ADDIS ABABA UNIVERSITY

COLLEGE OF DEVELOPMENT STUDIES

CENTER FOR REGIONAL AND LOCAL DEVELOPMENT STUDIES (CRLDS)

ELECTRIC VEHICLE ADOPTION IN ETHIOPIA: CHALLENGES AND OPPORTUNITIES FOR GREEN MOBILITY

A THESIS SUBMITTED TO COLLEGE OF DEVELOPMENT STUDIES PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTERS OF ARTS IN REGIONAL AND LOCAL DEVELOPMENT STUDIES

By

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Center for Regional and Local Development Studies (CRLDS)

This is to certify that the thesis prepared by Yared Nigussie, titled: Electric Vehicle Adoption in Ethiopia: Challenges and Opportunities for Green Mobility and submitted in partial fulfilment of the requirements for the Masters Degree in Regional and Local Development Studies (RLDS) complies with the regulation of the Addis Ababa University (AAU) and meets the accepted originality and quality.

Teshome Tafesse (PhD), Advisor

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Approval

This is to certify that the thesis prepared by Yared Nigussie titled: "Electric Vehicle Adoption in Ethiopia: Challenges and Opportunities for Green Mobility" is submitted in partial fulfilment of the requirements for the Degree of Master of Arts in Regional and Local Development Studies complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Declaration

This thesis is my original work and has not been presented in another Department of the University or institution. All sources and materials used for the thesis have been duly acknowledged.

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LIST OF ACRONYMS

BEV— Battery Electric Vehicle

CO_2 – Carbon Dioxide

DOI — Diffusion of Innovation

EVs — Electric Vehicles

EVSE — Electric Vehicle Supply Equipment

FCEV — Fuel Cell Electric Vehicle

HEV— Hybrid electric vehicles

ICEs —Internal Combustion Engines

IEA — International Energy Agency

KWh – Kilowatt-hour

PHEV — Plug-in Hybrid Electric Vehicle

MiNT — Ministry of Innovation and Technology

MoTL — Ministry of Transport and Logistics

SCT — Social Cognitive Theory

TAM — Technology Acceptance Model

TPB — Theory of Planned Behavior

UTAUT — Unified Theory of Acceptance and Use of Technology

ABSTRACT

Electric vehicles are crucial alternatives to create clean transportation by offering a variety of merits such as reducing air pollution, and dependency on oil. However, price, range anxiety, lack of infrastructure such as charging infrastructures are some of the barriers to ensure a swift adoption of electric vehicles. Ethiopia as a nation stands at a crossroads with regards to its transportation future. While grappling with air pollution and dependence on fossil fuels, the country also sees the potential of electric vehicles (EVs) to drive a cleaner and more sustainable mobility landscape. This study delves into the intricate dynamics of EV adoption in Ethiopia, analyzing the challenges hindering and opportunities propelling this transition. Ambitious government targets, Ethiopia's abundant renewable energy resources for instance hydropower and geothermal, cost-effective and environmentally friendly mode of the transportation, financial savings and reductions in energy consumption and harmful emissions are among the prospects of EVs adoption. This study employed a qualitative approach combined with a data analysis of charging infrastructure availability, range anxiety, and government policies with methods such as interviews with key stakeholders and surveys to assess users' perception. Both inductive and deductive analysis methods were employed in this study. Geographically, the study is confined to Addis Ababa city. Through a comprehensive analysis of the challenges and opportunities, this study provided a nuanced understanding of the factors influencing EV adoption in Ethiopia, identify key interventions and policy measures to accelerate the transition to electric mobility. The findings show that the main challenges of the adoption of electric vehicles in the first place are high upfront cost of electric vehicles, which is responded by 25% of the respondents. Limited charging infrastructure is being identified by 16.7% of respondents as a major conundrum to adopt the vehicles. Lack of awareness and knowledge among the population is another factor that limited the adoption of electric vehicles, according to 16.67% of respondents. High import taxes, limited charging infrastructure and inadequate policies such as absence of regulations to build and administer charging infrastructures are among the factors that are hindering swift adoption of electric vehicles. The study concludes that Ethiopia can leapfrog old systems and embrace EVs, leading in development and avoiding used gasoline cars. Overall, EV adoption promises a positive impact on future sustainability and efficiency. To encourage EV adoption in Ethiopia, the study recommends financial incentives such as reducing the purchase costs through tax breaks, subsidies, and above all customs exemptions, build charging stations, especially fast-charging options, and incentivize their installation. Non-financial incentives on the other hand includes dedicated parking, green zones, and other benefits for EVs.

1. Introduction

The origins of electric vehicles can be traced back to multiple inventors (Olabi et al., 2022). In 1828, Ányos Jedlik, a Hungarian inventor, constructed a small electric car powered by his own electric motor design (Bael, 2011). Around the same time, Thomas Davenport, an American blacksmith and the inventor of the first American DC motor, integrated his motor into a model electric car and ran it on a circular electrified track in 1834 (Asbury et al., 1884). In 1835, Dutch professor Sibrandus Starting and his instrument maker, Christopher Becker, collaborated on building an electric cart based on Michael Faraday's calculations (Campi, 2020). This scale model remains preserved today (Morimoto, 2015).. In 1838, Scottish inventor Robert Davidson developed an electric locomotive capable of reaching a speed of 6.4 kilometers per hour (Kubański, 2020). Between 1832 and 1839, another Scottish inventor, Robert Anderson, designed a rudimentary electric carriage (Campi, 2020). These early creations laid the foundation for the evolution of electric vehicles (Aruna Ponnupandian, 2021). Furthermore, Thomas Parker was also a person behind the development of reliable electric vehicles in 1884, followed by Ferdinand Porsche's innovative electric car in Germany in 1899 (Bhuvaneswara, 2022). These early electric vehicles offered distinct advantages over their steam and gasoline-powered counterparts, boasting quiet operation, minimal moving parts, and zero emissions (Cao et al., 2021).

Transportation is vital for modern society (Ivanova et al., 2023). It is essential for economic growth, providing a decent standard of living for everyone, and creating a wide range of benefits for individuals and businesses (Krishna, 2021). Despite its many benefits, the transportation sector is also a major contributor to climate change and air pollution; for instance, in 2020 alone, it accounted for over 16% of global carbon dioxide emissions (Hannah, 2020), which can have harmful effects on the surrounding and human health (Degirmenci & Breitner, 2018). Nations at large are on the cusp of a massive shift from traditional gasoline (petrol) vehicles to electric-powered ones, partly as a response to climate change (Anderson et al., 2022). Add to this, countries are looking for ways to reduce carbon emissions from the transportation sector, which currently accounts for 92% of transportation energy consumption and is powered almost entirely by fossil fuels (Khalili et al., 2019). The same study find out those electric vehicles (EVs) offer a promising solution, as they can be powered by renewable energy sources such as solar and wind power. This would help to reduce reliance on fossil fuels and make the transportation sector more environmentally friendly (Toolib et al., 2023). Among these alternatives are the electric vehicles, a car that uses electricity stored in batteries or other energy storage devices to power its one or more electric motors (Oluwayemi et al., 2023). Electric vehicles (EVs) can help to address the growing environmental, economic, and energy challenges of transportation, such as air pollution, climate change, and urbanization. EVs produce fewer greenhouse gases and pollutants than gasoline or diesel vehicles (IEA, 2022). Electric cars are one of the most effective ways to reduce environmental concerns (Anenberg et al., 2019) They are powered by electricity, which is a cleaner and more sustainable source of energy than gasoline (Raj, 2019). These vehicles have immediate torque, which means they can accelerate quickly (Ali, 2021). Even though developed countries like the United States are struggling to adopt electric vehicles (Wikström, 2015); developing countries are facing even greater challenge, for example, in Indonesia, over 94% of vehicles are fossil fuel-powered, while EVs account for only 0.2% (Veza et al., 2022). In

general, EVs can be categorized into battery electric vehicle (BEV), hybrid electric vehicle (HEV), plug-in hybrid electric vehicle (PHEV) and fuel cell electric vehicle (FCEV) (Faizal et al., 2019). BEV is driven by electric motors powered by batteries, while HEV and PHEV is driven solely by ICE, assisted by electric motors. FCEV is also driven by electric motors but powered by a fuel cell stack (Sadeghian et al., 2022). This study focuses solely on BEVs only, and the EVs discussed in the paper are referring to BEVs. Electric vehicles are up to 3 to 4 times more efficient per unit of input energy, lower fuel and maintenance costs, cut CO_2 emissions, better low-end torque for acceleration, heavy loads, and hill climbs and no sound pollution (IEA, 2020). On the other hand, according to IEA (2020), these vehicles have higher upfront costs, reduced range and charging convenience, range sensitivity to temperature and usage patterns, and consumers are unfamiliar with the technology.

