



ELSEVIER

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

Driving the electric vehicle agenda in Nigeria: The challenges, prospects and opportunities

Temitope Farinloye^a, Omotoye Oluwatobi^b, Ogochukwu Ugboma^c, Olayemi Funmilayo Dickson^d, Chinebuli Uzundu^e, Emmanuel Mogaji^{f,*}

^a Transformative Transport Service Design Initiative (TRATSEDI), Lagos, Nigeria

^b Teeside University, UK

^c Lagos State University, Ojo, Nigeria

^d National Centre for Technology Management, Nigeria

^e Edge Hill University, UK

^f Keele University, UK

ARTICLE INFO

Keywords:

Electric Vehicle
Adoption
Nigeria
Charging Infrastructure
Sustainable Transportation

ABSTRACT

In Nigeria, a developing country and prominent oil producer, the transition towards electric vehicle adoption is unfolding amidst unique challenges. This study addresses crucial research gaps concerning Electric vehicle adoption in developing nations, with Nigeria as a focal point. Through interviews with 31 experts, we have uncovered a landscape filled with challenges and opportunities. The hurdles include a scarcity of charging infrastructure, a heavy reliance on fossil fuels, affordability issues, and unequal access to energy. On the bright side, there are prospects for cost savings backed by government support, adaptable manufacturers, and the potential for renewable energy utilisation. We propose comprehensive awareness campaigns to fast-track electric vehicle adoption, expanding charging infrastructure, government-driven policies, and integrating localised technology, specifically focusing on last-mile transport. Our study contributes valuable insights into Electric vehicle adoption in developing countries, offering theoretical and practical implications for sustainable transportation solutions.

1. Introduction

The growing trend to explore the vast potential of electric vehicles (EVs) stems from the urgent need to mitigate the substantial environmental impact caused by internal combustion engine cars (Tarefi et al., 2021; Zhou et al., 2023; Schulz and Rode, 2022). Government policies like the introduction of the Ultra Low Emission Zone (ULEZ) in London and tightening of tail-pipe CO₂ targets for the automotive industry in the European Union have, in recent years, led to increased market shares of EVs (Henderson et al., 2022; Iwan et al., 2021; Morganti and Browne, 2018). The global automotive industry is heavily investing in EVs, resulting in a surge in EV adoption due to the increasing demand for efficient, clean, and environmentally friendly vehicles (Altenburg et al., 2016; Fevang et al., 2021; Secinaro et al., 2022). This demand is driven by the need to transition from petrol and diesel to a more environmentally friendly source of energy (Kar et al., 2022; Liao and Correia, 2022). Nonetheless, this shift towards EVs is not without its share of challenges,

* Corresponding author.

E-mail addresses: tfarinloye@tratsedi.com (T. Farinloye), c2335269@live.tees.ac.uk (O. Oluwatobi), o.ugboma@lasu.edu.ng (O. Ugboma), Olayemi.dickson@nacetem.com (O.F. Dickson), u.chinebuli@edge.ac.uk (C. Uzundu), E.mogaji@keele.ac.uk (E. Mogaji).

<https://doi.org/10.1016/j.trd.2024.104182>

Received 19 September 2023; Received in revised form 1 February 2024; Accepted 23 March 2024

Available online 4 April 2024

1361-9209/© 2024 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

including limited range and expensive batteries, encompassing manufacturer and consumer attitudes, as well as policymaking considerations (Duarte et al., 2021; Liao and Correia, 2022; Li et al., 2020; Patil et al., 2022). Therefore, it is crucial to comprehensively assess these challenges to foster a comprehensive understanding and offer the best support for this transformation.

The landscape of electric vehicle (EV) research has witnessed significant strides, with notable contributions from Patil et al. (2022), Sun et al. (2019), and Secinaro et al. (2022). However, these advancements have yet to entirely dispel certain limitations, creating gaps in our understanding of the broader EV terrain. While previous studies predominantly focus on addressing EVs' energy needs through alternative sources like Kar et al. (2022) and Li et al. (2020), this crucial emphasis overlooks a more comprehensive perspective. This study aims to fill this gap by delving into often-overlooked dimensions such as EV attitudes, demands, economic viability, and infrastructure considerations before delving into energy-sourcing strategies, as Greene et al. (2020) advocated. Furthermore, a substantial gap persists in the reliance on stated preferences or hypothetical survey data in existing EV literature. Coffman et al. (2017) highlighted the limitations of this reliance on survey data, echoing the concerns Lieven et al. (2011) raised about potential biases in forecasting EV uptake. Al-Alawi and Bradley (2013) emphasised the need to explore alternative data sources beyond surveys.

Moreover, a geographical gap is evident, with many studies predominantly conducted in technologically, financially, and policy-supported developed nations (Schulz and Rode, 2022; Hausteine et al., 2021; Fevang et al., 2021). Reviews by Liao et al. (2017) and Patil et al. (2023) showed a lack of mention of any African country in the studies reviewed. This gap hinders understanding the unique challenges and opportunities developing countries like Nigeria face in adopting EVs (Tarej et al., 2021; Rajper and Albrecht, 2020). Funke et al. (2019) acknowledged the current focus on the US and Europe, emphasising the need for future research to consider emerging markets. Singh et al. (2020) similarly called for additional studies in developing economies to advance understanding of consumer behaviour.

In light of this context, our study aims to thoroughly evaluate EV adoption within developing countries, transcending established insights derived from developed nations. To achieve this, we go beyond conventional surveys and quantitative methodologies, opting for a qualitative approach that involves engaging with experts and managers. This shift seeks to uncover nuanced insights into such environments' distinctive challenges and opportunities. The overarching goal is to contribute valuable knowledge that can effectively shape strategies for EV adoption in developing regions, addressing a crucial gap in the existing literature (Liao et al., 2017; Secinaro et al., 2022; Liao and Correia, 2022). Guiding this research is a central question: What are the challenges, prospects, and opportunities for EVs in Nigeria?

The focus on Nigeria is significant for many reasons: Firstly, Nigeria's status as an oil-producing nation creates hesitancy in embracing Electric Vehicles (EVs) due to dependence on domestically produced oil. In line with Altenburg et al.'s (2016) examination of electromobility in countries like Japan and Germany, comprehending the consequences of EV adoption in an oil-centric context is crucial. The reluctance in Nigeria can be rationalised by its economic structure, which is heavily reliant on oil revenue, acting as a substantial obstacle to quick EV acceptance. Policymakers and industry stakeholders may fear potential disruptions to the established economic order, necessitating a nuanced understanding of the dynamics between energy transition and economic stability. Bridging this gap calls for strategic initiatives, including incentives and targeted infrastructure development, to reshape the narrative and foster sustainable EV adoption in Nigeria.

Secondly, the country contends with electrical supply challenges, which presents a hurdle for EV adoption. In a country with limited power access, the viability of EVs becomes a pertinent question (Oladigbolu et al., 2022; Aba et al., 2023). However, adopting and accepting EVs could lead to advancements in the energy sector, with a potential shift towards cleaner and more sustainable sources, addressing both transportation and energy needs simultaneously.

Thirdly, The Nigerian government's commitment to carbon neutrality by 2060, highlighted in the Energy Transition Plan (ETP) unveiled at COP26, emphasises transformative efforts in key sectors, notably transport. With targets for a 10 % biofuel blend by 2030 and complete EV adoption by 2060, alongside the removal of fuel subsidies, government policies play a pivotal role in shaping the electric mobility landscape (Ajala, 2023). This ambitious agenda provides a compelling context for researching EV adoption in Nigeria, offering insights into the impact of governmental initiatives on the unfolding electric vehicle scenario, making it a crucial area for study.

Fourth, Nigeria boasts a substantial population - in the coming thirty years, the United Nations anticipates a population surge in Nigeria, projecting a rise from 216 million to 375 million people. Consequently, Nigeria is poised to become the world's fourth most populous country, trailing behind India, China, and the United States (Ikpoyi and Asadu, 2022), thus indicating that successful EV adoption here could potentially have a ripple effect on other developing countries (Mogaji and Nguyen, 2023; Mogaji and Nguyen, 2021; Soetan et al., 2021).

Lastly, Nigeria contends with severe air pollution and environmental degradation, especially in major cities. According to Ajala (2023), the transportation sector has historically contributed 48 % to the country's annual CO₂ emissions from fuel combustion. As of 2021, Nigeria is the fourth-highest carbon emitter in Africa, producing 136,986,780 metric tonnes. Shifting to electric vehicles offers a transformative solution, promising a substantial reduction in air pollution and greenhouse gas emissions. This transition aligns with global efforts for environmental conservation and climate change mitigation. Investigating the adoption of electric vehicles in Nigeria becomes imperative for addressing local challenges and contributing valuable insights to other developing nations grappling with similar environmental concerns.

This study employs a qualitative phenomenological approach to address the research question, collecting data from key informant participants (Von Soest, 2023). These individuals possess expertise in EVs in Nigeria, holding vital insights that are influential in policymaking concerning the subject. Additionally, beyond customer interviews or policy analysis, key informants facilitate the exploration of novel concepts and uncharted issues. These insights are subsequently subjected to thematic analysis (Braun and Clarke, 2022), forming a conceptual framework succinctly outlining EVs' challenges, prospects, and opportunities. This study's significance

lies in its theoretical contributions towards understanding EV challenges. It contributes to the limited body of work from developing countries (Rajper and Albrecht, 2020; Tarei et al., 2021), recognising the inherent structural challenges and the need to manage expectations concerning EV adoption.

Moreover, the study extends studies that have focused on literature review (Liao et al., 2017; Secinaro et al., 2022; Liao and Correia, 2022) to provide deeper insight which emerged from empirical data. This insight serves as a theoretical foundation for subsequent explorations of EVs. Significantly, this study also extends practical implications for management and policymaking, particularly concerning increasing EV adoption in developing countries, where socio-economic and infrastructural factors present unique challenges.

