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Driving sustainable mobility: a study of electric vehicle adoption in rural India

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Abstract

The global push for sustainable and eco-friendly transportation solutions has made the adoption of electric vehicles imperative. In India, EV adoption has shown promise, fueled by diverse product offerings and supportive government policies. However, rural India lags behind in EV adoption, despite being a significant market. To unlock the untapped potential, understanding the needs, attitudes, and barriers of rural consumers is crucial. This research conducts a study of rural Indian consumers and offers valuable design insights for automotive companies to formulate effective future strategies.

Keywords: electric vehicles, design research, sustainability, rural mobility, market implications

1. Introduction

Mobility has always been a significant driver of societal advancement throughout human history. While transportation has always played a vital role in shaping civilisations by fostering connectivity and trade, it also accounts for 24% of direct global CO2 emissions ("World Energy Investment 2023", 2023). As humanity grapples with climate change and urban congestion in the twenty-first century, transportation is undergoing a radical shift. Electric mobility, fuelled by clean and renewable energy sources, has emerged as a ray of hope for tackling these global issues.

Globally, the four-wheeler EV market has experienced exponential growth ("World Energy Investment 2023", 2023), surpassing 10 million units sold in 2022. Major markets, including China, Europe, and the United States, have witnessed substantial increases in EV sales. In tandem, emerging markets like India, Thailand, and Indonesia have shown promising growth in EV adoption, supported by varied product offerings by automotive companies and supportive government initiatives.

Around 65% of India's population lives in rural regions (Government of India and Ministry of Finance, 2023) and is a critical contributor to the nation's socio-economic fabric. Their mobility choices significantly impact the country's long-term development trajectory and are a critical segment for EV manufacturers. The attempts taken by the government and businesses to produce and promote EVs are commendable, but the focus has been on urban areas. Despite the potential, the penetration of EVs in rural areas lags behind that of urban regions. The rural Indian market poses a unique set of challenges and opportunities. Understanding rural consumers' specific needs and attitudes is crucial to bridging the adoption gap and driving EV uptake in these regions.

This study thus seeks to dive into the often-overlooked domain of rural India and investigate the electric mobility ecosystem from their perspective. Through a comprehensive analysis of consumer needs, design implications that will enable original equipment manufacturers (OEMs) to effectively cater to rural Indian consumers are identified. The design implications delve into various aspects, including consumer preferences, fears, and satisfaction levels with current internal combustion engine

vehicles. By providing in-depth insights into rural consumers' perceptions towards EVs, the research endeavours to bridge the knowledge gap surrounding EV adoption in rural India and drive a positive and transformative impact on India's transportation landscape. The next part of the paper is organised as follows: first, pertinent literature and the theoretical background are discussed. Next, the research model is presented. Following the methodology, the results are discussed with theoretical and design implications. The conclusions are given in the last part of the paper.

2. Literature review

To conduct a comprehensive literature review, the keywords "electric vehicles adoption in India", "EV adoption" and "electric vehicles acceptance in India" were searched on Google Scholar with additional filters that limited the search results to post-2020. Further, the search results were thoroughly analysed and the list was shortlisted based on the relevance to the research topic.

A considerable amount of research has been conducted to investigate the adoption of electric vehicles (EVs) across different countries. Initially, most studies, mainly from 2017, focused primarily on the USA, followed by other developed countries like Germany and the UK (Kumar and Alok, 2020; Li *et al.*, 2017). Subsequently, research on EV penetration and acceptance expanded to emerging markets, such as China (Li *et al.*, 2020), India (Shetty *et al.*, 2020), and Malaysia (Asadi *et al.*, 2021). A review of existing literature on EV adoption in various contexts, including both developing and adopting EVs, consumer perceptions towards EVs (Masurali and Surya, 2018; Navalagund *et al.*, 2020; Nazneen *et al.*, 2018), purchase intentions towards EVs (Asadi *et al.*, 2021), and attitudes towards EVs in different country-specific contexts, such as India, Malaysia, China, Spain, Poland and the European Union (Afroz *et al.*, 2015; Junquera *et al.*, 2016; Khurana *et al.*, 2020; Lewicki and Drożdż, 2021; Lo, 2014; Wang *et al.*, 2018) revealed that there remains a significant knowledge gap regarding EV adoption in developing countries as compared to their developed counterparts (Tunçel, 2022).

