Consumer Perspectives on Electric Vehicle Infrastructure in India: Survey Results

Jyoti Maheshwari, Srinivas Cherla, and Amit Garg

Abstract Transport sector accounts for about 20% of global energy use with around 25–30% emissions resulting from vehicles alone. Electric vehicles (EVs) are considered to be non-polluting and environment friendly substitutes to conventional fuel vehicles because they have a zero tail pipe emissions and electric traction is more efficient than regular engines. A primary survey was conducted across 10 cities (7 tier-1 cities and 3 tier-2 cities) in India and around 6000 sample surveys were administered in order to understand consumer perceptions for EVs. The purpose of the study was to understand current vehicle ownership and driving patterns of consumers, their awareness on EVs, purchase criteria and expectations for EVs, their views on public charging infrastructure and incentives offered by government. It would enable us to understand the drivers for improving acceptance of EVs and estimate their market potential. The survey analysis indicated that over 90% of the consumers travelled within 60 km per day and travel time was less than 2 hours. Also, consumers prioritized basic EV infrastructure as the most important criteria among the others impacting their purchase decision, followed by cost of EV and its performance. More than 50% of consumers favored quick charging option over normal charging option and were willing to pay double price for charging at quick charging stations. Lack of charging infrastructure, high upfront cost, low driving range etc. were found to be main barriers for large scale adoption of electric vehicles.

Keywords Electric vehicle · Charging infrastructure · Consumer perspective · Electric mobility

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1 Introduction

Transport sector accounts for about 20% of global energy use. Around 25–30% of emissions were resulting from vehicles alone [1]. Electric vehicles (EVs) play an important role for strategic developments as pollution free, noiseless and environment friendly substitutes to conventional fuel vehicles because of their high efficiency and low carbon footprint [2, 3]. They also enhance environment quality and sustainability without significantly affecting convenience [2].

National Electric Mobility Mission Plan (NEMMP) 2020, launched in 2013 by Government of India (GoI), aimed to accomplish fuel security by promoting hybrid and electric vehicles in the country. It targets to sale 6–7 million units of hybrid and electric vehicles such as electric cars, buses, light commercial vehicles, two-wheelers and three-wheelers, etc. every year starting from 2020 onwards by providing financial incentives. GoI has also launched "Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME)" scheme in 2015 to facilitate the major push for early adoption and market creation for hybrid and electric vehicles [4, 5].

Few studies indicated that lack of charging infrastructure has been one of the critical obstacles encountered by EVs than conventional vehicles. Also, the integration of new mobility services into existing infrastructure systems may create problems of acceptance, cooperation and compatibility. This would make EV charging infrastructure deployment a key issue for their use [3, 6, 7]. The current state of deployment of electric vehicles in Brazil and China was studied to promote their usage and their charging infrastructure in both private and public sectors [8]. The results of charge pricing model study for EV charging infrastructure based on public–private partnership projects in China indicated that the operating costs, electricity price, and charge volume were the main factors responsible for reasonable charge price [9]. Another study explored the potential of public charging infrastructure to encourage the sales of battery electric vehicle (BEV), enhancing electrified mileage and lowering greenhouse gas (GHG) emissions in US [10]. A study conducted by Davidov and Pantos, used an optimization model for planning EV charging stations which aimed at reducing the overall cost by enabling charging reliability and service quality anticipated by EV owners [11].

1.1 Abbreviations and Acronyms

2W	Two Wheeler
4W	Four Wheeler
BEV	Battery Electric Vehicle
EV	Electric Vehicles
FAME	Faster Adoption and Manufacturing of Hybrid and Electric Vehicles
GHG	Green House Gas
GoI	Government of India

HEV	Hybrid Electric Vehicles
ICEV	Internal Combustion Engine Vehicle
NEMMP	National Electric Mobility Mission Plan

2 Methodology

The main objective of current research is to understand the consumers' perspectives for EV and drivers that improve acceptance of EVs by reviewing the following aspects:

- Current vehicle ownerships and driving patterns
- Awareness on EVs
- Purchase criteria and expectations for EVs
- Expectations for public charging infrastructure.

The methodology for current research includes following main steps.