2. Literature review

2.1. Transformative trends of EV

In the 21st century, there has been a remarkable worldwide increase in the adoption of electric vehicles (EVs), driven by environmental concerns and the imperative for sustainable transportation solutions. Academic research has been attentive to these transformative trends, contributing to a growing body of literature that enriches our understanding of various aspects of the EV landscape. Notable studies include Liao and Correia (2022), who explored usage patterns, demand dynamics, and potential impacts of electric carsharing and micromobility, shedding light on urban mobility's evolving landscape. Liao et al. (2017) investigated consumer preferences for electric vehicles, providing insights into market dynamics. Sun et al. (2019) examined technological advancements in the EV industry. Secinaro et al. (2022) mapped the field of EV consumer behaviours, Rajper et al. (2020) explored EV prospects in developing countries, while Hardman (2019) delved into incentives' impact on EV adoption. Haghani et al. (2023) recognised a literature gap in EV research, particularly in developing countries like Africa, highlighting the need for comprehensive investigations in diverse global contexts.

Collectively, these studies contribute to our evolving knowledge of electric vehicles, addressing various aspects of their adoption, technology, consumer preferences, and policy implications. However, Haghani et al. (2023) noted a pronounced gap in the literature regarding research on EVs from many developing countries, with Africa being a notable example. Future research focusing on developing countries will contribute to a more inclusive and comprehensive understanding of the global EV landscape, fostering sustainable and environmentally responsible transportation solutions worldwide. While developed nations have led this transition, developing countries are increasingly exploring the integration of EVs into their transportation systems, highlighting the need for research that caters to diverse global contexts.

Efemwenkiele, Babalola and Dirisu (2020) conducted a conceptual study identifying several significant challenges related to EV adoption in developing countries. These include the elevated costs associated with EVs, the financial implications of establishing charging infrastructures, and the necessity for adequate electrical storage facilities. These challenges, if not addressed effectively, can impede the widespread adoption of EVs in these regions. Rajper and Albrecht (2022) also conducted a systematic literature review to assess the feasibility of different types of EVs in developing countries. Their findings suggest that electric four-wheelers face cost-related feasibility challenges in these regions. However, electric two-wheelers present a more promising option due to their affordability. This research underscores the importance of tailoring EV options to the economic realities of developing countries.

Terri et al. (2021) conducted a study specifically within the Indian context, examining barriers to EV adoption. Their research highlighted a range of barriers, including technological limitations, infrastructural gaps, financial constraints, behavioural factors, and external challenges. By ranking and prioritising these barriers, they provided a framework for decision-makers to allocate resources effectively. Barriers such as vehicle performance, charging infrastructure shortages, and limited consumer awareness emerged as critical roadblocks to EV adoption. Jaiswal et al. (2021) explored consumer adoption intentions for EVs in India, shedding light on factors influencing this decision. Their findings indicated that adoption intentions are directly and indirectly influenced by variables such as attitude, perceived usefulness, perceived ease of use, and perceived risk, with the moderation of financial incentives policies. These studies highlight the multifaceted challenges and opportunities surrounding EV adoption in developing countries, emphasising the need for tailored strategies to address these complexities.

2.2. EV adoption in Sub-Saharan Africa

In Sub-Saharan Africa, where unique challenges and opportunities exist for electric vehicle (EV) adoption, several studies have shed light on this region's potential. Collett, Hirmer, Dalkman, Crozier, Mulugetta, and McCulloch (2021) conducted a perspective article challenging the prevailing misconception that electric vehicles may not be suitable for Sub-Saharan Africa due to concerns about affordability and potential strain on electricity systems. Their research emphasises that context-specific methodologies and innovative approaches can unlock various benefits through EV adoption. These benefits include creating synergistic relationships between the transportation and electric sectors, suggesting that Sub-Saharan Africa can harness EVs to address its unique challenges.

Gilomee, Hull, Collett, McCulloch, and Booyen (2023) integrated electric mobility into Sub-Saharan Africa's informal mass transit system, primarily dominated by old and inefficient minibus taxis. Their study utilised simulation methodology to identify over-estimations in energy consumption, highlighting the urgent need for high-frequency mobility data for accurate electrification planning. Their research paves the way for more precise electromobility planning in Sub-Saharan Africa's paratransit system by pinpointing inaccuracies in current simulation models and providing recommendations for improved virtualisation. This underscores the importance of data accuracy in devising effective strategies for EV adoption in this region.

Aligning with the interest in public transport, Booyesen, Abraham, Rix, and Ndibatya (2021) examined the transition of public minibus taxis to electric vehicles in Kampala, Uganda. They specifically focused on the feasibility of using solar photovoltaic chargers for these vehicles. Using simulation environments to assess network impacts and charging capabilities, they emphasised the potential energy requirements and the feasibility of solar PV charging for taxis. Their study provides valuable insights into addressing the unique mobility patterns of these vehicles while considering the impact on power grids, which is crucial for the successful adoption of EVs in the region.

Ampah, Afrane, Agyekum, Adun, Yusuf, and Bamisile (2022) evaluated the effectiveness of standalone hydrogen refuelling and electric charging station renewable energy systems (HRECS) to facilitate the widespread deployment of electric vehicles in Sub-Saharan Africa, with Ghana as a case study. Their comprehensive examination of various hybrid renewable energy systems led to the conclusion that a hybrid system consisting of a biogas generator and solar technology showed the highest technical, economic, and ecological feasibility. This system could significantly reduce carbon dioxide emissions compared to traditional petrol-powered vehicles, emphasising the region's potential for sustainable EV adoption. These studies highlight Sub-Saharan Africa's potential for EV adoption and the need for context-specific strategies to overcome the region's unique challenges and leverage its opportunities.

2.3. EV adoption in Nigeria

In Nigeria, a growing body of research has been dedicated to understanding the multifaceted aspects of electric vehicle (EV) adoption, particularly concerning the techno-economic, environmental, and policy dimensions. These studies have primarily focused on the intricate interplay between the transportation and energy sectors within the Nigerian context. However, amidst this work, our present study aims to address a notable research gap.

Dioha et al. (2022) conducted a study utilising a bottom-up modelling framework to explore the potential implications of increased EV penetration in Nigeria. Their research boldly challenges the widely held misconception that Nigeria's electricity system, primarily natural gas-dominated, needs to be better suited to support decarbonisation efforts in the transportation and power sectors through EV adoption. Instead, Dioha et al. emphasise the pivotal role of renewable energy sources and innovative charging strategies in rendering EV adoption feasible and highly effective in the Nigerian context. Similarly, Agunbiade and Siyan (2020) embarked on an exploratory study to assess the prospects of EVs in Nigeria. Their work shed light on the burgeoning interest in EVs within the country, a subject that remains open for ongoing review and public discourse. A noteworthy aspect highlighted by this study is the significance of considering Nigeria's heavy reliance on crude oil production and the associated revenues when evaluating the potential impact of introducing EVs into the nation. While these studies provide valuable insights, a crucial research gap persists - a need for holistic awareness and perception of EV adoption among the general population in Nigeria. Existing research has predominantly focused on technical, economic, and policy dimensions but has yet to delve into the foundational issue of awareness and perception regarding EVs. This gap is the central focus of our current study.

Additionally, despite the substantial contributions made by Bawa and Nwohu (2023) in investigating the acceptance, potential, and challenges of EVs in Nigeria, they relied on commentary rather than empirical data to support their claims. This gap in empirical evidence regarding EV adoption in Nigeria needs to be addressed for a more comprehensive understanding of the subject. Moreover, [Oladigbolu et al. \(2022\)](#) examined the feasibility of EV charging solutions utilising renewable energy sources across Nigeria's diverse geographical and climatic conditions. Their study, while crucial, provides an opportunity to expand the scope of research to encompass broader African adoption, thus filling another noteworthy gap in the literature.

Furthermore, Akujor et al. (2022) highlighted the urgent need for decarbonisation in Nigeria's transport sector, which heavily relies on fossil fuels. Their study, grounded in a review-based methodology, underscored the dependence of various sub-sectors of Nigeria's transport system on fossil fuels, thus revealing the sector's environmental vulnerabilities. This research accentuates the need for a cautious and strategic approach to decarbonisation to safeguard the Nigerian economy. Lastly, [Brückmann et al. \(2021\)](#) investigated the adoption of battery electric vehicles (BEVs) in regions with limited policy support, aligning their research with the experiences of many developing countries. They identified key factors predicting BEV adoption, which included technology affinity, high income, green party preferences, and housing status. However, this research also underscores the need for a more nuanced understanding of EV adoption, considering the complex landscape of challenges and opportunities specific to developing countries like Nigeria.

2.4. Research gap

In light of the research conducted on EV adoption in developing countries, our present study aims to address three significant research gaps that have emerged. These gaps represent critical areas where further investigation is required to enhance our understanding of EV adoption in these regions, mainly focusing on Nigeria, and to contribute to developing effective policies and strategies for sustainable transportation solutions. These research gaps are as follows:

One notable research gap is the need for holistic awareness concerning EV adoption in developing countries. Despite the growing interest in EV adoption in nations like India, Uganda, Kenya, and Nigeria, there still needs to be a substantial gap in our understanding of EVs' overall awareness and direction among the general population. Existing studies have predominantly concentrated on technical, economic, and policy-related aspects, thus overlooking the fundamental issue of awareness and perception regarding EVs. It is imperative to comprehensively comprehend public attitudes and awareness to facilitate effective adoption strategies, which serve as the foundation for successful implementation.

Another significant research gap revolves around the scarcity of empirical insight on EV adoption, especially in Nigeria. While

several studies have explored the potential of EVs and scrutinised various techno-economic and environmental aspects, a substantial portion of this research remains exploratory, commentary-based, or heavily reliant on modelling and simulation. What is urgently required is a robust body of empirical research that gathers real-world data on EV adoption. This research should encompass a wide range of factors that influence consumer decisions, delve into user experiences, and provide insights into adoption rates within these developing countries. Such empirical insight is indispensable for assessing the current state of EV adoption and its dynamics in these regions.

The third critical research gap underscores the necessity for tailoring research to the specific context of developing countries, with a particular focus on Nigeria and other African nations. Many existing studies have drawn insights from developed countries, potentially neglecting developing regions' unique challenges and opportunities. Recent literature has highlighted substantial gaps in our understanding of EV research in Africa, including trends in electric vehicle adoption and consumer behaviours. To address these gaps effectively, research on EV adoption in developing countries must consider various factors, such as affordability, infrastructure limitations, and unreliable power supply. These challenges significantly differ from those encountered in developed nations, necessitating context-specific research. Such research should address the intricate landscape of challenges and opportunities distinctive to developing countries and offer tailored strategies for promoting EV adoption within these regions.