In an India focussed literature search around 25 papers were reviewed and the findings from the most relevant papers are listed as follows. Some of the reviewed research papers (Bhat *et al.*, 2022; Jaiswal *et al.*, 2021) collected data from the students enrolled in various colleges and universities in Bengaluru and the National Capital Region (NCR), respectively. (Ali and Naushad, 2022; Malik, 2021) surveyed respondents from Delhi and NCR. (Jain *et al.*, 2022) study comprised respondents who were either willing to purchase or had already purchased an EV residing in the NCR. (Sriram *et al.*, 2022; Verma *et al.*, 2020) collected data from Bengaluru. (Shankar and Kumari, 2019) conducted studies in the cities and their adjacent suburban areas of - Delhi, Chennai, Mumbai, Kolkata, and Bangalore. (Upadhyay and Kamble, 2023) selected the cities that had existing EV infrastructure being installed by public and private entities. The respondents were drawn from the cities of Mumbai, Pune, Nashik, Thane, Gandhinagar, Ahmedabad, Vadodara, Surat, Chennai, Tiruchirappalli, Madurai, Visakhapatnam, Hyderabad, Bengaluru, Hubballi, Mangaluru, Kochi, New Delhi, Agra, Faridabad, Noida, Gurugram, and Ghaziabad. (Singh *et al.*, 2023) conducted their study in the Himachal Pradesh state of India. (Bhattacharyya and Thakre, 2020) conducted interviews with 11 managers (experts from automotive domains) and 27 EV consumers (across the cities of Mumbai, Pune and Bengaluru in India).

A comprehensive analysis of literature focused on consumer-centric studies related to EVs in India revealed that the majority of these studies were centred around urban consumers, with little consideration given to the rural population. No studies were found that explored the demographic and psychographic profile of rural customers who are either current EV owners, potential buyers, or those who have chosen not to adopt EVs, leading to a significant gap in the understanding of rural consumers' perceptions of EVs in India. This absence of insights into customers' underlying motives and mechanisms for EV purchases in Rural India poses uncertainties for OEMs in terms of developing appropriate product offerings, service offerings, and an overall ecosystem. Furthermore, though the Indian government has put substantial efforts into promoting EV adoption, such as the implementation of major incentive schemes like FAME II and PLI, these schemes may require careful re-consideration to cater to rural India-specific requirements. Hence, the findings from this research paper in understanding the needs of rural India will be crucial in helping the Indian government in framing

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and implementing geography-specific policies and ensuring successful penetration of EVs in these regions.

3. Research objectives and methodology

Objective: Building on the gap identified in the comprehensive literature study, the specific objective of this research is to explicitly outline the consumer needs of rural consumers involving an in-depth understanding of their demographic and psychographic profiles, as well as their perceptions regarding EVs. The research further delves into gathering insights into how they view electric vehicles in terms of their advantages and disadvantages compared to traditional ICE vehicles and whether they consider EVs as a viable alternative to conventional ICE vehicles. Understanding consumer needs and perceptions leads to the most critical aspect of the study: identifying the design implications that influence rural consumers' decisions to consider or reject EVs and helping OEMs and the Indian Government formulate strategies or policies to promote EV adoption in rural areas.

Methodology: The overall methodology for the research consisted of - Primary Study, Categorization of the collected data and deriving Design Implications to guide future research. The primary study was done in the form of a Field Survey conducted to collect data and understand the needs and requirements of the Rural Indian population to promote Electric Vehicle adoption in rural areas. The inputs to the survey were collected by conducting in-person surveys across villages in the following states of India: Karnataka, Maharashtra, Haryana, Punjab, Rajasthan, Bihar and Jharkhand. The locations are all spread across different rural parts of the country to ensure a variety of responses and consumer experiences. They were selected at random based on their proximity to nodal towns and villages, more detailed information about the survey locations and sample size has been provided (Table 1). A total of 61 individuals were interviewed for this survey, and qualitative as well as quantitative data was collected to gain a comprehensive understanding of their needs. The only requirement from the respondents was that they should have experience in driving any automobile. The village heads were first approached and briefed about the study and they then introduced the researcher to the survey participants. To overcome the language barrier in some locations, local translators were hired. The demographic data of the respondents is provided (Table 2). A structured questionnaire was followed, and the respondents were questioned about their preferences regarding the available and desirable product offerings, charging-related requirements, service offerings, awareness and expectations from government policies, expectations and requirements from the EV ecosystem, and their fear of technology adoption or lack of trust in the new technologies.