1.2. Statement of the Problem

The transition to the deployment of electric vehicles (EVs) is slow and challenging process in many, especially developing countries (Dioha et al., 2022). Electric vehicles are becoming more and more attractive, both environmentally and economically, compared to traditional vehicles (Gebrehiwot & Bossche, 2014). However, there are still some major challenges to overcome before full vehicle electrification is achieved (IEA, 2023). The biggest challenge right now is electrical storage technology (Lewis et al., 2012). Electric vehicle batteries have much lower energy density and refueling/recharging rates than liquid fuels (Wikström, 2015). There are studies conducted on the factors influencing EVs adoption, for instance, as Toolib et al., (2023) put it that environmental concerns, government policy, incentives and charging infrastructures as main factors contributors to EVs adoption. Despite their benefits the adoption of plug-in electric vehicles (PEVs) in developed nations has been very slow mainly due to lack of charging facilities are being installed in developed countries in a very sluggish phase (Berry et al., 2013). Similarly, He et al., (2022) consider that one of the main challenges to the widespread adoption of electric vehicles (EVs) is their limited driving range.

EVs typically have a shorter range than gasoline-powered cars, which means that drivers need to be more mindful of how far they can travel before needing to recharge (Verma et al., 2020). This can be a significant barrier for people who drive long distances regularly or who live in areas with limited charging infrastructure (Egnér & Trosvik, 2018). Electric vehicles (EVs) will become increasingly common around the world, but it is unclear how quickly and how widely they will be adopted (D. Robinson, 2018). The inconvenience of finding compatible charging stations can deter some drivers from switching to EVs (Michael et al., 2022a). Consumers are facing more choices and have more varied preferences, making it harder for them to decide what to buy, and even though electric vehicles are becoming more popular, they are still not very common (Tu & Yang, 2019), whereas, the high price of EVs is a big reason why not everyone is switching to them yet (Yong & Park, 2017). EVs are typically more expensive than gasoline-powered vehicles (Vegh et al., 2022). This is due to the higher cost of lithium-ion batteries, which are the key component in EVs (IEA, 2022). Many consumers are hesitant to make a large upfront investment in an EV (Krishna, 2021). EVs are still more expensive than gas-powered

cars to buy, even though the cost of batteries has gone down a lot. This makes it harder for people to choose EVs (Muehlegger, 2020).

Government subsidies and tax breaks can help to offset the high upfront cost of EVs (Alanazi, 2023). The availability of affordable financing options can also make EVs more affordable for consumers (Chidambaram et al., 2023). However, many consumers do not have access to affordable financing options for EVs (Li et al., 2019; Paula & Maia, 2022). Furthermore, shortage of dedicated lanes for EVs is limiting their availability in a number of ways (Adhikari et al., 2020), among things, increased travel time due to the fact that EVs can be slower than gasoline-powered vehicles, especially in congested traffic (Mastoi et al., 2022). Another factor is their drive range (Kim et al., 2017). The same study find out that EVs have a limited driving range, and having to compete with other vehicles for road space can reduce their range even further, a fact that can make it difficult for EV drivers to travel long distances or to reach areas without charging infrastructure. When it comes to Africa, lack of awareness among the people in the Sahel region regarding the vehicles, unfavorable government policies, weak or unreliable power grids, effects of high temperatures by increasing battery degradation, the possible damage of electrical components of EVs due to dusty roads are the major challenges for the adoption of the vehicles (Arroyo-Arroyo & Vesin, 2022). In Ethiopia's case, switching the transportation sector to EVs would have a significant positive impact on the environment, both by reducing emissions and improving air quality (Eticha, 2023). According to this research by Eticha (2023), that is mainly attributable to EVs produce zero tailpipe emissions, unlike combustion vehicles. Meanwhile, as a developing nation and late adopter, the adoption of electric vehicles is at its lowest stage in Ethiopia (Eticha, 2023). The problem was exacerbated by shortage of foreign currency, a factor that has been hampering local EV assemblers' ability to expand the adoption of the vehicles (Mengesha, 2022). In addition the lack of charging stations outside of major cities is a major barrier to the adoption of electric vehicles (Mulugeta & Munir, 2022). According to the newspaper article Mulugeta and Munir (2022), this happened because potential EV buyers are concerned about being able to find a place to charge their vehicles when they travel or when they are away from their homes. Add to this factor, Traffic patterns in the capital cities of many low-income countries, such as Addis Ababa, are significantly impacted by the shared use of roads by pedestrians and a variety of vehicles, the high prevalence of single-lane roads, poor road conditions, and the lack of traffic signals (IEA, 2022). Another problem is associated with the cost of the vehicles. Electric vehicles operational cost is much lesser than that of the conventional vehicles (Teshome, 2022). According to Teshome (2022). However, the EVs purchase cost is around 65 percent more expensive than the internal conventional vehicles. Not only in Ethiopia but also in other developing countries consumer worries about the high cost, reliable power supply, ease of use, and features of electric vehicles are major obstacles to their adoption in developing countries (Dioha et al., 2022). There is a study conducted by Eticha (2023), which basically focuses on the use of electric vehicles to reduce the release of greenhouse gases through scientific models. But this study failed to explore the challenges and prospects of electric vehicles in Ethiopia. Therefore, this study will be conducted to fill an important gap by exploring the challenges and prospects of the adoption of the electric vehicles with respect to the green mobility initiative, which is not researched by other researchers.

1.3. Research Objectives

1.3.1 General Objective

The major objective of this study is to explore is to assess the challenges and opportunities associated with adopting electric vehicles in Ethiopia as a pathway towards green mobility.

1.3.2. Specific Objectives

To assess the challenges faced by electric vehicle importers and assemblers.

To assess consumer perceptions towards the adoption of electric vehicles in Ethiopia.

To explore the prospects for policies and strategies to promote electric vehicle adoption in Ethiopia.

1.3.3. Research Questions

What are the challenges faced by electric vehicle importers and assemblers?

What are the consumer perceptions towards the adoption of electric vehicles?

What are the policies and strategies which promote electric vehicle adoption in Ethiopia?

1.4. Significance of the Study

This study provides valuable insights into the challenges and opportunities for adopting electric vehicles in the specific study area and local community. The research can inform policymakers in developing strategies to promote electric vehicles and green mobility. It equips importers, analysts, and other stakeholders with recommendations to tap the opportunities for electric vehicles in the study area. Overall, the study establishes a foundation for future research to build upon in assessing electric vehicle adoption and expanding understanding of this emerging concept. By exploring this timely issue in depth, the research generates knowledge to guide evidence-based policies and sustainable practices.

1.5. Scope of the study

Constrained by time and financial resources, this study narrowly or thematically focused on the challenges and opportunities of green mobility, solely in the geographical area of the adoption of electric vehicles in Ethiopia's capital, Addis Ababa. The research utilized qualitative method including a literature review, stakeholder surveys, and in-depth interviews. This research utilized purposive sampling technique and the lack of existing research and data on this topic from governmental and non-governmental entities. Additionally, there are very few or limited experts and importers who allowed to participate in this study.

1.6. Organization of the thesis

This thesis was organized into five chapters. The first chapter discussed the background of the study, the statement of the problem, the objectives of the study, the research questions, the significance of the study, the delimitation/scope of the study, the limitations of the study, and the like. The second chapter reviewed related literature on the concept of electric vehicles, their practicability security, and their contribution to the environment and the economy. While the third chapter focused on methodologies employed in this research such as research method, data collection, and analysis method, sampling size and techniques, and ethical considerations in research. The fourth chapter presented and analyses the data generated through the data collection instruments. The final chapter concluded the research and indicates the policy implication of the study.