In summary, our study aims to bridge these three critical research gaps. By comprehensively assessing awareness and perception, gathering empirical data on EV adoption, and conducting context-specific research, we aspire to contribute to a more comprehensive understanding of EV adoption in developing countries, notably Nigeria. This, in turn, will aid in developing policies and strategies that foster sustainable and effective EV adoption, ultimately shaping the future of transportation in a more environmentally conscious and economically feasible manner.

3. Methodology

3.1. Interpretative phenomenological methodology with key informants

This study adopts a qualitative research approach, explicitly employing the key person interview methodology, to delve into the perspectives and insights of key stakeholders in Nigeria's electric vehicle (EV) industry. The key person interview methodology, also known as key informant or key stakeholder interviews, is a qualitative research technique designed to extract profound insights and knowledge from individuals recognised as experts or authoritative figures in a particular field. This approach is beneficial when researchers seek a profound understanding of complex issues, aim to tap into specialised expertise or delve deeply into specific subject areas. The primary objective of this research is to investigate the challenges, opportunities, and strategic dimensions of the Nigerian EV

Table 1
Demographics of Participants.

S/n	Pseudonym	Job Role	Gender	Years of Experience.
	Olatunji	Consumer Behaviour Analyst	Male	0–5 years
	Adekunle	Economic Analyst	Male	5–10 years
	Fatima	Economic Strategist	Female	0–5 years
	Usman	Energy and Environment Consultant	Male	5–10 years
	Uche	Energy Economist	Male	5–10 years
	Aminatu	Energy Economist	Female	5–10 years
	Olamide	Energy Economist	Female	5–10 years
	Musa	Energy Planner	Male	0–5 years
	Onyeka	Entrepreneur in Sustainable Energy	Female	5–10 years
	Olayinka	Entrepreneur in EV Conversions	Female	0–5 years
	Okonkwo	Entrepreneur in EV Manufacturing	Male	5–10 years
	Nwakwo	Entrepreneur in EV Manufacturing	Male	0–5 years
	John	Environmental Activist	Male	0–5 years
	Amina	Environmental Activist	Female	5–10 years
	Usman	Environmental Scientist	Male	5–10 years
	Ibrahim	EV Academic Research	Male	10 + years
	Eze	EV Academic Research	Male	10 + years
	Akin	EV Industry Expert	Male	0–5 years
	Aduke	Financial Expert	Female	5–10 years
	Bonzon	Fleet Manager	Male	5–10 years
	Joke	Fleet Managers	Female	0–5 years
	Adebambo	Policy Analyst	Female	10 + years
	Ayoola	Policy Analyst	Male	0–5 years
	Johnson	Production Manager	Male	5–10 years
	Nwachukwu	Public Policy Expert	Male	5–10 years
	Chukwudi	Renewable Energy Expert	Male	5–10 years
	Nenadi	Renewable Energy Expert	Female	5–10 years
	Ifeoma	Sustainability Expert	Female	5–10 years
	Okon	Technical Innovator	Male	5–10 years
	Jagun	Transport planner	Male	10 + years
	Tango	Urban Planner	Female	10 + years

market. Grounded in a phenomenological framework, this methodology centres on unravelling the lived experiences of individuals operating within the distinctive context of the Nigerian EV industry.

3.2. Participants recruitment

The selection of participants for key person interviews in this study is guided by their expertise, experience, and involvement in the field under investigation, making them key stakeholders, experts, or authorities in the domain of interest. These participants include industry professionals, academics, policymakers, practitioners, and relevant experts. A purposive and purposeful sampling approach was adopted to ensure the selection of individuals with the necessary knowledge and experience to provide valuable insights into the research topic. This involved identifying and recruiting participants through personal contacts, social media, professional networks, and recommendations from other experts. In total, 31 key stakeholders within the Nigerian EV industry were strategically recruited, each offering a unique perspective on EV adoption. The participants in our study represented diverse backgrounds and expertise, including EV Academic Research, Entrepreneurship in EV Manufacturing and Conversions, Environmental Activism, Scientific Research, Fleet Management, Planning, and Policy Analysis. They contributed valuable insights on market trends and infrastructure readiness, offered scholarly perspectives on environmental and economic impacts, and provided valuable viewpoints on the social and environmental aspects of EV adoption. Notably, most participants were male ($n = 19$, 61 %), and a significant portion had more than five years of relevant experience ($n = 22$, 71 %). Collectively, these participants paint a comprehensive and multidimensional picture of the Nigerian EV landscape. These interviews aim to tap into the extensive knowledge, rich experiences, and valuable insights these individuals hold, fostering a holistic understanding of the subject matter, its challenges, and its potential for growth within the Nigerian context. [Table 1](#) provides the participants' demographic information.

3.3. Data collection

The data collection process for this study involved conducting semi-structured interviews with the selected participants using video conferencing tools, primarily Zoom, spanning the months from February to April 2023. Semi-structured interviews allowed for a flexible and open-ended exchange of insights, complemented by a general set of topics or questions that guided the conversation. Researchers provided interview guides as a framework for discussion but encouraged participants to share their perspectives.

Crucially, explicit permission was diligently obtained from each participant before the interviews. A paramount aspect of this process was assuring participants of their responses' strict confidentiality and anonymity, fostering an atmosphere of openness and honesty throughout the interviews. Participants were explicitly informed that their identities and specific responses would not be disclosed in the research findings, underlining the commitment to safeguarding their privacy.

Furthermore, participants were conscientiously informed of their right to terminate the interview at any point without the obligation to provide a reason, ensuring their comfort and agency in the research process. Fortunately, all participants engaged in the interviews, demonstrating their willingness to contribute to the study. The interviews varied in duration, ranging from 32 to 67 min, with an average duration of approximately 48 min. This comprehensive data collection approach ensured the quality and integrity of the insights gathered from the participants. After interacting with the 31 participants, we achieved data saturation, signifying no new insights or information emerging. The documented repeated themes indicated no need for further follow-up or recruiting additional participants (Levitt et al., 2017).

3.4. Data analysis

The qualitative data collection process involved the generation of interview transcripts using transcription software, followed by manual checks for accuracy. These transcripts were then imported into NVivo, a qualitative data analysis tool, to facilitate the subsequent analysis. The analysis process adhered to Braun and Clarke's well-established six phases of thematic analysis (Braun and Clarke, 2022), with a specific emphasis on Reflexive Thematic Analysis, which underscores the interpretation of codes to yield more profound insights.

The analytical journey commenced with a thorough familiarisation with the data, characterised by repeated readings of the interview transcripts to identify connections and meanings that directly related to the research objectives. Subsequently, initial codes (referred to as case nodes) were generated within NVivo based on this in-depth familiarisation process. These initial case nodes were meticulously organised and merged into child nodes, which underwent review and further consolidation. This meticulous curation eventually yielded 19 overarching themes that systematically emerged from the data, following the principles outlined by Braun and Clarke (2022).

Some themes demonstrated close relationships throughout the analysis, while others appeared less significant or tangential to the central research questions. Consequently, dormant themes were judiciously excluded from the final analysis, a decision justified by their limited occurrence, lack of direct alignment with the research question, or potential to dilute the integrity of the findings. This discerning approach culminated in the retention of 76 child nodes (sub-sub themes/ first-order concepts) that effectively illustrated the diverse perspectives and experiences of the participants within the Nigerian EV industry.

Following further analysis, iteration and extensive discussions within the research team, these 76 child nodes were ultimately amalgamated into 12 sub-themes (second-order concepts) and then into three main themes (aggregate dimension), which addresses the research aim. These main themes are the typology that encapsulates the challenges, prospects and opportunities characterising the Nigerian EV industry. See [Table 2](#) for a breakdown of the themes. Collectively, these main themes offer a comprehensive understanding

Table 2
Summary of sub and main themes.

S/n	Initial codes (first-order concepts)	Sub-themes (second-order concepts)	Main (aggregate dimension)
	Raw Material Availability	Mega Challenges (Global Perspective)	The Challenges
	Battery Technology Sustainability		
	Infrastructure Investment Challenges		
	Global Coordination Efforts		
	Economic Conditions	Macro Challenges (Specific to Nigeria)	
	Limited Investment in EV Technology		
	Reliance on Petrol		
	Impact on Driving Choices		
	Limited Access to Electricity		
	Manufacturing Complexities	Meso Challenges (Organizational Issues)	
	Government Policies		
	Limited Investment in Support Services		
	Charging Infrastructure		
	Maintenance Challenges		
	Exchange Rate Fluctuations		
	Policy Constraints		
	Affordability Concerns	Micro Challenges (Individual Perspective)	
	Battery Reliability		
	Prevailing Consumer Attitudes		
	High Initial Costs		
	Preference for Older Vehicles		
	Scepticism Towards EV Technology		
	Lack of Trust in EVs		
	Range Anxiety Alleviation		
	Cost-Effective Alternative	Benefits - Cost Savings and Environmental Protection:	Opportunities
	Lower Maintenance Costs		
	Environmental Awareness		
	Affordability and Efficiency		
	Sustainability		
	Fuel Price Impact		
	Long-Term Financial Savings		
	Government Support	Support Structure - Government Initiatives:	
	Incremental Progress		
	Public Sector Leadership		
	Investment Catalysis		
	Consumer Incentives		
	Infrastructure Development		
	Urban Planning		
	Competitive Edge	Organisational Structure and Innovation:	
	Thriving Innovation		
	Adaptability		
	Dynamic Market		
	Entrepreneurship		
	Technical Capabilities		
	Partnership Opportunities		
	Abundant Sunlight	Energy Sources - Harnessing Renewable Energy	
	Renewable Resources		
	Sustainable Power		
	Environmental Impact		
	Charging Infrastructure		
	Green Economy		
	Global Sustainability Goals		
	Consumer Awareness	Raising Consumer Awareness and Changing Attitudes	Prospects – What can be done
	Stakeholder Collaboration		
	Infrastructure Investment		
	Urban Planning		
	Charging Solutions		
	Awareness Campaign		
	Charging Infrastructure Expansion	Expanding Consumer Support and Charging Infrastructure	
	Battery Swapping Technology		
	Consumer Support Services		
	Advocacy Efforts		
	Policy Incentives		
	Supportive Ecosystem		
	Government Leadership	Government-Led Policy Drive	
	Policymaker Prioritization		
	Stakeholder Engagement		

(continued on next page)

Table 2 (continued)

S/n	Initial codes (first-order concepts)	Sub-themes (second-order concepts)	Main (aggregate dimension)
	Oil Dependency Reduction Local Technology Integration Local Innovation Tailored Solutions Motorcycles and Tricycles Last-Mile Transport Business Viability Grassroots Adoption Transportation Diversity	Local Technology Integration and Last Mile Transport	

of the viewpoints held by key stakeholders within the industry, shedding light on the intricacies and dynamics that define their involvement in electric vehicles in Nigeria.

