

$$\frac{\text{TCO}}{km} = \frac{\left(PC - \frac{RV}{(1+r)^N}\right) X \text{CRF} + \frac{1}{N} \sum_{n=1}^{N} \frac{\text{AOC}}{(1+r)^n}}{\text{AKT}}$$

Where,

PC = purchase cost of the vehicle

RV = residual value of the vehicle at the end of vehicle life

CRF = capital recovery factor

AOC = annual operating cost of the vehicle

AKT = annual kilometers travelled

r = discount factor

N = lifetime of the vehicle (in years)

Input Details	E- SFV	CNG-SFV		
General Inputs				
Number of Vehicle	1	1		
Lifetime of Vehicle (yrs) (N)	10	10		
Annual distance (KM) (AKT)	15,750	29,200		
Total Distance Travel (10 yrs) (KM)	1,57,500	2,92,00		
Discount factor (%) (r)	10%	10%		
Capital Recovery Factor (CRF)	0.16	0.16		
Resale rate (%)	20%	10%		
0	Capital Cost			
Vehicle Purchase Cost (₹) (PC)	5,38,318	5,74,162		
Resale Value (₹) (RV)	1,07,663	57,416		
Total Capital Cost (₹) excl. Resale	5,38,318	5,74,162		
Value				
Annual Op	erational Cost (AOC)			
Staff Cost (₹)	2,16,000	2,16,000		
Maintenance Cost (₹)	37,332	38,499		
Average Fuel Cost (₹)	16,695	69,663		
Total Operational Cost (₹)	2,70,268	3,24,163		
Total Operational Cost for life of	27,02,687	32,41,634		
LCFV				
Average TCO (Rs./km)	15.68	18.35		

Summing Up

Research findings

- Small commercial vehicle electrification is still a challenge in India
- Less Electric Range/Charge followed by inadequate charging infrastructure are major barriers in EV adoption Recommendations
- EV charging/battery swapping infrastructure and ensuring technological improvements in enhancing electric range per charge desirable
- Need to develop and test various PPP schemes to meet the target of setting up extensive charging infrastructure.
- Conduct sensitization programmes for scaling up of EV adoption in small commercial vehicles
- Location identification of EV charging/battery swapping stations in accordance with overall demand of the area with essential attributes (parking space, accessibility, ease of setup, a convenient waiting area etc.) critical
- Need to develop standards and guidelines for the design and placement of charging/battery swapping stations.
- Local level layout plans with land reservation of charging stations necessary

Thank You