CHAPTER TWO

Literature Review

2.1. Introduction

In this chapter a review of related literature on the research problem has been extensively done. It discusses the theories that govern the adoption of electric vehicles, analyzes previous research on the topic conducted by other scholars, and delves further into the challenges and prospects green mobility in a case of adopting electric vehicles in Ethiopia. The review has extensively given an information about the gaps between the theories and policies that inform the researcher's needs. The chapter concludes by looking at the relationship between the independent and dependent variables for the research.

2.2. Theoretical Review

The theoretical review of this study examined the existing theories and research on electric vehicle adoption. A theoretical review of the research on electric vehicle adoption provides a valuable foundation for developing policies and programs to promote the adoption of electric vehicles. By understanding the challenges and opportunities, policymakers can design interventions that are more likely to be successful. There are a different theoretical perspectives that can be used to understand electric vehicle adoption. Some of the most relevant theories include Theory of Planned Behavior, Technology Acceptance Model, Innovation Diffusion Theory, Social Cognitive Theory and Unified Theory of Acceptance and Use of Technology.

2.2.1 Theory of Planned Behavior

The Theory of Planned Behavior (TPB) explains how people's attitudes, social norms, and perceived control over their behavior influence their intentions to perform a particular behavior (Zhan, 2022). This research fact extends the TPB to investigate the impact of cost and people’s behavior on people's intentions to adopt electric vehicles (EVs). Cost is a major barrier to EV adoption (Kennedy & Philbin, 2019), while people’s behavior refers to people's tendency to follow the actions of others (Eneizan, 2019). Attitude refers to a person's evaluation of a behavior as being favorable or unfavorable (Ling et al., 2021). For example, someone who has a positive attitude towards EVs may believe that they are environmentally friendly and cost-effective (Zhan, 2022). Subjective norm refers to a person's perception of the social pressure to perform a behavior (Haustein & Jensen, 2018). Perceived behavioral control refers to a person's belief in their ability to perform a behavior (Le et al., 2023) or in other words, if someone who believes that they can afford to purchase an EV and has access to charging infrastructure may be more likely to adopt the vehicles.

In this regard, as a developing country, India has been working to improve its EV charging infrastructure to make electric vehicles more popular or acceptable by many of the population (Deka et al., 2023). India's government FAME (Faster Adoption and Manufacturing of Electric Vehicles) scheme is among the example such initiatives, which aims to reach net zero emissions by 2050, 80% of India's two-wheelers and 30% of its four-wheelers will need to be electric (Dhar et al., 2017). A variety of factors that can influence the market for different types of vehicles (Rajper & Albrecht, 2020). Similarly, there are several factors that drive the adoption of electric vehicles (EVs), such as reducing greenhouse gas emissions (GHG), using energy efficiently, saving money on gasoline, and having low operating costs (Parajuly et al., 2020). However, there are also some factors that resist the adoption of EVs, such as their high purchase price, limited range, slow charging speed, and anxiety (EV drivers' worry of getting stuck with a dead battery before reaching their destination) about adopting a new technology (Sierzchula et al., 2012). Global warming has been a central issue in the last few decades, as it imposes multidimensional threats to ecology, environment, economy, and society. As one of the largest emitters of carbon dioxide (CO_2) in the world (Setiawan et al., 2022). Meanwhile, the transportation sector is a crucial area for action to enhance fuel quality and lower greenhouse gas emissions (Bekiaris et al., 2017). People's attitudes towards Battery Electric Vehicles (BEVs) has divided into three categories: functional, affective, and symbolic (S. Wang et al., 2016) Functional attitudes is mainly attributed by the high perceived purchase price of BEVs is a major barrier to adoption, which is only partly compensated by the lower operational costs (Tiwari et al., 2020). Symbolic attitudes is attached to the people's often association with the positive symbolic meanings with BEVs and their owners, such as higher status, openness to new ideas, and environmental and social values (Moons & de Pelsmacker, 2012). Meanwhile, the transportation sector is a significant contributor to greenhouse gas emissions and air pollution, accounting for approximately 23% of global energy-related CO_2 emissions in 2019 (UK Department for Transport, 2021). Electric vehicles (EVs) are widely recognized as a crucial solution to decarbonize transportation and enhance air quality (Yeğin & Ikram, 2022). Ethiopia, with its rapidly expanding economy and urbanization, represents a promising market for EVs (Muna & Kuo, 2022). The Ethiopian government has established ambitious targets for EV adoption, including the goal of having 1 million EVs on the road by 2030 (Mulugeta & Munir, 2022).

2.2.2 Technology Acceptance Model

The Technology Acceptance Model (TAM) is a theory of information systems that models how users come to accept and use new technologies (Davis, 1989). This theory was developed by Fred Davis in 1989 and has been widely used to predict the adoption of a wide range of new technologies, including electric vehicles (EVs) (Yousif & Alsamydai, 2019) and (Özdemir & Barutçu, 2022). TAM explains that people's intentions to use a technology are the best predictor of whether they will actually use it (McCord, 2006). Furthermore, the TAM model suggests that people's use of a technology system is determined by their beliefs about the system's usefulness and ease of use, as well as their overall attitude towards the system (Ambak et al., 2016). In the case of the electric vehicle (EV) market, it is important to consider the social and technological

factors that will influence its development, because it is a sociotechnical system (Raza, 2023). This model posits that two key factors influence a person's decision to adopt a new technology (Zhang et al., 2022). Perceived usefulness mainly stressed the extent to which a person believes that the new technology will be beneficial to them (Kim et al., 2017). On the other hand perceived ease of use mainly pointed out that the extent to which a person believes that the new technology will be easy to learn and use (Bauer et al., 2021).

In the context of EVs, perceived usefulness may be influenced by factors such as the lower cost of operation and maintenance, the environmental benefits of EVs, and the performance advantages of EVs (Khazaei & Tareq, 2021). other researches argue that the perceived ease of use may be influenced by factors such as the availability of charging stations, the ease of charging EVs, and the user-friendliness of EV interfaces (Baatar et al., 2019). The TAM model is a simple and straightforward model that has been widely used to study the adoption of new technologies. It is also a relatively well-tested model, with a large body of research supporting its validity (Hwang & Lee, 2021). However, according Hwang & Lee, 2021, the TAM model has also been criticized for a number of reasons. One criticism is that the model is too simplistic and does not account for all of the factors that influence technology adoption (Yousif & Alsamydai, 2019). For example, the TAM model does not account for social factors, such as social norms and peer pressure, which can also influence technology adoption (Plananska & Ehrenzeller, 2021).

2.2.3 Innovation Diffusion Theory

Joseph Schumpeter viewed innovation as the driving force behind economic advancement (Kaya, 2015). According to Kaya (2015), there are a three-stage innovation process; and these process encompasses idea generation or the initial conception of a new concept or invention, product development, which is the transformation of the invention into a marketable product or service and diffusion, mainly focused on the widespread adoption and imitation of the innovation throughout the economy. In the area of innovation diffusion, Rogers' (2003) work on a DOI (Diffusion of Innovation) framework has been attracting attention for decades (Seign & Bogenberger, 2012). The DOI theory provides a framework for understanding the process by which new ideas, products, or technologies are adopted by individuals, groups, or organizations. This theory suggests that new products and technologies are adopted by individuals and organizations over time through a five-stage process: awareness, interest, evaluation, trial, and adoption. Furthermore, the technology acceptance model suggests that the decision to adopt a new technology is influenced by two factors: perceived usefulness and perceived ease of use (Hardman & Tal, 2021). The theory has been applied to a wide range of innovations, including electric vehicles (Li et al., 2019). According to DOI, the adoption of an innovation is influenced by five key characteristics (Dütschke & Peters, 2016). These factors are:-

1. Relative advantage: The perceived benefit of the innovation compared to existing alternatives.
2. Compatibility: The degree to which the innovation is consistent with existing values, beliefs, and practices.

3. Complexity: The difficulty of understanding and using the innovation.
4. Trialability: The ease with which the innovation can be tested or experimented with, and
5. Observability: The degree to which the results of using the innovation can be seen or observed by others (Breschi et al., 2023)

In addition to these five characteristics, DOI also identifies five adopter categories (Rogers, 2006). According to Rogers (2006) these categories are:

Innovators: The first individuals to adopt an innovation.

Early adopters: Individuals who are ahead of the main adoption curve.

Early majority: Individuals who adopt an innovation after the early adopters.