More details about the questionnaire, responses and exhaustive demographic details can be accessed by following this link: https://docs.google.com/spreadsheets/d/1NbMS-qZghcoN2ONx5kDVw_mL-BguOIt3SkD4tmJoXg8/edit?usp=sharing

Table 1. Field survey locations and sample details

Village	Terakanambi	Mysore	Badlapur	Mattewal	Gharuan	Sinodia,	Chorauan	Tumbaguttu
State	Karnataka		Maharashtra	Punjab		Rajasthan	Bihar	Jharkhand
Sample	9	6	6	8	7	9	9	7

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Table 2. Demographic details of the respondents

	Demographic Variables	No. of Respondents	%
1	Age		
	18-29	24	39.34%
	30-49	34	55.74%
	50+	3	4.92%
2	Gender		
	Male	52	85.25%
	Female	9	14.75%
3	Education		
	Illiterate	2	3.28%
	Dropped out before matriculation	5	8.20%
	Matriculation	12	19.67%
	Intermediate	11	18.03%
	Diploma	4	6.56%
	Bachelor's Degree	25	40.98%
	Master's Degree	2	3.28%
4	Holding a Driver's License	44	72.13%
5	Experienced EVs before	22	36.07%

	Demographic Variables	No. of Respondents	%
6	Years of Driving Experience		
	0-5 Years	17	27.87%
	6-10 Years	15	24.59%
	11-20 Years	18	29.51%
	21+ Years	11	18.03%
7	Approx. distance covered per day (Kms)		
	0-20	21	34.43%
	21-40	15	24.59%
	41-60	9	14.75%
	61-80	3	4.92%
	81-100	6	9.84%
	100+	7	11.48%
8	Payload (Kgs)		
	0-60	15	24.59%
	61-120	3	4.92%
	121+	1	1.64%
9	Vehicles Owned		
	2-Wheeler	55	90.16%
	4-Wheeler	19	31.15%

3.1. Consumer needs

The observations derived from the study are classified and recorded as Product offerings related to consumer needs and the lack of trust in EVs (or the fear of technology adoption) related issues.

3.1.1. Product offerings related to consumer needs

A variety of product offerings emerged as important considerations in response to the field study conducted. Firstly, hybrid 2-wheeler EVs, which seamlessly blend electric propulsion technology with conventional fuel sources are highly preferred to address the range anxiety. The importance of improved energy efficiency in EVs was also emphasised by respondents to increase their driving range and allow them to go longer distances on a single charge. The initial cost of EVs should be comparable to or even less than that of ICE vehicles, which is another significant expectation. Participants also emphasised the need for cheaper EV batteries, particularly considering that they must be replaced on average every 3 years. Additionally, it emerged that improved battery state-of-charge displays were crucial for user comfort. To successfully negotiate rural terrains, respondents stressed the significance of increasing the ground clearance or chassis height of EVs. Recognising the multi-purpose character of these vehicles in rural areas, participants suggested the design of flat-profiled seats for two-wheeled EVs to assist loading purposes. The respondents also expressed a desire for distinctive, futuristic, and aesthetically appealing EV designs, showing that aesthetic concerns were not overlooked. The results also emphasised the value of battery backup solutions for boosting the dependability of EV use, particularly in areas with erratic power supplies. Finally, rural consumers desire that EVs have performance or loading capabilities that are on par with or better than those of conventional ICE vehicles to ensure that they can effectively and

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efficiently satisfy their daily transportation demands. As electric mobility spreads across the region, these findings together shed light on the product characteristics and qualities that are likely to appeal to rural Indian consumers. On the charging infrastructure, the respondents stressed the need for a broader network of charging stations and shortened charging times to reduce vehicle downtime and fulfil the practical requirement for quick refuelling. The respondents stressed the availability of abundant solar power and thereby the possibility of integrating solar or self-charging features for EV adoption.