1. Shortlisting cities to conduct EV surveys
2. Conducting comprehensive survey in order to understand consumer perceptions on EVs and its infrastructure
3. Review the current state of infrastructure and barriers affecting the adoption of EVs.

Considering social, economic, technical and political aspects (refer Appendix 1) to conduct EV surveys, 10 cities (7 tier-I and 3 tier-II cities) were shortlisted. Total 6000 consumers were surveyed by conducting primary survey in selected cities (600 surveys in each city) to understand the consumers' perceptions for EVs. The cities selected for surveys include New Delhi, Mumbai, Kolkata, Chennai, Bangalore, Ahmedabad, Pune, Nagpur, Jaipur and Ludhiana.

3 Results

Figure 1 presents the share of surveyed consumers by age group and gender-wise while Fig. 2 presents gender wise vehicle ownership. About 61–68% of survey consumers were of young age group i.e. below 35 years of age (see Fig. 1). Both male and female consumers have high preference for 2W, followed by public transport (or taxi) in females while hatchback type of 4-wheeler (4W) in males (see Fig. 2).

Figure 3 compares vehicle ownership with mode of travel preferred by consumer for daily commute. It is obvious that higher ownership of 4Ws would enhance their preference of travelling by 4Ws. Also, the inclination for 2Ws drops and increases for 4Ws by 33, 62 and 66% with increase in the ownerships of 4Ws.

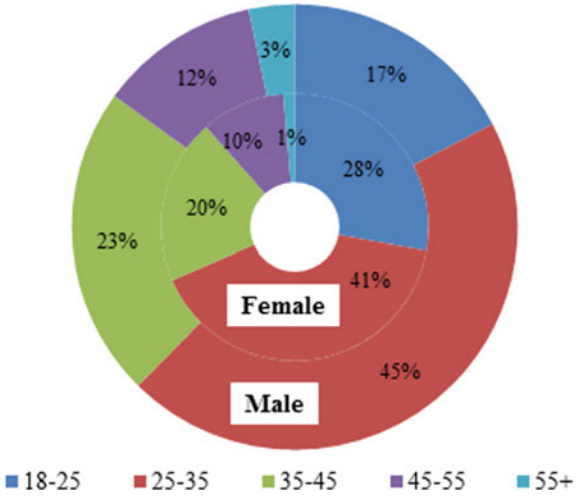


Fig. 1 Age group and gender-wise distribution of survey consumers

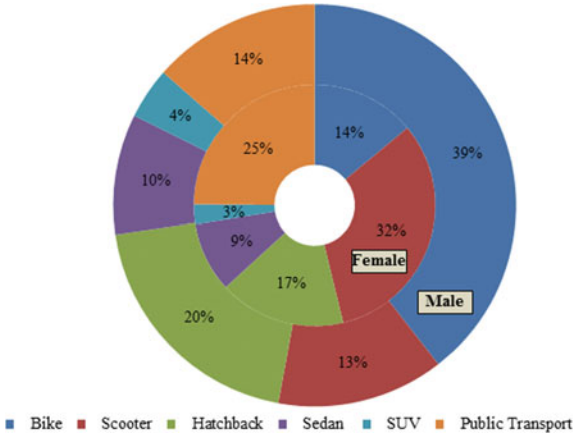


Fig. 2 Gender-wise vehicle ownership

Figure 4 shows city-wise the current and likely ownership of battery electric vehicles (BEV) or hybrid electric vehicles (HEV). Around 18–41% of internal combustion engine vehicle (ICEV) owners were interested to buy EVs in future. Also, their intention to own hybrid EV is more than battery EV (see Fig. 4).

Figure 5 shows average travel time of surveyed consumers with preferred modes of transport. As can be seen that travel time was within an hour (<60 minutes) for majority of consumers using 2Ws, while it was more than an hour for significant number of consumers using 4Ws.