Late majority: Individuals who adopt an innovation after the majority of the population.

Laggards: Individuals who adopt an innovation only after it has become widely accepted.

At an individual level, the DOI theory also emphasizes the influence of individual characteristics and social factors on the adoption process (Taghizad-Tavana et al., 2023). In a similar fashion, individuals' innovativeness, their personal beliefs and attitudes, and their social networks all contribute to their decision to adopt or reject an innovation (Bekiaris et al., 2017). Social influence, particularly from peers and opinion leaders, can be a powerful motivator for adoption (Manjula. B. C et al., 2022).

Understanding the factors that promote or hinder EV adoption is crucial for developing effective strategies to accelerate EV uptake (Viola, 2021). The first one in this regard is analyzing the role of government policies such as examining the impact of government policies, such as tax incentives and subsidies, on EV adoption is essential for policymakers to make informed decisions (Ling et al., 2021). Another study by Salari (2022) depicts that identifying the characteristics and motivations of different adopter segments can help tailor marketing and educational efforts to specific groups. At the same time this study further recognizes that exploring the influence of social factors or investigating the role of social networks, opinion leaders, and community norms in EV adoption can provide insights into how social influence drives behavior. Previous studies conducted by (Automotive IQ, 2023) pointed out that creating mathematical models to predict the diffusion of EV adoption can aid in planning and resource allocation for EV infrastructure development and policy implementation. Sato & Saijo (2016) found that the diffusion of innovation theory was a good predictor of the adoption of EVs in Norway. This study found that early adopters of EVs were more likely to be aware of EVs, to have a positive attitude towards EVs, and to perceive EVs as being useful and easy to use.

2.2.4 Social Cognitive Theory

Social Cognitive Theory (SCT) strategizes a framework for understanding how people learn and adopt new behaviors (Mao et al., 2023). The theory suggests that people learn new behaviors by observing others, receiving reinforcement, and believing that they have the ability to perform the behavior (Seuwou et al., 2020). Social Cognitive Theory has been used to study the adoption of electric vehicles (EVs) to understand how people learn about EVs, form attitudes and beliefs about them, and decide whether or not to adopt them (Du et al., 2018) and (Yang & Tan, 2019). Studies have shown that attitudes toward behavior, subjective norms, perceived behavioral control, and personal norms are significant factors influencing the intention to purchase an electric vehicle (Qian & Yin, 2017). Qian and Yin (2017) also highlighted the importance of compatibility between sustainable products and consumer values and beliefs as a key determinant of EV purchase intention. According to (Lim et al., 2019) the key concepts of SCT are based on:

Observational learning: People learn new behaviors by observing others. This can be done through direct observation or through exposure to media messages.

Reinforcement: People are more likely to repeat behaviors that are reinforced, or rewarded, which can be done through positive reinforcement, such as praise or rewards, or through negative reinforcement, such as avoiding punishment.

Self-efficacy: People are more likely to adopt a behavior if they believe that they have the ability to perform it. Self-efficacy is influenced by past experiences, social modeling, and physiological cues.

Meanwhile, (Khazaei & Tareq, 2021), articulate that the Social Cognitive Theory (SCT) has been used to study several aspects of EV adoption, including:

Awareness of EVs: People who are more aware of EVs are more likely to adopt them.

Attitudes towards EVs: People who have positive attitudes towards EVs are more likely to adopt them.

Social norms: People are more likely to adopt a behavior if they believe that their peers and other important people in their lives approve of it.

Self-efficacy: People who believe that they have the ability to drive and maintain an EV are more likely to adopt it.

Despite extensive research on the factors influencing green purchase intention, the findings remain inconclusive and inconsistent (Y. Joshi & Rahman, 2015). Moreover, another study highlighted the need to consider the interplay of both personal and environmental (external) factors to gain a comprehensive understanding of green purchase behavior (White et al., 2019). However, personal factors such as environmental attitude, environmental knowledge, and collective environmental efficacy have been found to have an uncertain relationship with green purchase intention (Jin Lim et al., 2019). (O. J. Mei et al., 2012) and (Uddin & Khan, 2016) argued that there is an presence of attitude-behavioral gaps. On the other hand various terms have been employed to describe behaviors that positively impact the environment, including ecologically concerned consumption, environmentally conscious behavior, environmental activism, pro-environmental behavior, sustainable consumption behavior, and green consumption behavior (Kabadayı et al., 2015).

Another study by White et al., (2019) found out that the TAM and TPB were good predictors of the intention to purchase an EV in Italy. The study found that perceived usefulness and perceived ease of use were the most important factors influencing the intention to purchase an EV. Attitude and subjective norms were also important factors, but to a lesser extent. These studies suggest that a number of factors influence the adoption of EVs (Michael et al., 2022b). These factors include awareness, attitude, subjective norms, perceived usefulness, perceived ease of use, and perceived behavioral control (Johansson et al., 2022). Governments and businesses can promote the adoption of EVs by addressing these factors (Rezvani et al., 2015).

2.2.5. Unified Theory of Acceptance

The Extended Unified Theory of Acceptance and Use of Technology has been increasingly implemented as the theoretical framework to study the factors that influence usage or adoption intentions (Venkatesh et al., 2012). This theory encompasses external motivations, such as performance expectancy, effort expectancy, social influence, and facilitating conditions, and internal motivations, such as hedonic motivation, price value, and habit, offering a wide ranging theoretical foundation on which to do this (Chien et al., 2023). This study further assets that the Unified Theory of Acceptance and Use of Technology (UTAUT) is a well-established theoretical framework that has been widely applied to various technologies, including electric vehicles (EVs). According to Chien et al., 2023, this theory or model postulates four key constructs that influence an individual's intention to use a particular technology:

1. Performance Expectancy: The degree to which an individual expects the technology to perform well and meet their needs;
2. Effort Expectancy: The ease or difficulty of using the technology;
3. Social Influence: The influence of others on an individual's decision to use the technology, and last but not least;
4. Facilitating Conditions: The availability of resources and infrastructure that support the use of the technology.

A study by Faizah Mashahadi, 2023 on the other hand examines the role of religiosity, along with UTAUT constructs, in influencing EV adoption intention and behavior. Religious values foster moral principles that motivate individuals to engage in environmentally responsible behaviors (Karimi et al., 2022). A comprehensive review of existing models led to the development of the Unified Theory of Acceptance and Use of Technology (Abbasi et al., 2021), (Karimi et al., 2022) and (Viswanath, Venkatesh, 2012).

2.3. Empirical Review

In this section of a brief overview of the thesis topic, including the significance of adopting electric vehicles (EVs) in Ethiopia along with the challenges and opportunities associated will be reviewed.

2.3.1. Challenges of electric vehicles adoption

The transportation sector is a major contributor to greenhouse gas emissions and air pollution, both of which have significant negative impacts on human health and the environment (Adjei-Ampomah, 2020). Electric vehicles (EVs) offer a promising solution to these challenges, as they produce zero tailpipe emissions and can significantly reduce air pollution (Stockkamp et al., 2021). Low-emission mobility is a crucial element in the shift towards a low-carbon, circular economy (Rovňák et al., 2022). In the meantime, the general theory of green mobility associated with electric vehicles (EVs) is a framework that outlines the role of EVs in achieving sustainable transportation systems (Castro, 2020). It encompasses various aspects, including environmental benefits, technological advancements, infrastructure development, and policy considerations (Wikström, 2015). Furthermore, the transition to EVs can significantly improve air quality, especially in urban areas, leading to improved public health and reduced healthcare costs (Collett et al., 2021). The study of EV adoption raises significant questions about the nature of knowledge and the existence of EVs as a technological phenomenon (Geng, 2021). Electric vehicle (EV) technology is still in its early stages of development, and there are a number of challenges that need to be addressed before EVs can be widely adopted (Hossain et al., 2022). These challenges further clarified by a study include limitations of battery technology, underdeveloped infrastructure, lack of public policy support, and low consumer awareness (Butt & Singh, 2023). There are various challenges to adopt green mobility (Magnusson, 2011). The first challenge is the high upfront cost (Tu & Yang, 2019). Another study revealed that green mobility options can be more expensive than traditional forms of transportation, such as cars, which can make it difficult for people to afford them (Ali, 2021). Many consumers recognize the environmental advantages of electric vehicles (EVs), but they are unwilling to pay a higher price for them (Pelyhe, 2011). Additionally, consumers are concerned about the range of EVs, even though current models can typically meet the daily driving needs of most people (Gyimesi & Viswanathan, 2011) and (Globisch et al., 2018). Some studies also depicted the shortcomings of the EVs, which offer environmental benefits but face challenges in gaining widespread user adoption due to their higher purchasing price compared to gasoline-powered counterparts and their limited range (Ziefle et al., 2014). According to Zilfie (2014), many EVs fall short of the desired range of 150-200km, making them less appealing to potential buyers who may be concerned about running out of power before reaching their destination. In the meantime, the high price factor has been cemented by other studies. One of the key factors hindering the widespread adoption of EVs is their high purchase price compared to conventional gasoline-powered vehicles (Lévay et al., 2017). However, other study suggest that the relatively low cost of gasoline can counterbalance this barrier and promote EV sales (Caperello & Kurani, 2012).