3.1.2. Lack of trust in EVs and the fear of technology adoption

Important insights into rural Indian consumers' hesitation to embrace new technology, especially EVs, were obtained from the field survey. While the participants were open to trying out new technologies, they showcased a clear lack of trust in EV usage. They emphasised on the need for designing EVs with reliability and safety in mind, especially during extreme weather events like heavy monsoon rains. The study also emphasised the cognitive load that comes with route planning in the absence of charging infrastructure. The respondents further expressed their inability to understand and operate the Human-Machine Interfaces in new vehicles. For those who are not tech-savvy, these sophisticated interfaces - which include touchscreen displays and intricate infotainment systems - can be intimidating and distracting while driving. Furthermore, strong brand loyalty was demonstrated by rural consumers, who favoured buying EVs from reliable, well-known companies. Dependability and brand allegiance were important factors in their decision-making. The brand allegiance strongly added to the earlier observation about the consumer's fear of new technology adoption, making them go for familiar brands. Another major concern of the potential consumers was the fear of technology becoming obsolete (like in the case of mobile phones). This concern is amplified by the fear of the inability to resale the old vehicle in the pre-owned vehicles market, significantly affecting the long-term viability of EVs. Respondents reiterated the fear of the availability of dependable service professionals or assistance and lack of access to replacement components for the EVs given the unique complexity of EV technology. The observations from this field study highlight the factors affecting the adoption of EVs among rural Indian customers. It is critical to recognise and cater to the special requirements and preferences of rural customers; hence, in the next section, this study offers valuable insights and design recommendations to OEMs on tailoring their product, service and overall ecosystem offerings to meet the specific needs and preferences of rural consumers.

4. Results and discussions

Based on the survey responses, certain suggestions and future design implications can be drawn for the OEMs, which will influence the adoption of EVs in rural India. The research insights reflected that while there is a clear consensus amongst the respondents that EVs are the future of automobiles and that EVs will replace ICE vehicles in future, the respondents are worried that the current EVs provide compromised performance compared to the ICE offerings (Fig 1), indicating a substantial scope for OEMs and designers to come up with rural-focused products. Hence, we have outlined some suggestions for the OEMs, followed by the design implications drawn from the research.

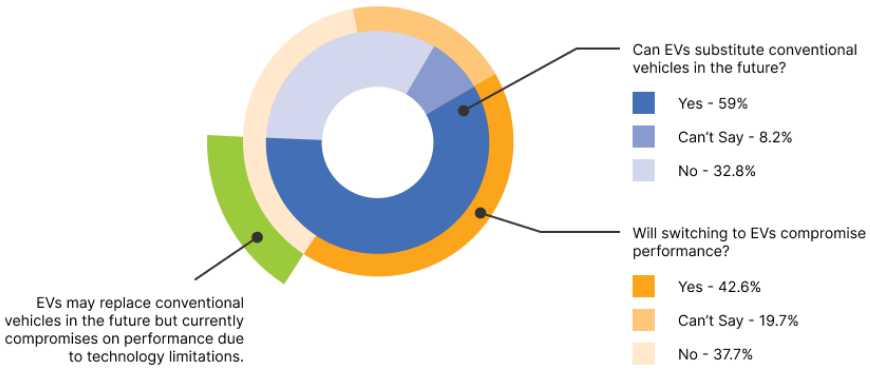

Figure 1. Survey data highlighting the sample worried about current EVs providing compromised performance compared to the ICE offerings

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4.1. Suggestions for the OEMs

4.1.1. Cost optimisation

More than half of the sample population would potentially purchase an EV only if it costs the same as ICE vehicles (Fig 2). However, they felt EVs are low-cost and money-saving on running expenses, indicating that the high upfront costs are a major concern and inhibitor of EV adoption for rural consumers. Hence, OEMS must reduce the upfront costs of EVs, which, along with low operational costs, can be a strong incentive to promote the adoption of EVs in rural areas.

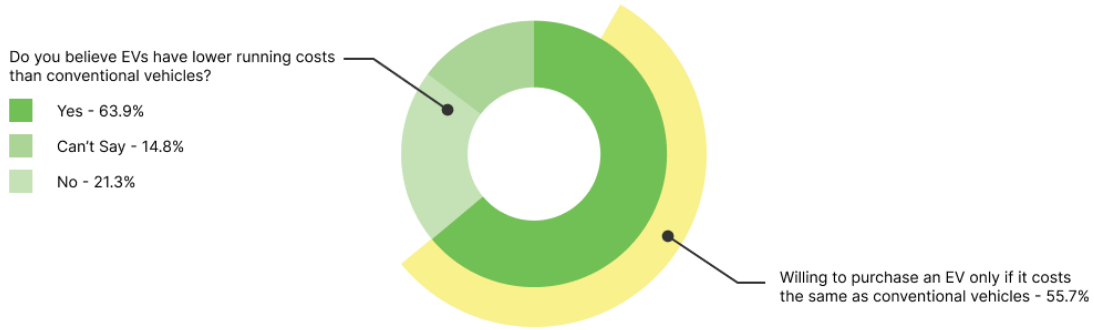

Figure 2. Survey data highlighting insights regarding the perception of running costs and upfront costs of EVs

4.1.2. Addressing range anxiety

Range Anxiety emerged to be one of the most prominent concerns among the people interviewed. In a typical rural context, even riding a 2W EV to the nearest service station is a concern as a typical range of a 2W EV (55-60km) is not sufficient to even reach the nearest service centre (~ 90km or further away). As a solution, OEMs can explore technologies like hybrids in 2-wheeler EVs and improve the accuracy of the SoC algorithms to enable the display of realistic distance to empty on the dashboards of the EVs to address the range anxiety issues faced by the rural population.