Figure 6 shows multiple statements describing various aspects of EV to estimate the level of awareness on EV among the survey consumers. On an average, around 39% of consumers don't know enough about EV to agree or disagree on

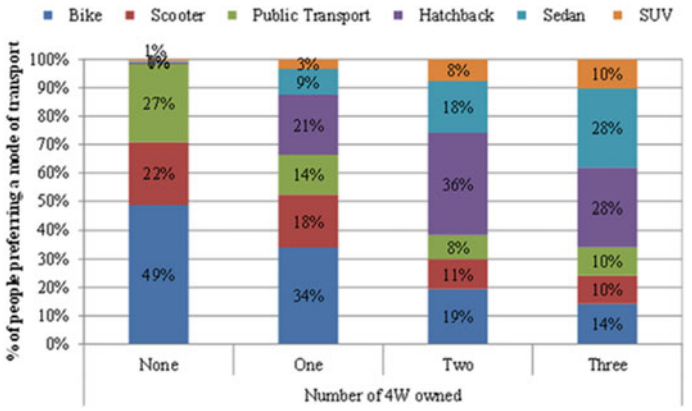


Fig. 3 Vehicle ownership versus preferred travel mode

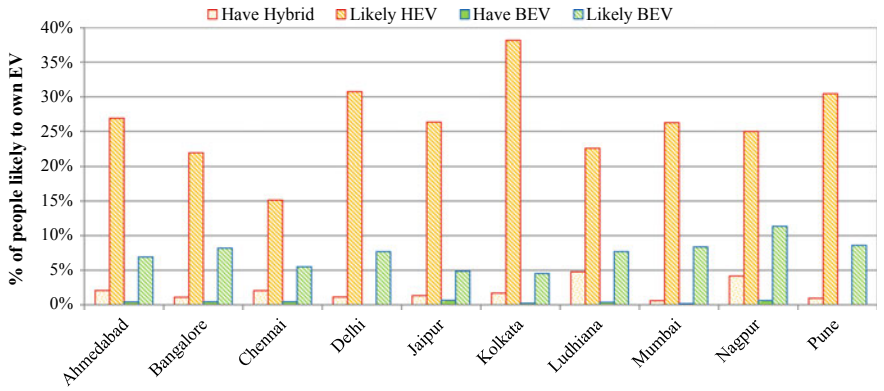


Fig. 4 City-wise current and likely ownership of BEV or HEV

a particular statement. The statements on which consumers agreed incorrectly or disagreed incorrectly both were highlighted with red colour.

Figure 7 presents the consumers' view on EV ownership and battery recharging. About 71% of consumers agreed for battery swapping instead of recharging and 45% agreed on leasing EV instead of purchasing. Also, significant number of consumers preferred the charging of EVs at home because of non-availability of public charging stations at present.

Figure 8 presents various attributes of EV that can be considered for making purchase decision by estimating their significance and uncertainty. Analysis indicated that consumers rated functional attributes such as time to recharge, range and charging infrastructure higher than personal attributes such as price, availability of variants, service and running cost etc. It does not mean that price, service or running cost won't