Researchers further identified another factor for the slow adoption of the vehicles. For instance, as (Ajanovic, 2015) put it that the prior challenges in the adoption of electric vehicles is lack of infrastructure; green mobility options require adequate infrastructure, such as bike lanes, sidewalks, and public transportation systems. These infrastructures can also be expensive to build and maintain (Bauer et al., 2021). The financial feasibility of public charging infrastructure is a critical factor influencing the adoption of electric vehicles (Faizal et al., 2019). Currently, the shortage of public charging facilities represents a major obstacle hindering the growth of the EV market (Alanazi, 2023). At the same time, other studies show the limitation of batteries life and charging infrastructures. While electric vehicles (EVs) are gaining popularity, many current models suffer from inefficiencies, heavy battery weights, and limited range, with maximum

single-charge distances ranging from 99.78 to 498.90 kilometers (Mali et al., 2022). This challenge has further consolidated by a study (W. Joshi, 2022), which found that the lack of public charging stations is a major barrier to EV adoption, with only around 10% of private cars having access to one at home. The study also found that the number of public charging stations is not growing fast enough to keep up with the increasing number of EVs on the road. Another study on the other spectrum advocates that although the number of charging stations has increased and plug standardization has been (Nilufar, 2021) achieved, the uneven distribution of charging infrastructure across the European Union continues to hinder seamless electric vehicle travel across the region (J. Robinson & Erickson, 2016). These studies and surveys all point to the fact that the lack of charging infrastructure is a major barrier to EV adoption. Until more public charging stations are available, EV adoption will likely continue to be slow and limited (Nilufar, 2021). The other challenge in the adoption of electric vehicles is a range anxiety (Pappis et al., 2021). Range anxiety encompasses the apprehension that an electric vehicle (EV) will deplete its battery power before reaching a suitable charging station (Pevec et al., 2019). Range anxiety can cause consumers to hesitate to purchase EVs, even if they are interested in the environmental and economic benefits that EVs offer (Tran et al., 2020). Many consumers who are considering purchasing an EV will consider range anxiety to be a major factor in their decision-making process (Ajanovic, 2015). To that end, researches indicate that if they are not confident that they will be able to find a charging station when they need one, they may be less likely to purchase an EV (Y. Mei et al., 2022). Additionally, another research cautions that range anxiety can lead consumers to develop negative perceptions of EVs. They may view EVs as being impractical or unreliable, even if this is not actually the case (Dua et al., 2021). Other researches also depict that range anxiety can also discourage consumers from continuing to own EVs if they have already purchased one If they experience range anxiety on a regular basis, they may be more likely to sell their EV and purchase a traditional gasoline-powered vehicle (Candra, 2022). A PhD Dissertation by (Fetene, 2016) further pointed out that among the primary concerns surrounding Battery Electric Vehicles (BEVs) is the extended recharging time, ranging from 20 minutes to several hours, depending on the type of charging equipment and the battery type. He clarifies that driving range affordable BEVs is limited, further exacerbating range anxiety. A study by (Soltani et al., 2019) conveys that the decision-making process to purchase EV was also shaped by government policies, fuel prices, safety considerations, and tax incentives.

The adoption of electric vehicles hosts' number of challenges, lack of policies to back its adoption is among these lack of supportive policies (Villareal, 2011). It was asserted that the current speed of transition toward EVs is not fast enough for the government to observe clear economic and environmental impacts (Wattana & Wattana, 2022). Hence, public policy focus should be shifted from EV's demonstration to proper adoption in actual transportation systems (Preedakorn et al., 2023). This study further highlighted that Singapore normally inflates the cost of private cars for citizens, in order to limit the amount of vehicles and mitigate traffic congestion (Growth, 2022). Some studies on the other spectrum put it that there is uncertainty of policies, which have been implemented to embolden the deployment of the vehicles. Despite the implementation of policies aimed at promoting electric vehicles (EVs) through consumer awareness campaigns, financial incentives, and infrastructure development, there is still significant uncertainty regarding the effectiveness of these efforts and the long-term success of EVs in the automotive market (Morton et al., 2014).

2.3.2. Prospects of electric vehicles adoption

Adopting electric vehicles across Sub-Saharan Africa would lead to an immediate decline in greenhouse gas emissions, even when considering the current electricity generation portfolio (Collett et al., 2021). This survey further explained that countries like Ethiopia, Uganda, the Democratic Republic of the Congo (DRC), and Namibia hold the greatest promise for achieving significant emissions reductions through EV adoption. Electric mobility offers a cost-effective and environmentally friendly mode of transportation, providing both financial savings and reductions in energy consumption and harmful emission (Rajper & Albrecht, 2020). Electric vehicles play a crucial role in the development of smart cities, leveraging technology and data to optimize energy consumption, minimize emissions, and enhance the quality of life for residents (Patil, 2022). By integrating electric vehicles with smart city infrastructure, including intelligent traffic management systems, electric vehicle charging networks, and smart grids, a more sustainable and efficient urban environment that benefits both individuals and communities as a whole will be created (Jamaludin et al., 2021). There are some effort to boost the adoption of EVs across developing countries as described by (Varalakshmi et al., 2022) India's government's new Manufacturing — Linked Incentive Scheme (PLI) program aims to boost domestic battery manufacturing and reduce dependence on imports. Such efforts will strengthen the EV industry's infrastructure and promote environmentally friendly automobile production — both established automotive companies and new investors are eligible for this scheme (Varalakshmi et al., 2022). The prospects of adopting electric vehicles (EVs) are very positive, according to a wide range of studies (Haghani et al., 2023; Rajper & Albrecht, 2020). For instance, the global EV sales are expected to reach 26 million in 2023 and 66 million in 2030, according to the International Energy Agency (IEA). This represents a Compound Annual Growth Rate (CAGR) of over 30% (IEA, 2022).

Studies also convey that EVs are gaining traction as a more sustainable and environmentally friendly alternative to traditional gasoline-powered vehicles (Rajper & Albrecht, 2020). The global EV market is also expected to grow significantly in the coming years, driven by several factors, including government incentives, declining battery costs, and increasing consumer demand (Tschiesner A., 2020). For some other studies, the driving forces for EV adoption are among others are environmental EVs produce zero tailpipe emissions (Nosova et al., 2018), which can significantly reduce air pollution and greenhouse gas emissions, contributing to a cleaner and healthier environment (Raines, 2009). Government Policies and incentives are also the other innovating factors identified world widely as incentivizing ingredients to promote EV adoption, such as tax breaks, subsidies, and preferential parking (Helwig et al., 2013). The ever-evolving advancement of battery technology, which leads to batteries with longer ranges, shorter charging times, and lower costs are among the prospects of boosting the acceptability of the vehicles (Patil, 2022). Another study further delves further into the consumers attitude and founded out that consumer awareness of the environmental and economic benefits of EVs is growing, leading to increased demand and EVs are becoming more stylish, affordable, and technologically advanced, further boosting their appeal (McElgunn, 2018). Fluctuating oil price mentioned as another determinant factor (Arnob, 2023; Kah, 2018). The fluctuation of oil prices