4.1.3. Resale value of vehicles

The Resale value of the vehicle is seen as a very important factor by the majority of the sample population when considering purchasing an EV. While this fear is primarily attributed to the degradation and hence the need for replacement of the battery, respondents also feared the technology that goes into the vehicle becoming obsolete (similar to the case of mobile phones). OEMs can address this by offering exchange or buyback programs, upgradability options on the launch of a newer technology vehicle and guaranteeing competitive resale prices for EVs in the resale vehicle market.

4.2. Design implications

4.2.1. Designing a new form for two-wheeler EVs for off-road and agricultural use

Almost 79% of the respondents felt EVs were appealing; some among the remaining 21% did not find the current EV designs appealing. Designers may take this as an opportunity to explore an entirely new form factor, especially for the 2-wheeler EVs, having the likes of the ruggedness of a motorbike and the convenience of a scooter. The aesthetics of the vehicle should be distinctive, futuristic, and visually appealing, in addition to being able to possess a substantial load-bearing capability in duty cycles for usage in fields and on farms that are relevant to rural environments. For example, A scooter with increased wheel size (14 inches) and flat seating for the rider as well as a pillion, along with the flexibility of removing the rear seat and converting it into a load-carrying support member, will be a good addition. Furthermore, designers could develop new form factors, such as off-road electric vehicles and autonomous robots in the agricultural sector and solve challenges such as labour shortages, addressing seasons of higher demands and environmental issues.

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4.2.2. Designing a new HMI dashboard for electric vehicles for rural consumers

Both the two-wheeler and four-wheeler EVs on offer today are feature-packed. However, these long lists of features often come at the cost of very complex Human-Machine Interface Dashboards, creating an adaptability issue for the rural population, especially given the gap in literacy rates between rural and urban Indian populations (Office of the Registrar General & Census Commissioner, 2011). Further aggravating the fear of adopting EVs is the lack of usability of the HMI dashboards, which was also frequently mentioned by the not-very-technologically-aware survey respondents. As per the data, while most of the participants felt excited about adopting a new technology, this excitement did not translate into their trust towards EVs. The research revealed that rural users are generally sceptical about adopting EVs (Fig 3). There is a perception that EVs require more attention to operate safely, adding to concerns about battery and road safety. While the younger customers with higher levels of education are more aware of the benefits of EVs and are more likely to adopt them, the older or less tech-savvy individuals in rural India showcased a lower level of familiarity and acceptance, specifically of advanced technological features on the Human Machine Interface (HMI), reverse modes and proximity unlocking. If these features are designed intuitively and with simplicity in mind, rural users may be more inclined to embrace them.

We recommend that the concept of a “declutter" or simplified display mode, generally used in the context of aircraft avionics and cockpit displays, be used in automotive applications relevant to rural areas where users may be less familiar with the technology. In aircraft emergencies, the pilot must have access to the most critical information without distractions from less important data. When in a declutter mode, cockpit display systems typically prioritise and present only essential flight data, such as altitude, airspeed, attitude, heading, and navigation information, while temporarily removing or minimising less critical or non-essential information from the screens, thereby reducing the cognitive load on the pilot, and allowing to focus on the most critical information during high-stress situations. Though these modes are designed to improve safety during critical phases of aircraft travel, in the case of automobiles, a similar concept can help reduce cognitive load and distractions for drivers and improve overall safety and usability on the roads.