3.5. Rigour and credibility

Ethical considerations were at the forefront of this research, emphasising voluntary participation and the unwavering respect for participants' autonomy throughout the study. Member checks reinforced this commitment to ethical conduct, a vital step in the research process. Member checks involved the sharing of interview transcripts and research findings with participants to validate the accuracy of their representation within the study. Notably, all participants unequivocally concurred with the interview transcripts, requiring no alterations or amendments. Consequently, their exact words were meticulously integrated into the final report, preserving the authenticity and integrity of their contributions.

The research team maintained a steadfast dedication to reflexivity, continuously acknowledging and addressing potential biases that may have arisen during the study. This ongoing introspection ensured a comprehensive and nuanced understanding of the participants' experiences and viewpoints. A comprehensive table of themes (refer to Table 2) has been provided as a further testament to the research's credibility and validity. This table visualises the rigorous process through which themes were developed and refined, offering transparency and demonstrating the study's robustness in its thematic analysis.

4. Findings

Our engagement with the key information has unveiled the intricate landscape of electric vehicle (EV) adoption in Nigeria. Through thorough thematic analysis, our findings have illuminated crucial themes related to the challenges, opportunities, and prospects in this evolving landscape. These themes shed light on the multifaceted nature of the journey towards EV adoption in Nigeria.

4.1. The challenges

The challenges associated with electric vehicle (EV) adoption in Nigeria can be categorised into four key dimensions: Mega, Macro, Meso, and Micro, each presenting unique obstacles to widespread adoption.

4.2. Mega challenges (Global Perspective)

Like many other nations, Nigeria faces global challenges related to EV adoption. These include limited access to essential raw materials for EV production, concerns regarding the sustainability of battery technologies, and the need for significant investments in EV infrastructure. These challenges are recognised globally and require coordinated efforts to address. Akin, an EV Industry Expert, said: "Nigeria, like many other nations, faces global challenges in EV adoption, such as access to raw materials and concerns about battery technology." These concerns were also exacerbated by Aminatu, an Energy Economist who said, "Global factors like the availability of raw materials and investment concerns are overarching challenges Nigeria shares with the international community in the transition to EVs." Ibrahim, EV Academic Research, reassured Nigerians, saying "We are not the only country struggling with EV adoption; it is a global challenge, and we need to recognise our unique challenges and find ways around it." Participants agreed that EV adoption in Nigeria is separate from the global context, recognising that challenges like battery sourcing and global investment affect the nation's efforts to embrace electric mobility.

4.3. Macro challenges (Specific to Nigeria)

Aligning with the reassuring words of Ibrahim, as explained under the global challenges, there are macro challenges specific to Nigeria. These challenges are deeply rooted in the country's economic conditions, limited investments in EV technology, and heavy reliance on petrol as the primary energy source for transportation. Nigeria's economic situation and its dependence on fossil fuels significantly limit how people choose to drive. Adebayo, an Economic Analyst, said: "There are challenges specific to Nigeria, including economic conditions, limited investments, and heavy reliance on petrol, influencing people's driving choices." This was further corroborated

by Uche, an Energy Economist who said: ‘Nigeria’s unique challenges, including economic conditions and reliance on petrol, impact the feasibility of EV adoption.’ Ifeoma, a Sustainability Expert, described her concern: ‘The entrenched use of petrol all contributes to challenges in Nigeria’s EV transition.’ Furthermore, concerns about the limited access to electricity in many parts of Nigeria present a formidable obstacle, as potential EV owners may be hesitant to invest in a vehicle that requires charging when a reliable power supply is not guaranteed. Okon, a Technical Innovator, shared his concern, saying:

“It can be discouraging to think about using electricity to power our cars in a place where we are still working hard to ensure households have a steady supply of electricity to keep their fridges running or entrepreneurs run their small businesses. Much like many other developing nations, Nigeria is constantly battling to improve electricity access and reliability. It is a challenge that makes us pause and ponder. How do we strike a balance between moving forward with innovative transportation solutions and fulfilling the immediate and crucial needs of the people?”

4.4. Meso challenges (Organizational Issues)

Organisational challenges affecting EV adoption encompass the experiences of car manufacturers, allied support service providers, and businesses attempting to incorporate EVs into their operations. Participants in the study highlighted the complexities of manufacturing in Nigeria, citing issues such as exchange rate fluctuations, government policies, and inadequate investment in critical support services like charging infrastructure and maintenance. A Public Policy Expert, Nwachukwu, also said that ‘limited manufacturing experiences in Nigeria, government policies, and limited investments in support services like charging infrastructure, are notable barriers to EV adoption in Nigeria’. Nwakwo, an Entrepreneur in EV Manufacturing, said:

Even though the global community is buzzing about EVs, let us get real about the challenges of doing EV business right here in Nigeria. It is no walk in the park. We are talking about hurdles like sourcing materials, dealing with exchange rates, and finding the right workforce, and we need help getting me started on consumer attitudes. It is a tough nut to crack.

During our discussions, participants astutely pointed out the intricacies of the EV supply situation in Nigeria. They shed light on the significant challenge of producing EVs within the country. Importing cars and considering second-hand EVs were recognised as potential alternatives. However, the participants went beyond these observations. They emphasised the importance of nurturing local solutions and supporting homegrown manufacturers despite the impediments. Their insights underscored the potential for indigenous innovation and entrepreneurship within the EV sector. This approach aligns with the broader goal of promoting domestic industries and addresses the unique challenges and opportunities present in the Nigerian context. Okonkwo, an Entrepreneur in EV Manufacturing, advocated for ‘a more sustainable, long-term strategy that fosters local talent and manufacturing capabilities, ultimately contributing to the growth and self-sufficiency of the EV industry in the country.’.

4.5. Micro challenges (Individual Perspective)

Individual challenges related to EV adoption come into play at the micro level. These include concerns about affordability, battery reliability, and prevailing attitudes towards EVs. Many participants noted that a significant portion of the Nigerian population may need more time to prepare for EVs due to cost-related factors. Affordability remains a significant barrier, as electric vehicles are more expensive than conventional gasoline-powered cars. Eze, an EV Academic Research, said:

“Several factors contribute to the expected low adoption of EVs in Nigeria. If we step back and ask ourselves, how many people can afford a car here? And then, if we narrow it down further, how many can afford a brand-new car, let alone an electric vehicle, with its unique cost considerations and maintenance needs? Don’t get me wrong, EVs are undoubtedly a fantastic initiative, but we must always consider the Nigerian context. It is a context where affordability plays a significant role in consumer choices, and practicality often precedes the latest trends.”

Additionally, there is a prevailing preference for older vehicles among Nigerians, who may need help to afford new EVs. Furthermore, scepticism and a lack of trust in EV technology contribute to the hesitancy among individuals to embrace this emerging mode of transportation. Olatunji, a Consumer Behaviour Analyst, said: ‘

“Beyond the factors of affordability, battery technology, and prevailing consumer attitudes, there is another crucial point to consider. Many consumers in Nigeria strongly prefer older vehicles – the ones they trust, the ones that local mechanics in Lagos can easily repair, and the ones for which spare parts are readily available. It all boils down to what works best for the typical Nigerian consumer, which often means sticking with what is familiar and practical.”

Participants unanimously acknowledge that unique individual challenges are tied to Nigeria’s socio-economic context, which could substantially influence electric vehicle adoption. They emphasise the need for a comprehensive understanding of these issues before imposing global aspirations for EV adoption on the African landscape.

4.6. Opportunities

Benefits – Cost Savings and Environmental Protection:

One significant opportunity for EV adoption in Nigeria is the potential for substantial cost savings. As petrol prices continue to rise,

many consumers are increasingly interested in EVs as a cost-effective alternative. Olamide, an Energy Economist, states,

“The soaring price of petrol in Nigeria is increasingly turning the spotlight on electric vehicles (EVs) as an appealing alternative. With the cost of running conventional vehicles becoming a significant concern, many individuals are reevaluating their options and contemplating potentially investing in EVs to enjoy substantial fuel cost savings.”

Respondents in the study pointed out that efficient management of EVs could lead to substantial financial savings. Additionally, there are significant benefits related to maintenance costs. EVs have fewer mechanical components than traditional internal combustion engine (ICE) vehicles, resulting in lower maintenance expenses. Akin, an EV Industry Expert, notes, “Lower maintenance expenses associated with EVs are a compelling benefit. The reduced need for mechanical repairs can result in significant long-term savings for vehicle owners.”

Moreover, the participants recognised the growing importance of environmental protection. They noted that the global trend towards environmental consciousness has reached Nigeria, and more people are making a conscious effort to reduce their carbon footprint by choosing electric cars. Amina, an Environmental Activist, said:

As environmental awareness regarding transportation grows, a noticeable shift is occurring among individuals, especially the younger people in Lagos, who are becoming increasingly conscious of the environmental impact of their travel choices. They are cycling, and more Nigerians are expected to opt for electric vehicles as a deliberate measure to combat air pollution.

The investigation into the potential cost savings and environmental advantages associated with electric vehicles (EVs) strongly aligns with Nigeria’s imperative to lessen its reliance on traditional fossil fuels for transportation and, instead, explore cleaner and more sustainable mobility alternatives. While participants express scepticism about the feasibility of reducing fuel dependency, they collectively acknowledge that it is a critical decision that necessitates careful consideration and strategic action.