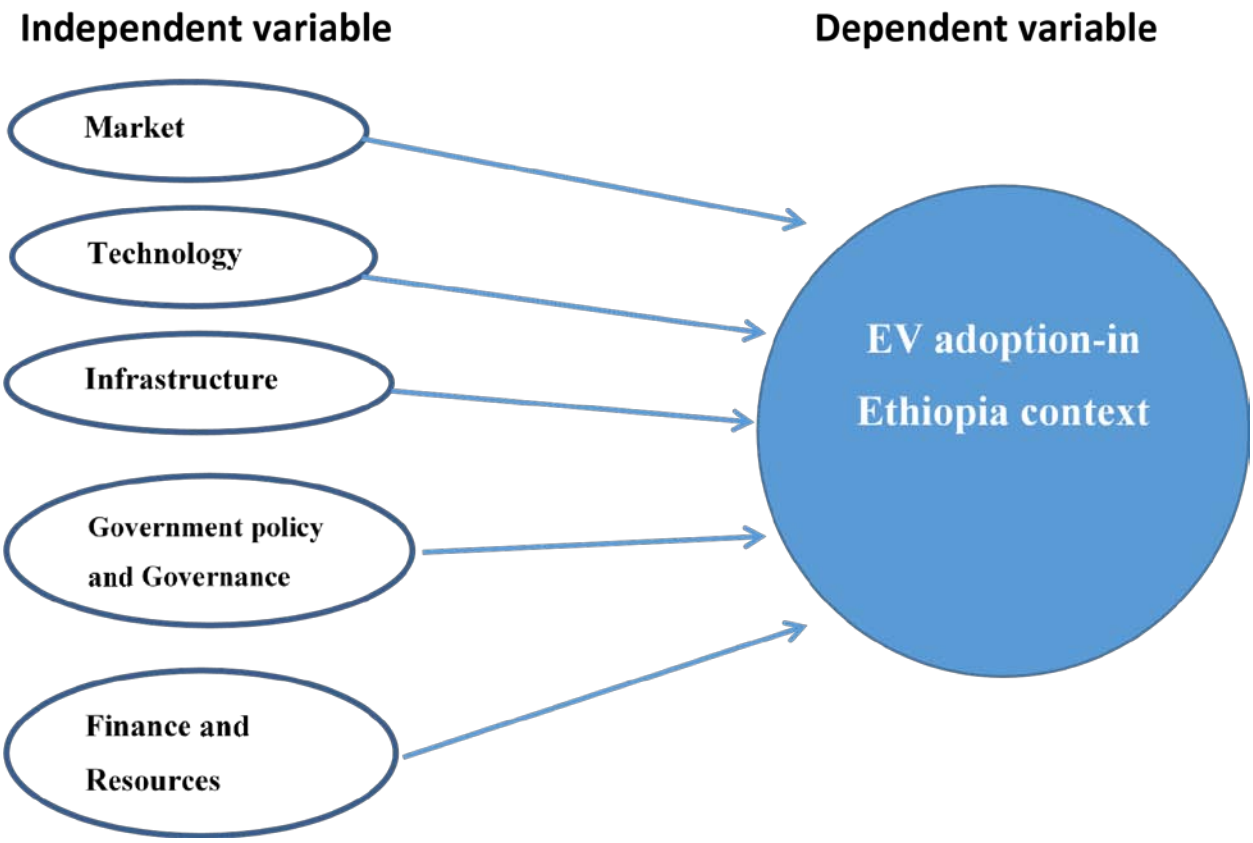
can impact consumer choices (Bushnell et al., 2022). When oil prices are high, EVs become more attractive due to their lower operating costs (Castillo et al., 2023). When we compare other factors in the adoption of vehicles study suggest that non-adopters of EVs are still not perceiving EVs at the same level as internal combustion engine vehicles (ICEVs) in terms of performance, price, and reliability (Priessner et al., 2018). According to this study lack of perceived equivalence is likely due to the limited evidence available on the long-term reliability and performance of EVs. The major factor for the mass deployment of these vehicles across nations is environmental degradation (J. Wang et al., 2019). Researches show that the adoption of electric vehicles show a varying figure (Alyamani et al., 2023). While electric vehicles have not been a major focus for most Arab countries, particularly those in Africa, there has been a growing surge of interest in recent months (Ahmed et al., 2021). This research found out that Jordan, the United Arab Emirates (UAE), Saudi Arabia, Oman, Morocco, and Egypt have all taken significant steps to introduce electric vehicles and promote environmentally friendly transportation, demonstrating their commitment to staying at the forefront of technology and addressing global warming concerns. However, Current EV owners are frustrated by the lack of EV repair centers and workshops compared to those for ICEVs (Quak et al., 2016). By the same token, a study in Denmark (Ninh, 2013) found that the relative newness of EV technology means that there are fewer qualified and trained EV mechanics, resulting in higher costs for even simple repairs and longer wait times for more complex ones. EV charging infrastructure is crucial for widespread adoption, but the specific challenges vary depending on the Saudi Arabia's context while the need for adequate charging stations and qualified EV maintenance technicians applies universally, additional concerns arise in Saudi Arabia and other regions with strained electricity grids (Alotaibi et al., 2022). According to Alotaibi et al., (2022), in these areas, the increasing demand from EV charging can overburden the existing electricity infrastructure, potentially leading to disruptions and blackouts. Researchers also delved into or are primarily concerned about the escalating harmonic distortion arising from the surge in energy consumption as charging stations amplify the electrical grid's peak current in Qatar (Al-Shaiba et al., 2023). On the other hand, the UAE's efforts to promote EV adoption are in line with its broader goal of achieving a sustainable future (Sundarakani et al., 2023). This research pointed out that Qatar has set ambitious targets for reducing its carbon footprint and is investing heavily in renewable energy sources. EV adoption is seen as a key component of this strategy, as it can help to reduce reliance on fossil fuels and improve air quality (Bridi & Al Hosani, 2020).

In case of Africa, in the pursuit of energy access expansion and environmental sustainability, many African nations are poised to make substantial investments in the power sector in the years to come (Agunbiade & Siyan, 2020; Bawa & Nwohu, 2023; Michael et al., 2022a). The prospects of adopting electric vehicles (EVs) in Africa are promising, driven by factors such as environmental factors, rapid urbanization, declining battery costs, and expansion of renewable energy (African Development Bank Group, 2021; Broadbent et al., 2019; Lukuyu et al., 2022). Likewise, Ethiopia, particularly, the capital Addis Ababa has been challenged by the environmental pollution due to the gases emitted from Internal Combustion Engines (ICEs) (Eticha, 2023). In addition to their environmental impact, the rising fuel costs of gasoline-powered vehicles are a growing concern (Xinhua, 2023). To mitigate this issue, the Ethiopian government has implemented various measures, including exempting electric vehicles from value-added tax (VAT), excise tax, and surtaxes (Hansson, 2022). Additionally, the import tax on electric vehicles has been reduced to 15% for fully assembled vehicles and 5% for semi-

assembled vehicles (Eticha, 2023). These measures are intended to encourage investment in electric vehicle assembly and importation, ultimately making these vehicles more affordable for consumers (Kuhudzai, 2022). Ethiopia is one of the most vulnerable countries to the impacts of climate change, such as droughts, floods, and food insecurity (Negussie & Demie, 2015). The country has also committed to reduce its greenhouse gas emissions by 64% by 2030 under the Paris Agreement (Delbeke et al., 2019) EVs could help Ethiopia achieve its climate goals by reducing its dependence on fossil fuels and lowering its carbon footprint (Kristos, 2022). EVs could also provide social benefits, such as improving air quality, reducing noise pollution, creating jobs, and enhancing mobility and access to services for rural communities (Eticha, 2023). Despite all these positive developments, stakeholders in the burgeoning Ethiopia's EV sector including assemblers and users, have expressed concerns over several obstacles that are impeding progress (Endale, 2023). According to Endale (2023), among these challenges are exorbitant insurance premiums, the lack of well-defined EV market regulations, inadequate infrastructure, and a dearth of qualified professionals in the field of green mobility. Add to this lack of foreign currency impedes the growth of the sector (Mengesha, 2022). While the Ethiopian government has implemented policies to encourage the adoption of EVs, there remains a knowledge gap among Ethiopians regarding EVs, leading to concerns and doubts about their usage, especially with respect to battery durability and charging infrastructure (Kristos, 2022).

2.3.3. Conceptual Framework

Diagram 1: Conceptual Framework which shows the electric vehicles adoption in Ethiopia and the factors affecting it.



Source: Developed by the researcher.