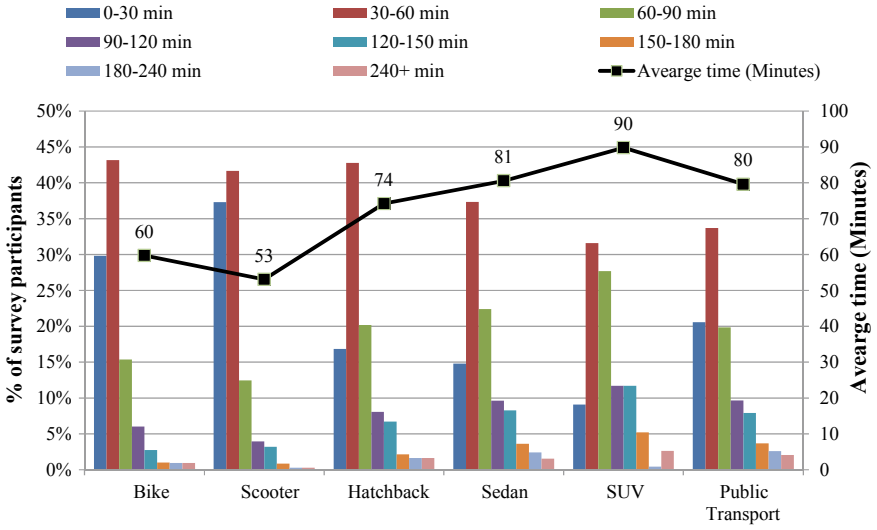


Fig. 5 Distribution of travel time with preferred travel mode

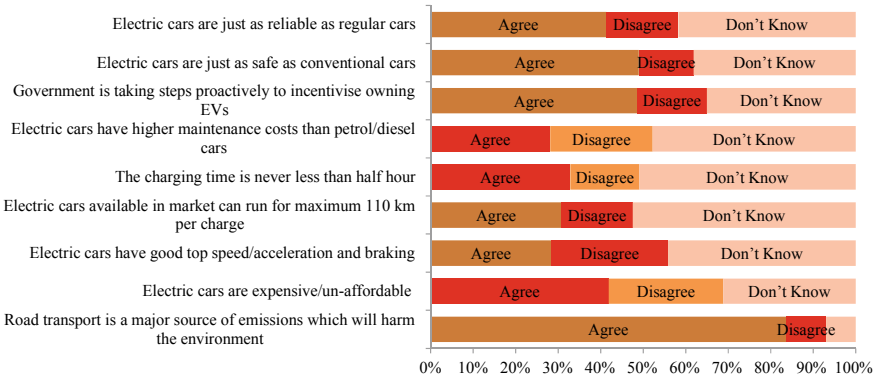


Fig. 6 Awareness level on various aspects of EVs among the consumers

affect purchase decision but consumers look for best value for money for EV purchase if the externalities such as charging cost, charging time etc. can be addressed.

The current study also attempted to estimate for how much time the consumers were willing to wait at public charging station with a booster charge with range extension of 30, 60 and 90 km (see Fig. 9). Results indicated that about 50% of consumers were time sensitive and were willing to pay double for quick charging services than regular power charges if quick charging services would be available. Around 20% of the consumers were cost constrained and preferred normal charging even though the waiting time was 8 times more for normal charging.

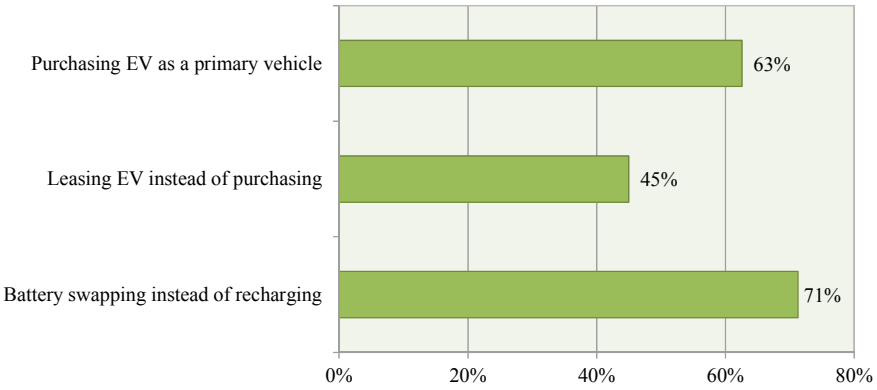


Fig. 7 Consumers' view for EV ownership and recharging

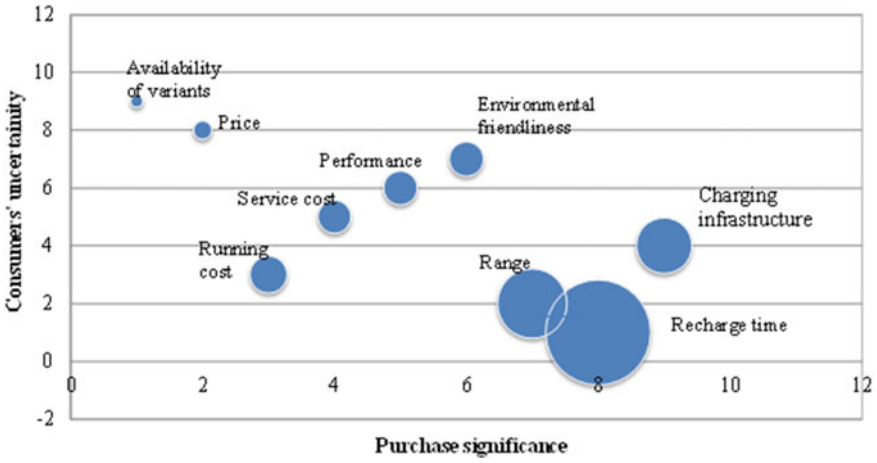


Fig. 8 Consumers' perspectives on various attributes for EV purchase versus uncertainty