Support Structure - Government Initiatives:

The Nigerian government’s efforts to support EV adoption represent a commendable opportunity. While participants acknowledged that these initiatives may not be sufficient, they recognised steps in the right direction. Adebambo, a Policy Analyst, observes, “Government support for EVs in Nigeria is advancing, albeit gradually. Increased investments and favourable policies for electric mobility can accelerate adoption and drive the shift towards sustainable transportation solutions.” There are calls for government parastatals to invest in electric fleets and promote the use of EVs within government agencies.

Additionally, participants highlighted the importance of government investments in the EV sector, which could catalyse growth and development. Government support is crucial in creating an environment that enables EV adoption in the country. Nwachukwu, a Public Policy Expert, suggests, “Government parastatals can have a big impact by investing in electric fleets. Their consistent vehicle purchases can boost the economy and signal support for the EV market, setting an example and stimulating its growth.”

Fatima, an Economic Strategist, comments, “Government incentives, like tax breaks for electric vehicles, can motivate consumers to transition to EVs, fostering a more favourable environment for electric mobility.” Musa, an Energy Planner, states, “Government backing is essential for building the necessary EV infrastructure, including charging stations and grid upgrades. Public-private partnerships can be instrumental in this regard.” Another participant, Tango, an Urban Planner, adds, “Government support also extends to urban planning. Well-designed cities with EV-friendly infrastructure can promote electric mobility and reduce traffic congestion.” These quotes, offered by experts and practitioners, provide comprehensive insights into the opportunities associated with electric vehicle adoption in Nigeria, spanning cost savings, environmental benefits, and the role of government initiatives.

Organisational structure and innovation:

Manufacturers in Nigeria perceive several benefits in the organisational structure for EVs. Their location and size provide advantages in swiftly delivering EVs to those in need. Participants noted that the adaptability of their organisations allows them to navigate the market efficiently. Johnson, Production Manager in an EV company, emphasises, “Our organisational structure offers a competitive edge. Being a local manufacturer allows us to respond to market demands swiftly, ensuring timely delivery of EVs to consumers.”

Interestingly, the study revealed that innovation in EVs is not limited to large manufacturers; many individuals and small workshops are actively working on EV projects, including tricycles and conversions of ICE vehicles to electric. Olayinka, an Entrepreneur in EV Conversions, notes, “Innovation in EVs is thriving in Nigeria. Small workshops and individuals are actively contributing to the EV ecosystem. We are converting ICE vehicles to electric and exploring unique solutions like electric tricycles.”. This grassroots innovation demonstrates the country’s diverse EV development and adoption opportunities.

Furthermore, participants recognised the importance of technical capabilities and partnerships. The industry is gradually shifting towards EVs, making establishing and building partnerships to enhance EV adoption in Nigeria easier. Eze, an EV Academic researcher, highlights, “It is fascinating to see how adaptable Nigerian businesses are to electric vehicles. Both large manufacturers and nimble startups are jumping on the EV bandwagon, creating a dynamic and ever-evolving market right here in the country.” Okon, a Technical Innovator, adds, “Technical capabilities are on the rise. The shift towards EVs has created opportunities for partnerships and collaborations, driving innovation and enhancing our capabilities in the electric mobility sector.”

Energy Sources - Harnessing Renewable Energy:

Practitioners highlighted the immense potential of solar and other renewable energy sources in Nigeria. They stressed that electricity generation should be fine for the country, given its abundant sunlight and various renewable energy resources. Harnessing these energy sources could provide a reliable and sustainable power supply for EVs, addressing one of the critical concerns regarding charging infrastructure. The transition to renewable energy for charging can significantly reduce the environmental impact of EVs while ensuring energy availability. Chukwudi, a Renewable Energy Expert, states, “Solar and other renewables hold immense potential

for Nigeria's energy needs. We have an abundance of sunlight and diverse renewable resources. It is time to harness these sources to power our EVs sustainably." Mr. Adewale, an Energy Planner, explains, "Electricity generation should not be a major concern in Nigeria. With proper planning and investment in renewable energy infrastructure, we can ensure a reliable and eco-friendly power supply for EVs."

Participants noted that transitioning to renewable energy for EV charging is a win-win. It addresses the charging infrastructure challenge while contributing to Nigeria's commitment to reducing carbon emissions and fostering a green economy. They acknowledge that renewable energy adoption aligns with global sustainability goals. Usman, an Environmental Scientist, comments, "Nigeria has the potential to lead the way in sustainable transportation by harnessing its abundant renewable resources for EVs." Nigeria presents various opportunities for EV adoption, including cost savings, government support, organisational adaptability, grassroots innovation, and the potential to harness abundant renewable energy sources. When leveraged effectively, these opportunities can contribute to the growth of the EV market and sustainable transportation solutions in the country.

4.7. Prospects – What can be done?

Given the challenges and opportunities, several promising prospects exist for the successful adoption of electric vehicles (EVs) in Nigeria. Participants in the study articulated several key areas that require attention and concerted efforts to catalyse the growth of EVs in the country.

Raising Consumer Awareness and Changing Attitudes

One of the foremost prospects identified is the need to address consumer-facing challenges, particularly the prevailing attitude towards internal combustion engine (ICE) vehicles. Participants underscored the necessity of creating widespread awareness about the benefits and prospects of EVs. They called for a comprehensive and co-created campaign involving all stakeholders, similar to the campaigns that introduced diamonds and mobile phones. Such a campaign would inform the public about the availability and advantages of EVs. John, an Environmental Activist, said: 'Imagine if we all teamed up, stakeholders and tech founders, to launch an electric vehicle awareness campaign that rivals the ones that made diamonds a must-have and what mobile companies did when they brought GSM to Nigeria. It is time for a collective push toward a greener, electric future'.

However, participants emphasised that concurrent investments in infrastructure should accompany this awareness campaign to support the increasing consumer demand. Adequate urban planning is vital to ensure the availability of convenient charging points across the country. Joke, a Fleet Manager said: 'You see, it is not a one-way street. Just producing EVs will not cut it. We have got to invest in the infrastructure, too. Charging points everywhere, urban planning on point - that is the road to electric success'. Aduke, a Financial Expert, also corroborated this, saying, "Raising awareness is the first step. However, it must go hand in hand with investment in charging infrastructure. This is where the banks can come in, to support investment in these infrastructures as without the convenience of charging, EV adoption will remain a challenge." Participants concur that a well-executed awareness campaign is key to unlocking EV adoption in Nigeria despite consumer reluctance and a prevailing dependence on oil. They emphasise the transformative power of education in reshaping people's attitudes and fostering the understanding needed to make informed decisions. While recognising that this process may take time, they view it as an essential long-term investment in transitioning to sustainable transportation solutions.

Expanding consumer support and charging infrastructure

In addition to raising awareness, expanding consumer support is imperative to encourage existing EV users and entice more individuals to adopt EVs. Participants advocated for substantial investments in charging infrastructure, including developing battery-swapping technologies. The concept of swappable batteries garnered attention, and stakeholders proposed investing in creating standardised, exchangeable battery packs. To bolster adoption, participants highlighted the importance of maintenance services, advocacy efforts, and the formulation of supportive policies. Nenadi, a Renewable Energy Expert, shared her idea, noting that:

As the global demand for EVs grows and its influence reaches Nigeria, there is a resounding call for expanding customer service and offering innovative solutions to address consumer concerns like range anxiety. This shift presents a fantastic opportunity to make EVs more appealing to Nigerian consumers. One exciting prospect on the horizon is the possibility of battery swapping for tricycles and motorcycles, which could be a game-changer for transport tech startups in the country. It is an exciting time for innovation in the Nigerian transportation sector!

These experts emphasised the need for significant investments in infrastructure to support those who might be considering switching from traditional combustion engine vehicles to EVs. Nwakwo, an Entrepreneur in EV Manufacturing, highlighted Nigerians' ingenious and creative capabilities, citing examples like the impressive skill of converting British right-hand drive vehicles to left-hand drive in Nigeria. These talents, they believe, can be harnessed to transition combustion engine vehicles into EVs. The consensus is clear. Olayinka, an Entrepreneur in EV Conversions, concluded, 'With the right support, including investments in maintenance services and creating a supportive ecosystem, Nigeria can tap into its vast potential for EV innovation and adoption. It is all about empowering the local talent.'

Government-Led policy drive

Participants emphasised that the support structure for EV adoption needs to be broadened, mainly through government initiatives. They stressed the significance of a top-down approach, with the government leading the charge by recognising the reduced dependence on oil and the pressing need to protect the environment. Participants expressed significant scepticism regarding the transition of government fleets to EVs. Ifeoma, a Sustainability Expert, recalled an incident when a senator raised the idea of EVs in the Nigerian Senate, only to have it met with laughter. This highlights the prevailing reluctance and lack of enthusiasm for EVs within certain government circles. However, participants unanimously emphasised that for EV adoption to gain momentum, it must begin with strong

government support and leadership. The consensus is clear: government backing is essential to drive the EV agenda forward in Nigeria. Jagun, a Transport planner, noted, “The government should recognise the importance of EV adoption and lead by example. When policymakers prioritise sustainability, it sends a strong signal to other stakeholders.”. This position was also corroborated by Amina, an Environmental Activist, who said - “Government support is pivotal. Acknowledging the shift away from oil dependency and emphasising environmental protection can drive the EV agenda in Nigeria.”. However, as an Economic Strategist, Fatima believes the government cannot do it alone. She noted, “*Collaboration is key for EV success. It may take time, but a well-coordinated effort involving government, manufacturers, advocacy groups, and consumers will lead to a strategic and sustainable approach.*”

Participants stressed the pivotal role of a robust policy drive in paving the way for comprehensive stakeholder engagement in the electric vehicle (EV) ecosystem. They underscored the importance of ensuring that all relevant parties are actively involved and motivated to contribute to the growth of EV adoption. Ayoola, a Policy Analyst, highlighted ongoing efforts to position Nigeria as a leading country in vehicle electrification to achieve net-zero emissions by 2060. These efforts include plans to promote local production of electric vehicles. However, the Production Manager Johnson emphasised that these policies must be effectively implemented to achieve the desired impact. Participants recognised the unique transportation needs in Nigeria; they emphasised that policies should be tailored to address these distinctive requirements within the context of EV adoption. Participants advocated for policies that consider and accommodate Nigeria’s specific transportation landscape and needs in the EV ecosystem.