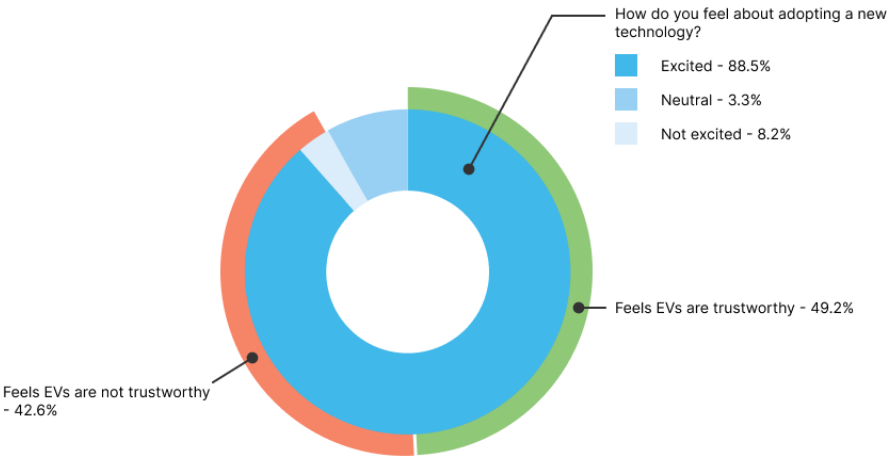

Figure 3. Survey data highlighting the sceptical perception of rural users about adopting EVs

Technological adoption in rural areas is often gradual and depends on the perceived utility and relevance of the technology. The study reveals that currently, people in rural areas use vehicles primarily for basic transportation needs, and some of the advanced features available in the current vehicles may not be essential. Manufacturers might, in the short term, prioritise factors like cost, range, and durability over advanced features and solve the concerns related to both the higher costs and the fear of technology adoption in rural areas. In the longer term, when the usability and user-friendliness of these technologies improve over time, firstly, the benefits of such features can be effectively communicated to potential users. Then, as more people gain experience with EVs, these feature-loaded EVs will become more common in rural settings. To enable this flexibility of feature disablement or enhancement, companies in the automotive industry can rapidly start progressing towards software-defined vehicles (SDVs).

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Software-defined vehicles are a revolutionary change from hardware-centric vehicles to software-centric vehicles. A software-defined vehicle (SDV) separates the hardware from its software. It is updateable and upgradeable over the air, allowing various functions and features to be customised, configured, and controlled through software. In the rural context, when the users become more confident and comfortable with using the advanced technologies on the electric 2-wheelers, these advanced features that previously required hardware changes can be instantly added or improved through software, reducing the need for physical upgrades.

In summary, while there may be initial apprehension or reluctance to use technologies like HMI and reverse modes in electric 2-wheelers in rural India, these concerns can be addressed through building a holistic buyback/upgradability ecosystem, user-friendly design, and educating/demonstrating the practical benefits of the advanced features. The key is to strike a balance between technological advancement and the specific needs and preferences of rural users and enable the advancements over a software upgrade when the users are ready.

4.2.3. Designing formal education and training programs for promotion and awareness about electric vehicles in rural areas

In order to promote awareness about EVs in rural India, formal education and training programs can be designed to address the overall lack of knowledge and driving skills required for operating EVs (including Electric Buses and Trucks). The lack of knowledge about the functionalities of modern EVs can be attributed to the fear or hesitation in adopting the advanced technologies. Training initiatives from the manufacturers and government should also focus on promoting digital literacy and addressing specific concerns and misconceptions prevalent in rural areas in addition to providing an understanding of EV technology. Individuals less familiar with modern tech features must be equipped with the skills to operate the interfaces comfortably.

4.2.4. Addressing range anxiety through design-oriented solutions

For most of the respondents, range anxiety is synonymous with EVs. The fear of running out of battery charge adds to the cognitive load of the rider. The rider has always to keep track of the State of Charge (SoC) of the battery and plan the rides accordingly. Additionally, the long charging period has also to be considered during trip planning. EVs limit the opportunity for a sudden change of ride plan, which occurs quite frequently. There is a scope to explore and design solutions like hybrids, range extenders or swappable batteries to address the range anxiety issues faced by the rural population. Designers can investigate designing and sizing the battery appropriately based on the usage of rural customers and building reliable battery leasing options or adding a smaller capacity limp home engine to the EVs which could charge the battery on the go. In addition to the appropriate sizing, if a one-size-fits-all approach does not work, rural-centric battery variants may be offered as a solution. This approach will, in turn, optimise the charging time as well.

5. Conclusions

A dedicated study of the rural customers' needs and a focused delivery of adapted EV solutions are necessary for a holistic adoption of EVs across the geographies of developing nations, as shown in the study conducted in the Indian context. The adoption of EVs in rural India has the potential to improve environmental sustainability and reduce transportation costs in these regions.