4 Conclusions

The survey analysis indicated around 90% of the consumers travelled under 60 km per day and their travel time was less than 2 hours. The consumers ranked basic EV infrastructure (charging time and charging stations) higher than its range, performance, price, running cost, etc. More than 50% of consumers favoured quick charging option over normal charging and showed willingness to pay double price for charging at quick charging stations. However, lack of basic charging infrastructure, high upfront cost, low driving range etc. were estimated as main barriers for large scale adoption

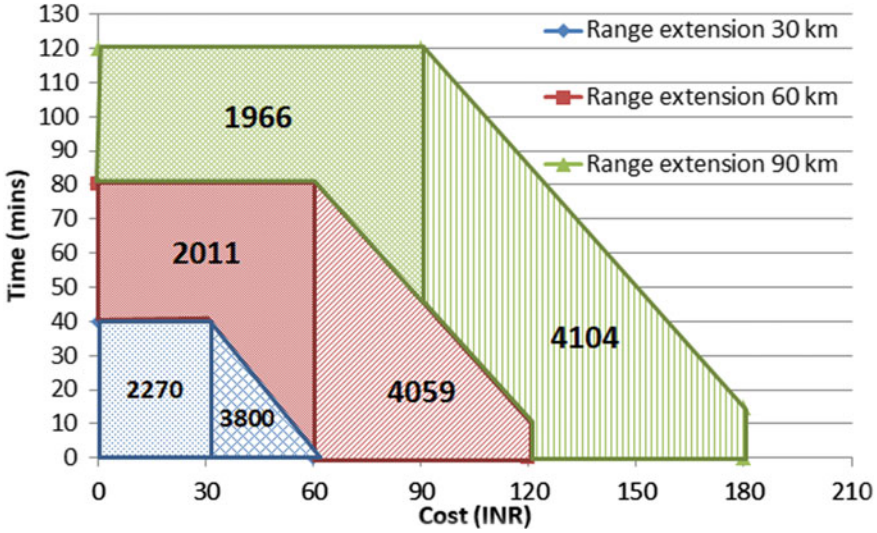
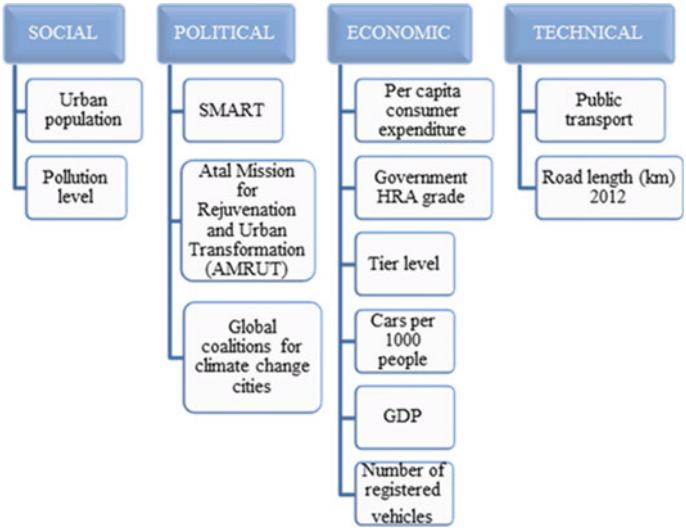


Fig. 9 Public charging preferences

of electric vehicles. Enabling tax rebates, low cost financing, free charging infrastructure etc. could be assessed as most desirable public policy and regulatory measures for promoting the ownership of EVs in future.

Appendix

Criteria Used for Shortlisting Cities to Conduct EV Survey



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