Local technology integration and last mile transport

Recognising the unique travel needs in Nigeria, participants called for integrating local technology and tailored solutions. They emphasised the significance of adapting EVs to suit the country’s diverse transportation landscape, including using motorcycles and tricycles. Participants advocated developing EVs tailored for last-mile transport modes, which could significantly expedite adoption, especially when the business case aligns with economic feasibility. The gradual expansion into the private car segment should be complemented by initiatives targeting these essential last-mile transport modes. Drawing upon the example of Nigerian mechanics adept at transforming the steering systems of cars, participants emphasised the vital significance of local innovation in addressing the distinctive travel needs of Nigerians. They highlighted that underestimating the importance of local ingenuity would be a mistake, particularly in the context of motorcycle and tricycle use.

Participants firmly stated that customised electric vehicle (EV) solutions tailored for these modes of transport represent the path forward. They recognised that embracing local innovation to develop EVs suited to Nigeria’s diverse transportation landscape, including motorcycles and tricycles, is pivotal to achieving widespread EV adoption within the country. “Bonzon, A fleet Manager, noted that. ”Motorcycles and tricycles play a vital role in Nigerian transportation. EVs designed for these modes and local innovations can drive EV adoption from the grassroots.“ Akin, an EV Industry Expert, noted that:

Last-mile transport is crucial in Nigerian communities. Producing electric motorcycles and tricycles with swappable batteries can lead to broader adoption. When this aligns with the economic viability, and businesses witness its cost-effectiveness, it can accelerate EV adoption while fulfilling transportation needs, benefiting both sustainability and the economy in Nigeria.

Participants stressed the need for a multifaceted, coordinated approach to fully realise the promising prospects of EV adoption in Nigeria. They anticipate a gradual yet strategic journey, emphasising the importance of holistic collaboration among the government, manufacturers, advocacy groups, and consumers. This united effort is poised to overcome challenges and ultimately pave the way for a sustainable, eco-friendly transportation future in Nigeria.

5. Discussion

The transportation sector is a formidable contender for the title of one of the most significant contributors to global CO₂ emissions (Brückmann and Bernauer, 2020). Given this undeniable reality, it is unsurprising that adopting EVs has sparked academic interest. Our present study adds to this ongoing discussion with scholars delving deep into various facets of this transition, from comprehensive literature reviews (Curtin et al., 2017; Patil et al., 2022; Liao and Correia, 2022) to scrutinising consumer adoption behaviours (Secinaro et al., 2022; Tarei et al., 2021) and probing attitudes towards alternative energy sources for transportation (Li et al., 2020; Kar et al., 2022). These studies have illuminated various strategies, including subsidies and enhanced charging infrastructure, which pull public support towards EVs. Simultaneously, they have explored the push factors, such as carbon taxes and regulations aimed at phasing out fossil fuel vehicles (Brückmann and Bernauer, 2020).

Nigeria presents a unique dimension to the discourse on phasing out fossil fuel vehicles and adopting EVs. Altenburg et al. (2016) dissected the emergence of electromobility in car-producing nations like Japan and Germany. In our context, Nigeria’s status as an oil-producing nation adds a fascinating twist to the narrative. We must critically examine whether and how Nigeria can disentangle itself from fossil fuel reliance and embrace EVs (Agunbiade and Siyan, 2020; Bawa and Nwohu, 2023). It is essential to recognise that Nigerians may still require vehicles to transport their oil, which could influence the speed of their transition away from internal combustion engine (ICE) cars. Moreover, Nigeria’s position as an emerging economy presents unique challenges that may differ from those faced by developed nations (Agunbiade and Siyan, 2020; Bawa and Nwohu, 2023). While this is not an excuse, our findings from Nigeria echo common trends discussed in the literature, particularly regarding concerns about affordability, accessibility, and interest in EVs (Brückmann and Bernauer, 2020; Liao et al., 2017; Rajper and Albrecht, 2020; Morganti and Browne, 2018).

In line with studies focused on developing countries like India (Terri et al., 2021) and Uganda (Booyesen et al., 2021), we have identified a range of barriers encompassing technological limitations, infrastructural gaps, financial constraints, behavioural factors, and external challenges. However, we draw inspiration from Collett’s (2021) work, which challenges the prevailing notion that electric vehicles may not suit Sub-Saharan Africa. It suggests significant potential for EVs in Africa, particularly as interest in electric public

transport grows (Giliomee et al., 2023; Booysen et al., 2021). Our study aligns with Collett’s perspective, emphasising the need to temper expectations regarding EV adoption in Africa and advocating for a localised approach. Each country has its unique limitations and challenges. Even developed nations like Switzerland, as revealed by Brückmann et al. (2021), face difficulties in Battery Electric Vehicle (BEV) adoption despite limited policy support for EVs. This highlights that developing countries must be allowed the flexibility to manage their progress and adoption.

In managing these expectations, we must also acknowledge the inventive potential of these nations as they explore EV technologies. While global challenges persist, we commend efforts to address macro-challenges and capitalise on EV opportunities. With initiatives to convert motorcycles and tricycles in Nigeria to electric vehicles, car manufacturing companies dedicating production lines to EVs, and the emergence of electric bicycles, the EV landscape is undergoing a transformation that demands adequate support. Numerous studies have emphasised that policy interventions are pivotal in driving EV adoption (Curtin et al., 2017; Brückmann and Bernauer, 2020). Our study underscores the significance of policy considerations for Nigeria. Experts have noted the need for clear and reassuring public messaging from the government to demonstrate their commitment to supporting this transition. This policy-focused approach aligns with concerns raised in India (Kar et al., 2022; Tarei et al., 2021), China (Li et al., 2020), Uganda (Booyesen et al., 2021), and many other developing countries (Rajper and Albrecht, 2020).

Nigeria’s transition towards EV adoption is not solely driven by environmental sustainability but is a multifaceted strategy aligning with broader economic and developmental goals. As a prominent oil producer and exporter, the country recognises the need to diversify its economy, reducing overdependence on oil revenue susceptible to global price fluctuations. As highlighted in the Nigerian government’s Energy Transition Plan (ETP), there is an emphasis on transformative efforts with the transport sector, and the shift to EVs also offers an opportunity for technological advancement, fostering innovation and creating new job opportunities, thereby contributing to economic development (Ajala, 2023).

While fixed costs are associated with establishing EV infrastructure, the long-term benefits outweigh these initial investments. The strategic move towards EV adoption can enhance energy security, reduce air pollution, and position Nigeria as a proactive player in the global transition towards sustainable energy practices. Despite being classified as a less developed country, Nigeria’s consideration of EV adoption is crucial for achieving sustainable development goals, addressing pressing environmental challenges, and ensuring resilience against future economic uncertainties (Aba et al., 2023). The move towards cleaner and more sustainable transportation aligns with global trends and positions Nigeria as a forward-thinking nation in the evolving landscape of energy transition and mobility (Ajala, 2023).

To summarise our study exploring critical research gaps in EV adoption, Fig. 1 depicts a comprehensive conceptual framework to bolster EV adoption in Nigeria. It acknowledges the EV ecosystem, from manufacturers to diverse consumer categories such as private individuals, government fleets, and commercial enterprises. Within this framework, particular attention is given to the challenges confronting consumers and offers support structures that manufacturers can utilise to mitigate these obstacles effectively.

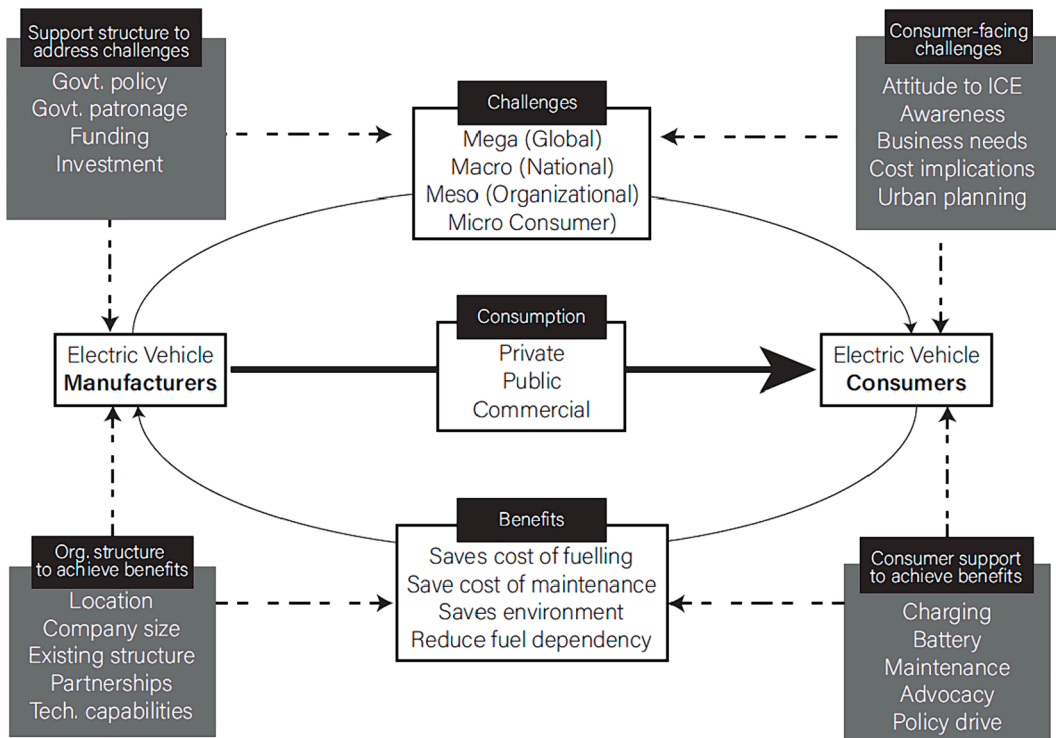


Fig. 1. Conceptual framework for enhancing the adoption of EVs in Nigeria.

Furthermore, the framework acknowledges the various benefits of EV adoption and underscores the importance of establishing consumer support mechanisms to maximise these advantages. By amalgamating qualitative insights from our research, this framework provides a holistic perspective, facilitating the development of policies and strategies for sustainable and economically feasible transportation solutions. In the subsequent subsection, we delve into our study's theoretical implications and managerial insights.