References

Masurali, A. and Surya, P. (2018), "Perception and Awareness Level of Potential Customers towards Electric Cars", *International Journal for Research in Applied Science and Engineering Technology*, International Journal for Research in Applied Science and Engineering Technology (IJRASET), Vol. 6 No. 3, pp. 359–362, https://dx.doi.org/10.22214/ijraset.2018.3056.

Afroz, R., Masud, M.M., Akhtar, R., Islam, Md. A. and Duasa, J.B. (2015), "Consumer purchase intention towards environmentally friendly vehicles: an empirical investigation in Kuala Lumpur, Malaysia", *Environmental Science and Pollution Research*, Vol. 22 No. 20, pp. 16153–16163, https://dx.doi.org/10.1007/s11356-015-4841-8.

https://doi.org/10.1017/pds.2024.145 Published online by Cambridge University Press

Ali, I. and Naushad, M. (2022), "A Study to Investigate What Tempts Consumers to Adopt Electric Vehicles", *World Electric Vehicle Journal*, Vol. 13 No. 2, p. 26, https://dx.doi.org/10.3390/wevj13020026.

Asadi, S., Nilashi, M., Samad, S., Abdullah, R., Mahmoud, M., Alkinani, M.H. and Yadegaridehkordi, E. (2021), "Factors impacting consumers' intention toward adoption of electric vehicles in Malaysia", *Journal of Cleaner Production*, Elsevier, Vol. 282, p. 124474, https://dx.doi.org/10.1016/J.JCLEPRO.2020.124474.

Bhat, F.A., Verma, M. and Verma, A. (2022), "Measuring and Modelling Electric Vehicle Adoption of Indian Consumers", *Transportation in Developing Economies*, Springer Science and Business Media LLC, Vol. 8 No. 1, https://dx.doi.org/10.1007/s40890-021-00143-2.

Bhattacharyya, S.S. and Thakre, S. (2020), "Exploring the factors influencing electric vehicle adoption: an empirical investigation in the emerging economy context of India", *Foresight*, Emerald Group Holdings Ltd., Vol. 23 No. 3, pp. 311–326, https://dx.doi.org/10.1108/FS-04-2020-0037.

Government of India and Ministry of Finance. (2023), "Economic Survey 2022-2023", November.

Jain, N.K., Bhaskar, K. and Jain, S. (2022), "What drives adoption intention of electric vehicles in India? An integrated UTAUT model with environmental concerns, perceived risk and government support", *Research in Transportation Business and Management*, Elsevier Ltd, Vol. 42, https://dx.doi.org/10.1016/j.rtbm.2021.100730.

Jaiswal, D., Kaushal, V., Kant, R. and Singh, P.K. (2021), "Consumer adoption intention for electric vehicles: Insights and evidence from Indian sustainable transportation", *Technological Forecasting and Social Change*, Elsevier Inc., Vol. 173, https://dx.doi.org/10.1016/j.techfore.2021.121089.

Junquera, B., Moreno, B. and Álvarez, R. (2016), "Analyzing consumer attitudes towards electric vehicle purchasing intentions in Spain: Technological limitations and vehicle confidence", *Technological Forecasting and Social Change*, North-Holland, Vol. 109, pp. 6–14, https://dx.doi.org/10.1016/J.TECHFORE.2016.05.006.

Sriram, K.V., Michael, L.K., Hungund, S.S. and Fernandes, M. (2022), "Factors influencing adoption of electric vehicles – A case in India", *Cogent Engineering*, Vol. 9 No. 1, https://dx.doi.org/10.1080/23311916.2022.2085375.

Khurana, A., Kumar, V.V.R. and Sidhpuria, M. (2020), "A Study on the Adoption of Electric Vehicles in India: The Mediating Role of Attitude", *Vision*, Sage Publications India Pvt. Ltd, Vol. 24 No. 1, pp. 23–34, https://dx.doi.org/10.1177/0972262919875548.

Kumar, R.R. and Alok, K. (2020), "Adoption of electric vehicle: A literature review and prospects for sustainability", *Journal of Cleaner Production*, Elsevier Ltd, November, https://dx.doi.org/10.1016/j.jclepro.2019.119911.

Lewicki, W. and Drożdż, W. (2021), "Electromobility and its Development Prospects in the Context of Industry 4.0: A Comparative Study of Poland and the European Union Electromobility and its Development Prospects in the Context of Industry 4.0: A Comparative Study of Poland and the European Union 136", *European Research Studies Journal*.