As indicated in the diagram of the conceptual framework, the study is highly focused on the challenges of the adoption of electric vehicles six categories. This study is not limited in its scope and tried to identify the general challenges of electric vehicles adoption using different categories like technological, infrastructural, cost, policy and lack of foreign exchange and it presented the critical ones that need immediate action.

Chapter Three

Research Design and Methodology

This section presents the description and justification of research methodology. It begins with providing detail information about the study area and followed describing detail about the research methodology and presents, specifically, the application of the philosophical foundation, the research design, sources and tools of data collection, sampling procedures, sampling technique and sample size determination, techniques of data presentation and analysis. In this section, since this is electric vehicle research, procedures on ethical considerations are presented. The methodology issues are explained along with their strategies (steps, sequencing of approaches, and procedures of application). The methodology discussion includes the rationale behind employing each of the methods, tools, data sources, sample population, data analysis, and interpretation.

3.2. Description of the Study Area

3.1.1 The Geographical Location of the Study Area

With a total area of 540 square kilometer Addis Ababa is situated in the central part of Ethiopia. Astronomically Addis Ababa is located between 38 degree 40 seconds and 38-degree 55 seconds East longitude and between 8 degree 50 seconds 89 degree 5 minutes north latitude. In terms of relative location it is encircled by Oromia region. It has five transportation routes which connects it with the rest of the country.

The below map shows the astronomical location of Addis Ababa.

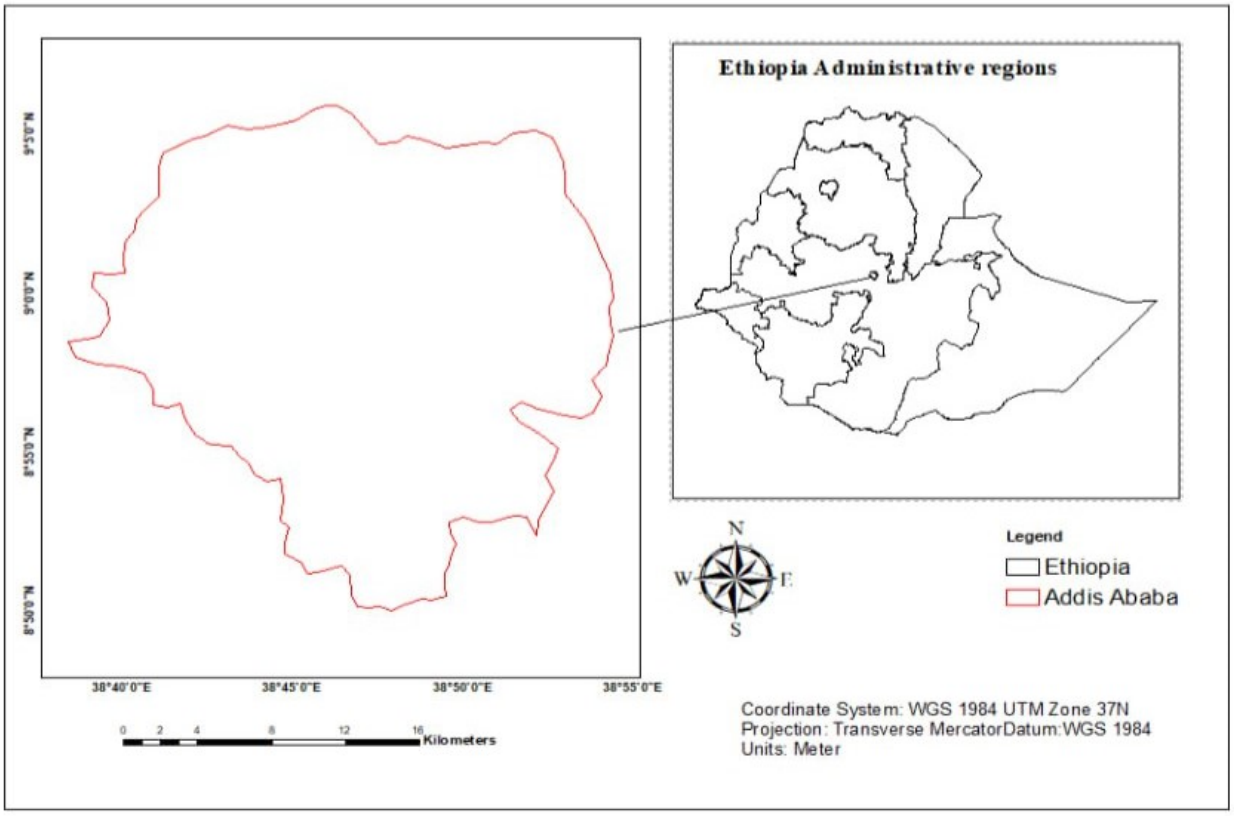


Figure 2. Astronomical location of Addis Ababa. Source: Space Science and Geospatial Institute, 2023.

On the other hand, figure 3 (below) shows 11 sub cities of Addis Ababa including Lemi Kura sub city, which is recently added by taking a slice of Bole and Yeka sub cities.

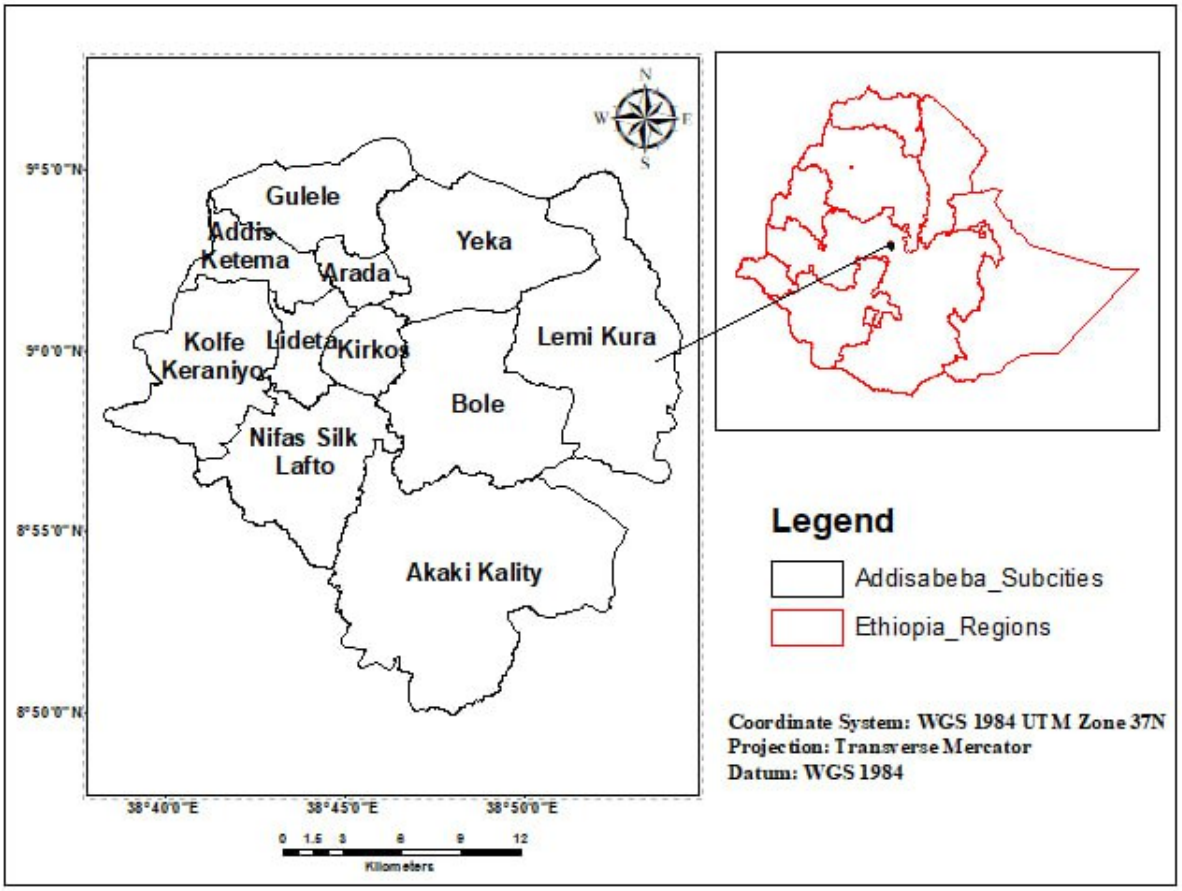


Figure 3. The map of sub-cities of Addis Ababa**.** Source: Space Science and Geospatial Institute, 2023.