5.1. Theoretical contributions

Our study makes a significant theoretical contribution by offering empirical insights into electric vehicles (EVs), focusing specifically on Nigeria—a country of strategic importance as a major oil producer with a large population. This empirical approach distinguishes our contribution from prior literature, which often leaned heavily on literature reviews (Liao et al., 2017; Secinaro et al., 2022; Liao and Correia, 2022) or conceptual approaches (Bawa and Nwohu, 2023; Hossain et al., 2022; Showers and Raji, 2020). Additionally, our study addresses the substantial gap in existing EV literature, marked by a reliance on stated preferences or hypothetical survey data (Al-Alawi and Bradley, 2013; Coffman et al., 2017), by providing qualitative empirical insights from key stakeholders. This approach establishes a robust empirical foundation, offering a valuable reference point to understand the complexities of EV adoption in a country characterised by unique economic, social, and environmental factors.

Our second theoretical contribution lies in providing insights into contextualising EV adoption within a resource-rich nation like Nigeria, where the significant dependence on oil production adds a unique dimension to the EV landscape. Previous research has explored the emergence of electromobility in car-producing countries like Japan and Germany (Altenburg et al., 2016). Our study delves into the complexities of EV adoption within an oil-producing country. This context-specific analysis sheds light on the distinct challenges and opportunities associated with EV adoption in resource-rich nations, enriching the theoretical framework for understanding such transitions.

Third, while our study focuses on Nigeria, the theoretical contributions can extend beyond the country's borders. Researchers and policymakers in other developing nations can apply lessons and insights from our study's theoretical framework to their contexts. This comparative analysis can foster a broader understanding of the nuances of EV adoption in diverse global settings. Specifically, we noted that beyond just the countries producing the cars (Altenburg et al., 2016), there is a need to explore the countries producing the oil to critically establish their motivations to switch away from fossil fuel, which they have to alternative energy sources.

Fourth, engaging with practitioners adds a practical dimension to our study. In an emerging area like EV (Liao et al., 2017; Rajper and Albrecht, 2020), engaging and collaborating with industry experts or policymakers offers key insights that are essential for EV adoption success in Nigeria. These insights differ from customers, and the engagement enriches our research and contributes theoretically by bridging the gap between academia and real-world EV implementation.

Lastly, our study offers a conceptual framework for EV adoption. As illustrated in Fig. 1, we highlight the challenges, opportunities, and prospects of EV adoption, which can serve as a valuable contribution to the field. This framework synthesises empirical findings and practitioner insights into a structured model that can guide future research and policy development in Nigeria and other developing countries facing similar challenges.

5.2. Managerial implications

Successfully navigating the complexities of electric vehicle (EV) adoption in Nigeria necessitates a holistic and strategic approach. The following recommendations serve as a roadmap for the country to achieve a successful and sustainable transition to widespread EV adoption.

Addressing global challenges, such as limited raw materials and sustainability concerns, requires Nigeria's active participation in international collaborations. By engaging in these efforts, the country can secure access to essential resources for EV production and contribute to developing sustainable solutions on a global scale. Unique economic conditions and heavy reliance on petrol pose significant obstacles, necessitating targeted investments in local solutions. Initiatives to reduce dependence on traditional fuel sources and overcome electricity accessibility issues are crucial, requiring collaborative efforts between the government, businesses, and international entities. To overcome organisational challenges, Nigeria should prioritise the development of local manufacturing support. This involves nurturing talent, overcoming production hurdles, and fostering indigenous innovation within the EV sector. Tailoring strategies to Nigeria's socio-economic context is essential to address individual challenges, including affordability concerns and scepticism. Financial incentives, subsidies for EV adoption, and comprehensive awareness campaigns highlighting benefits are recommended. Building trust in EV technology requires dispelling scepticism while incorporating local preferences in marketing can enhance consumer acceptance. Nigeria can pave the way for successful and sustainable EV adoption through these recommendations.

Capitalising on cost savings and environmental benefits, Nigeria can position EVs as a financially viable and eco-friendly alternative, aligning with the imperative to reduce reliance on traditional fuels. Government initiatives provide a foundational opportunity, and Nigeria should strengthen support, investments, and policy incentives for accelerated transition to sustainable transportation. The country's organisational adaptability, including fostering partnerships and supporting innovation from large manufacturers and local workshops, is crucial for sustained growth in the EV sector. Additionally, leveraging abundant solar and renewable resources is vital for Nigeria's energy needs. Transitioning to renewable energy for EV charging aligns with global sustainability goals and enhances Nigeria's potential to lead in sustainable transportation, contributing to long-term environmental and economic benefits.

Launching a comprehensive awareness campaign, emphasising EV benefits and garnering public support is crucial. Strategic investments in charging infrastructure, battery-swapping technologies, and maintenance services are imperative to complement awareness efforts and address consumer reluctance. Supportive policies and innovative solutions, such as battery swapping for

tricycles, can enhance EV appeal for Nigerian consumers. Government backing is pivotal, necessitating a collaborative effort involving government bodies, manufacturers, advocacy groups, and consumers. This unified approach is essential for a strategic and sustainable drive towards EV adoption in Nigeria. Tailoring EVs for local transportation needs, including motorcycles and tricycles, mandates local technology integration. Embracing local innovation and nurturing indigenous talent can foster widespread adoption, particularly in the crucial last-mile transport segment.

Table 3 succinctly presents the major themes from in-depth discussions surrounding EV adoption in Nigeria. Each summary captures essential elements such as challenges, opportunities, and strategic recommendations articulated by diverse stakeholders. This comprehensive overview encapsulates the Nigerian EV ecosystem, accompanied by relevant practical implications.

While our study focuses on Nigeria, an oil-rich developing country grappling with electric supply challenges, our findings offer insights applicable to electric mobility in developing regions with a heavy oil industry. We illuminate the potential for diversifying energy sources in oil-producing nations, contributing to discussions on reducing reliance on traditional oil-based industries. Policy-makers in similar developing regions can benefit from insights gleaned from Nigeria's electric mobility landscape, guiding the

Table 3
Key Themes in Nigerian Electric Vehicle (EV) Adoption Landscape.

Main theme	Sub Theme and summary	Practical Implications
The Challenges	<p>Mega Challenges (Global Perspective) <i>Global obstacles include limited raw materials, sustainability concerns, and the need for EV infrastructure investments. Nigeria acknowledges shared challenges, emphasising coordinated efforts for EV adoption.</i></p> <p>Macro Challenges (Specific to Nigeria) <i>Economic conditions, limited investments, and petrol reliance hinder EV adoption in Nigeria. Challenges include electricity access and unique socio-economic factors, requiring tailored solutions.</i></p> <p>Meso Challenges (Organizational Issues) <i>Organisational hurdles in Nigeria include manufacturing complexities, policy issues, and insufficient support services. Overcoming barriers involves nurturing local solutions and supporting indigenous EV manufacturing.</i></p> <p>Micro Challenges (Individual Perspective) <i>Affordability, battery reliability, and scepticism pose individual challenges for EV adoption in Nigeria. Recognising socio-economic nuances is crucial before imposing global EV aspirations.</i></p>	<p>Global challenges, such as limited raw materials and sustainability concerns, necessitate coordinated international efforts. Nigeria must collaborate on a global scale for resource access and sustainable solutions.</p> <p>Nigeria's economic conditions and reliance on petrol pose unique obstacles. Addressing economic challenges requires targeted investments, emphasising the need for local solutions and overcoming electricity accessibility issues.</p> <p>Organisational challenges highlight the need for local manufacturing support. Nigeria should focus on nurturing local talent, overcoming manufacturing hurdles, and supporting indigenous innovation within the EV sector.</p>
Opportunities	<p>Benefits - Cost Savings and Environmental Protection: <i>Rising petrol prices drive interest in cost-effective EVs in Nigeria. Lower maintenance expenses and environmental consciousness contribute to the appeal of electric vehicles.</i></p> <p>Support Structure - Government Initiatives: <i>Government efforts to support EV adoption in Nigeria are commendable but must be revised. Calls for increased investments, favourable policies, and public-private partnerships underscore the crucial role of government support for sustainable transportation solutions.</i></p> <p>Organisational Structure and Innovation: <i>Nigeria's organisational structure offers a competitive edge for EV manufacturers. Innovation extends to grassroots initiatives, emphasising the country's adaptability and dynamic market evolution.</i></p> <p>Energy Sources - Harnessing Renewable Energy: <i>Solar and renewables hold immense potential for EVs in Nigeria, providing a sustainable power supply. Transitioning to renewable energy aligns with global sustainability goals, requiring proper planning and investment.</i></p>	<p>Cost savings and environmental benefits present an opportunity for Nigeria to promote EVs as a financially viable and eco-friendly alternative, aligning with the country's need to reduce reliance on traditional fuels.</p> <p>Government initiatives provide a foundation for EV adoption. Nigeria should enhance these efforts, ensuring consistent support, investments, and policy incentives to accelerate the transition to sustainable transportation.</p> <p>Nigeria's organisational adaptability offers a competitive edge. Fostering partnerships, supporting innovation from large manufacturers and local workshops, and capitalising on technical capabilities are crucial for sustained growth in the EV sector. Leveraging abundant solar and renewable resources is vital for Nigeria's energy needs. Transitioning to renewable energy for EV charging aligns with global sustainability goals and enhances Nigeria's potential to lead in sustainable transportation.</p>
Prospects – What can be done?	<p>Raising Consumer Awareness and Changing Attitudes <i>A comprehensive awareness campaign is needed to shift attitudes toward EVs in Nigeria. Education, along with infrastructure investments, is viewed as a long-term investment in sustainable transportation.</i></p> <p>Expanding Consumer Support and Charging Infrastructure <i>Expanding consumer support involves substantial investments in charging infrastructure, emphasising battery-swapping technologies. Maintenance services, advocacy efforts, and supportive policies are crucial for comprehensive consumer support.</i></p> <p>Government-Led Policy Drive <i>Strong government support is pivotal for EV adoption in Nigeria. Despite scepticism, well-implemented policies tailored to Nigeria's transportation needs and collaborative efforts are crucial for success.</i></p> <p>Local Technology Integration and Last Mile Transport <i>Customised EV solutions for last-mile transport modes and local innovation are vital for Nigeria's diverse transportation needs. A coordinated approach involving government, manufacturers, and advocacy groups is emphasised.</i></p>	<p>A comprehensive awareness campaign is essential, emphasising EV benefits and garnering public support. Infrastructure investment, urban planning, and banking support are crucial to complement awareness efforts and overcome consumer reluctance.</p> <p>Significant investments in charging infrastructure, battery-swapping technologies, and maintenance services are imperative. Supportive policies and innovative solutions, such as tricycle battery swapping, can make EVs more appealing and practical for Nigerian consumers.</p> <p>Government support is pivotal, but collaboration is critical. A well-coordinated effort involving government, manufacturers, advocacy groups, and consumers is necessary for a strategic and sustainable approach to drive EV adoption in Nigeria.</p> <p>Tailoring EVs for local transportation needs, including motorcycles and tricycles, requires local technology integration. Embracing local innovation and nurturing indigenous talent can drive widespread adoption, especially in the essential last-mile transport segment.</p>

adaptation of transportation systems for global sustainability. Our study's recommendations have broader policy implications, facilitating a balance between economic interests and environmental sustainability. Valuable insights on consumer behaviour, infrastructure development, and government support from our findings can inform industries adapting to this evolving landscape. Manufacturers, suppliers, and service providers in oil-dependent economies can consider these implications for sustainable business practices. Delving into Nigeria's unique challenges and opportunities in electric mobility, our study offers nuanced and practical implications for other developing regions with a heavy reliance on the oil industry.