Li, L., Wang, Z., Chen, L. and Wang, Z. (2020), "Consumer preferences for battery electric vehicles: A choice experimental survey in China", *Transportation Research Part D: Transport and Environment*, Pergamon, Vol. 78, p. 102185, https://dx.doi.org/10.1016/J.TRD.2019.11.014.

Li, W., Long, R., Chen, H. and Geng, J. (2017), "A review of factors influencing consumer intentions to adopt battery electric vehicles", *Renewable and Sustainable Energy Reviews*, Pergamon, Vol. 78, pp. 318–328, https://dx.doi.org/10.1016/J.RSER.2017.04.076.

Lo, K. (2014), "Interested but unsure: Public attitudes toward electric vehicles in China", *Electronic Green Journal*, California Digital Library (CDL), Vol. 1 No. 36, https://dx.doi.org/10.5070/g313618031.

Malik, C. (2021), "ENVIRONMENTALLY CONSCIOUS CONSUMERS AND ELECTRIC VEHICLE ADOPTION BEHAVIOUR: MODERATING ROLE OF PERCEIVED ECONOMIC BENEFIT", Academy of Marketing Studies Journal.

Navalagund, N., Mahantshetti, S. and Nulkar, G. (2020), "Factors influencing purchase intention towards E-vehicles among the Potential Indian consumers-A study on Karnataka region", *Journal of the Social Sciences*, https://dx.doi.org/10.13140/RG.2.2.28103.11686.

Nazneen, A., Ali, I., Bhalla, P., Professor, A., Salamah, I. and Professor, A.A. (2018), "A Study of Consumer Perception and Purchase Intention of Electric Vehicles Chaning dimensions of Visual Merchandising View project A Study of Consumer Perception and Purchase Intention of Electric Vehicles", *European Journal of Scientific Research*.

Office of the Registrar General & Census Commissioner, I. (2011), Census of India.

Shankar, A. and Kumari, P. (2019), "Exploring the enablers and inhibitors of electric vehicle adoption intention from sellers' perspective in India: A view of the dual-factor model", *International Journal of Nonprofit and Voluntary Sector Marketing*, Wiley-Blackwell Publishing Ltd, Vol. 24 No. 4, https://dx.doi.org/10.1002/nvsm.1662.

https://doi.org/10.1017/pds.2024.145 Published online by Cambridge University Press

Shetty, D.K., Shetty, S., Rodrigues, L.R., Naik, N., Maddodi, C.B., Malarout, N. and Sooriyaperakasam, N. (2020), "Barriers to widespread adoption of plug-in electric vehicles in emerging Asian markets: An analysis of consumer behavioral attitudes and perceptions", *Cogent Engineering*, Cogent OA, Vol. 7 No. 1, https://dx.doi.org/10.1080/23311916.2020.1796198.

Singh, H., Singh, V., Singh, T. and Higueras-Castillo, E. (2023), "Electric vehicle adoption intention in the Himalayan region using UTAUT2 – NAM model", *Case Studies on Transport Policy*, Elsevier Ltd, Vol. 11, https://dx.doi.org/10.1016/j.cstp.2022.100946.

Tunçel, N. (2022), "Intention to purchase electric vehicles: Evidence from an emerging market", *Research in Transportation Business and Management*, Elsevier Ltd, Vol. 43, https://dx.doi.org/10.1016/j.rtbm.2021.100764.

Upadhyay, N. and Kamble, A. (2023), "Examining Indian consumer pro-environment purchase intention of electric vehicles: Perspective of stimulus-organism-response", *Technological Forecasting and Social Change*, Elsevier Inc., Vol. 189, https://dx.doi.org/10.1016/j.techfore.2023.122344.

Verma, M., Verma, A. and Khan, M. (2020), "Factors Influencing the Adoption of Electric Vehicles in Bengaluru", *Transportation in Developing Economies*, Springer Science and Business Media LLC, Vol. 6 No. 2, https://dx.doi.org/10.1007/s40890-020-0100-x.

Wang, S., Wang, J., Li, J., Wang, J. and Liang, L. (2018), "Policy implications for promoting the adoption of electric vehicles: Do consumer's knowledge, perceived risk and financial incentive policy matter?", *Transportation Research Part A: Policy and Practice*, Pergamon, Vol. 117, pp. 58–69, https://dx.doi.org/10.1016/J.TRA.2018.08.014.

"World Energy Investment 2023". (2023), IEA (2023), World Energy Investment 2023, IEA, Paris , November.

https://doi.org/10.1017/pds.2024.145 Published online by Cambridge University Press