6. Conclusion

As a developing country and oil producer, Nigeria is navigating the global shift towards EV adoption. However, its unique complexities impact the rate of adoption. Through interviews with EV experts and stakeholders, our study addresses critical research gaps in EV adoption in developing countries, focusing on Nigeria. First, we tackle the lack of holistic awareness by advocating for comprehensive awareness campaigns and concurrent investments in charging infrastructure to change public attitudes and understanding, bridging the awareness gap. Second, we fill the gap of scarce empirical data by providing real-world insights into EV adoption, encompassing challenges and opportunities unique to Nigeria. Third, we tailor our research to the specific context of developing nations, addressing challenges such as affordability, infrastructure limitations, and unreliable power supply. By doing so, our work contributes to a better understanding of EV adoption in developing regions, aiding the development of policies and strategies for sustainable and economically feasible transportation solutions.

While our study contributes significantly, it has limitations. We have not directly engaged with consumers, leaving room for future research on their behaviours and attitudes. Our focus on Nigeria limits generalizability, encouraging future studies to explore broader contexts. We have employed qualitative methods, suggesting the need for quantitative data collection. Additionally, our conceptual framework invites further exploration and validation, allowing researchers to extend and apply it globally, ultimately advancing EV adoption efforts.

CRedit authorship contribution statement

Temitope Farinloye: Conceptualization, Data curation, Investigation, Methodology. **Omotoye Oluwatobi:** Conceptualization, Data curation, Writing – original draft, Writing – review & editing. **Ogochukwu Ugboma:** Writing – review & editing. **Olayemi Funmilayo Dickson:** Writing – original draft, Writing – review & editing. **Chinebuli Uzundu:** Methodology, Writing – review & editing. **Emmanuel Mogaji:** Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Writing – original draft, Writing – review & editing.

References

- Aba, M., Amado, N., Rodrigues, A., Sauer, I., Richardson, A., 2023. Energy transition pathways for the Nigerian Road Transport: implication for energy carrier, powertrain technology, and CO₂ emission. *Sustain. Prod. Consum.* 38 (1), 55–68.
- Ajala, S., 2023. Nigeria's bold leap to boost e-mobility and shrink its emissions. Retrieved from <https://energytransition.org/2023/11/nigerias-bold-leap-to-boost-e-mobility-and-shrink-its-emissions/>.
- Al-Alawi, B., Bradley, T., 2013. Review of hybrid, plug-in hybrid, and electric vehicle market modeling studies. *Renew. Sustain. Energy Rev.* 21, 190–203.
- Altenburg, T., Schamp, E., Chaudhary, A., 2016. The emergence of electromobility: comparing technological pathways in France, Germany, China and India. *Sci. Public Policy* 43 (4), 464–475.
- Braun, V., Clarke, V., 2022. Conceptual and design thinking for thematic analysis. *Qual. Psychol.* 9 (1), 3–31.
- Brückmann, G., Bernauer, T., 2020. What drives public support for policies to enhance electric vehicle adoption? *Environ. Res. Lett.* 15 (9), 094002.
- Curtin, J., McInerney, C., Gallachóir, B., 2017. Financial incentives to mobilise local citizens as investors in low-carbon technologies: a systematic literature review. *Renew. Sustain. Energy Rev.* 75, 534–547.
- Duarte, G., Silva, Baptista, P., 2021. Assessment of wireless charging impacts based on real-world driving patterns: case study in Lisbon, Portugal. *Sustain. Cities Soc.* 71, 102952.
- Fevang, E., Figenbaum, E., Fridström, L., Halse, A., Hauge, K., Johansen, B., Raaum, O., 2021. Who goes electric? The anatomy of electric car ownership in Norway. *Transp. Res. Part D: Transp. Environ.* 92, 102727.
- Funke, S., Sprei, F., Gnann, T., Plötz, P., 2019. How much charging infrastructure do electric vehicles need? A review of the evidence and international comparison. *Transp. Res. Part D: Transp. Environ.* 77, 224–242.
- Greene, D., Kontou, E., Borlaug, B., Brooker, A., Muratori, M., 2020. Public charging infrastructure for plug-in electric vehicles: what is it worth? *Transp. Res. Part D: Transp. Environ.* 78, 102182.
- Haustein, S., Jensen, A., Cherchi, E., 2021. Battery electric vehicle adoption in Denmark and Sweden: recent changes, related factors and policy implications. *Energy Policy* 149, 112096.
- Henderson, A., Cao, M., Liu, Q., 2022. Access-based consumption, behaviour change and future mobility: insights from visions of Car Sharing in greater London. *Future Transportation* 2 (1), 216–236.
- Ikpoi, D., Asadu, C., 2022. World Population hits 8 billion, creating many challenges. Retrieved from <https://www.independent.co.uk/news/nigeria-ap-united-nations-india-john-magufuli-b2225300.html>.
- Iwan, S., Nürnberg, M., Jedliński, M., Kijewska, K., 2021. Efficiency of light electric vehicles in last mile deliveries—Szczecin case study. *Sustain. Cities Soc.* 74, 103167.
- Kar, S., Bansal, R., Harichandan, S., 2022. An empirical study on intention to use hydrogen fuel cell vehicles in India. *Int. J. Hydrogen Energy* 47 (46), 19999–20015.
- Li, L., Wang, Z., Chen, L., Wang, Z., 2020. Consumer preferences for battery electric vehicles: a choice experimental survey in China. *Transp. Res. Part D: Transp. Environ.* 78, 102185.
- Liao, F., Correia, G., 2022. Electric carsharing and micromobility: a literature review on their usage pattern, demand, and potential impacts. *Int. J. Sustain. Transp.* 16 (3), 269–286.
- Liao, F., Molin, E., van Wee, B., 2017. Consumer preferences for electric vehicles: a literature review. *Transp. Rev.* 37 (3), 252–275.
- Lieven, T., Mühlmeier, S., Henkel, S., Waller, J., 2011. Who will buy electric cars? an empirical study in Germany. *Transp. Res. Part D: Transp. Environ.* 16 (3), 236–243.

- Mogaji, E., Nguyen, N., 2021. Transportation satisfaction of disabled passengers: evidence from a developing country. *Transp. Res. Part D: Transp. Environ.* 98, 102982.
- Mogaji, E., Nguyen, N., 2023. Exploring interactions between commuters with disabilities and transport service providers. *J. Serv. Mark.* 37 (6), 762–787.
- Morganti, E., Browne, M., 2018. Technical and operational obstacles to the adoption of electric vans in France and the UK: an operator perspective. *Transp. Policy* 63 (1), 90–97.
- Oladigbolu, J., Mujeeb, A., Imam, A., Rushdi, A., 2022. Design, technical and economic optimization of renewable energy-based electric vehicle charging stations in Africa: the case of Nigeria. *Energies* 16 (1), 397–417.
- Patil, P., Kazemzadeh, K., Bansal, P., 2022. Integration of charging behavior into infrastructure planning and management of electric vehicles: a systematic review and framework. *Sustain. Cities Soc.* 88 (1), 104265.
- Patil, P., Kazemzadeh, K., Bansal, P., 2023. Integration of charging behavior into infrastructure planning and management of electric vehicles: a systematic review and framework. *Sustain. Cities Soc.* 88, 104265.
- Rajper, S., Albrecht, J., 2020. Prospects of electric vehicles in the developing countries: a literature review. *Sustainability* 12 (5), 1906–1918.
- Schulz, F., Rode, J., 2022. Public charging infrastructure and electric vehicles in Norway. *Energy Policy* 160, 112660.
- Secinaro, S., Calandra, D., Lanzalunga, F., Ferraris, A., 2022. Electric vehicles' consumer behaviours: mapping the field and providing a research agenda. *J. Bus. Res.* 150, 399–416.
- Singh, V., Singh, V., Vaibhav, S., 2020. A review and simple meta-analysis of factors influencing adoption of electric vehicles. *Transp. Res. Part D: Transp. Environ.* 86, 102436.
- Soetan, T., Mogaji, E., Nguyen, N., 2021. Financial services experience and consumption in Nigeria. *J. Serv. Mark.* 35 (7), 947–961.
- Sun, X., Li, Z., Wang, X., Li, C., 2019. Technology development of electric vehicles: a review. *Energies* 13 (1), 90–102.
- Tarei, P., Chand, P., Gupta, H., 2021. Barriers to the adoption of electric vehicles: evidence from India. *J. Clean. Prod.* 291, 125847.
- Von Soest, C., 2023. Why do we speak to experts? Reviving the strength of the expert interview method. *Perspect. Polit.* 21 (1), 277–287.
- Zhou, W., Cleaver, C.J., Dunant, C.F., Allwood, J.M., Lin, J., 2023. Cost, range anxiety and future electricity supply: a review of how today's technology trends may influence the future uptake of BEVs. *Renew. Sustain. Energy Rev.* 173, 113074.