Addis Ababa is home to the headquarters of the African Union, the United Nations Economic Commission for Africa, and many other international organizations, making it a major hub for diplomacy and development in Africa. Addis Ababa is also a major economic and cultural center for Ethiopia. It is home to many universities, research institutions, and businesses. The city is also a major tourist destination, and is known for its many historical and cultural attractions.

3.2 Research Design and Approach

Research design includes the research questions, the methods that will be used to collect data, and the analysis that will be used to interpret the data (Creswell, 2009). Cross-sectional design is adopted in this study because it is useful to collect the data about current attitudes, opinions, or beliefs of the stakeholders to explore the challenges and prospects of adopting electric vehicles. The data will be collected from policy makers, electric vehicle assemblers and users. Electric vehicle adoption in Ethiopia involves a complex interplay of factors, including technological advancements, government policies, consumer behavior, and infrastructure development. A

qualitative approach allows for in-depth exploration of these factors, providing nuanced insights into the underlying motivations, challenges, and opportunities associated with electric vehicle adoption in Ethiopia. Qualitative research is adept at capturing the lived experiences, attitudes, and perspectives of individuals involved in electric vehicle adoption. This is crucial for understanding the knowledge, technological, economic and policy-related factors that influence adoption decisions and identifying barriers and facilitators to widespread adoption. Though there are varieties of data collection method in qualitative approach of research, this study will use in-depth interviews and questionnaire, allowing for in-depth exploration of their thoughts, experiences, and perspectives to answer the research questions. In this study an inductive research used to analyze the content through categorization of relevant themes verification of themes and testing of their applicability to the interviewed sample.

In qualitative research, investigators construct knowledge grounded in the lived experiences of individuals, shaped by social and historical factors. They actively engage with participants to explore issues, collaborate, and promote change. This approach embraces constructivist and advocacy perspectives, aiming to develop theories (Macdonald, 2012). Through inductive reasoning, qualitative research builds theories, particularly in areas where limited knowledge exists.

3.3 Data Sources and Methods of Data Collection

Both primary and secondary data were collected for the study. The primary data of the study collected from importers of electric vehicles, government institution experts and sellers of EV users, who are located in Addis Ababa through questionnaires and interviews. Secondary data includes reports and strategies such as the Climate Resilient Green Economy Strategy, the transport policy as well as other documents. Businesses that operate in Ethiopia, such as car importers, collect data on their operations.

3.4 Data collection Tools and Measurements

The study was used the subsequent varieties of data collection tools to triangulate or confirm alike information thereby increasing the validity of the results.

Survey Questionnaire: A structured questionnaire was used as the data collection tool for the third objective of the study. The questionnaire was compiled by basing the objectives of the study and using information derived from electric vehicles owner.

To ease the process of conducting the survey, a questionnaire was translated into Amharic (the study area's common local language). Before conducting the survey, questionnaires pre-tested to modify some of the questions that could be either irrelevant, missing, or are out of context.

In-depth Interview: in-depth interview was conducted to collect qualitative data to address the first and second objectives related with the challenges faced by EVs importer and assemblers.

3.5. Sampling Technique

Purposive sampling technique was deployed in this study. The list of available importers obtained and since there are few car importers, all EVs importers respondents will be considered as respondents for the study. From all those individuals who have purchased electric vehicles will be interviewed as the data obtained from the importers and Ministry of Transport and

Logistics, purposive sampling method will be employed to select them as respondents for the developed data collection tool. The study will consider all importers and sellers in addition to the users of EVs who are located in Addis Ababa. Moreover, those responsible government officials and respective concerned officer of sector offices were considered for the study.

3.6. Sampling Size

This study employed purposive sampling technique as far as the data collected from few stakeholders and EV drivers across Addis Ababa is concerned. Hence, the data collected is from 24 respondents including experts at governmental entities, EV owners and importer, who are few in number and they are well acquainted with the topic of the study. The sample size of 24 is manageable and practical in terms of resource constraints, data collection efforts, and data analysis processes. Qualitative research often involves theoretical sampling, where new participants are selected based on insights gained from previous interviews. This iterative approach allows for a more focused and insightful sample, even with a smaller size (Patton, 2002; Qureshi, 2018). Furthermore, a qualitative research is not primarily concerned with statistical generalization but rather with providing deep contextual understanding on the area of the study. However, there are limitations of using small sample size for this study. The findings from a small sample may not be easily generalizable to the broader population. This is because the sample may not adequately represent the diversity of experiences, perspectives, and socioeconomic backgrounds within the population. Furthermore, a small sample may provide less scope for developing robust and generalizable theories (Creswell, 2013). There is also a potential for missing important themes in such a way that while qualitative studies can generate rich insights, a larger sample may provide more opportunities to identify patterns, connections, and theoretical frameworks.

3.6.1. Sampling Frame

The target population for this study comprises individuals residing in Addis Ababa, who own EVs. The data from these respondents will be used to explore the challenges and opportunities of adopting electric vehicles. Existing survey data collected from urban residents can be used to identify individuals who have own EVs or who possess characteristics associated with EV adoption, such as higher education levels or environmental consciousness. To ensure that the sample is representative of the target population purposive sampling method and stratification employed due to the fact that there are very few experts and individuals from which the data was collected using factors such as gender, age and their socioeconomic status. Stratifying by age captured the perspectives of potential EV adopters from different age groups, such as young professionals or families. Whereas their socioeconomic status quite ensured that the sample includes individuals from different income levels and educational backgrounds. The participants from the samples in this thesis are EV adopters in Addis Ababa, stakeholders in the EV sector, such as experts at governmental institutions, industry representatives including importers and assemblers. All the sample population and participants will be from Addis Ababa, Ethiopia due to time and budget constraints.

3.7. Methods of Data Collection

The study employed qualitative research of data collection to delve into the perceptions, attitudes, and experiences of individuals and groups involved in the EV ecosystem, providing valuable insights into the challenges and prospects for green mobility in the country.

3.7.1. Data Collection Techniques

The relevant qualitative data was collected from 24 respondents using through survey using questionnaire, secondary information, unstructured interviews and in-depth interview with stakeholders.

3.7.2 In-depth Interviews

In-depth interviews are a core qualitative research method that involves conducting one-on-one conversations with participants to understand their perspectives and experiences in detail. For this research, in-depth interviews could be conducted with a diverse range of stakeholders, including EV users, dealers and experts working at governmental institutions involved in EV policy development.

3.7.2. Secondary information

Secondary information is based on intensive literature review of published materials like books, articles and other scholarly materials. Different authors and researchers have written on the issue of electric vehicles challenges and prospects. Also, there are various reports and governmental documents were used for the purpose of the study. Data for this investigation was collected from both primary and secondary sources. Secondary data provided the foundation for the research questions and the link to existing knowledge (Leeuw et al., 2023). This data was gathered through a thorough review of existing literature. Primary data was collected using open-ended and close-ended questionnaires, which yielded detailed qualitative and quantitative data on relevant issues, as well as semi-structured interviews. Questionnaires were employed to ensure that all respondents answered a similar set of questions, providing an efficient method for gathering responses from a large population sample, which facilitated quantitative analysis. Interviews allowed the researchers to gather valid and reliable information relevant to answering the research questions.

3.7.3. Data Analysis Method

This study on electric vehicle (EV) adoption in Ethiopia utilizes inductive data analysis methods. Inductively, start by examining the data closely to identify patterns, categories, and themes. This bottom-up approach involves gradually organizing the data into more abstract units of information. Thematic data analysis method used that identified recurring themes, patterns, and concepts within the data involves coding the data assigning labels or categories and developing a thematic framework that represents the core themes, and writing a thematic report that described the themes and their relationships to each other.

3.7.4. Study Population and sample

3.7.4.1 Study Population

The target population for this research on electric vehicle adoption in Ethiopia encompasses several key groups. Firstly, electric vehicle owners in Addis Ababa provide insights into consumer perceptions, interests, and barriers. Electric vehicle manufacturers and importers operating in the Ethiopian market are also an important population, as their experiences can reveal challenges and opportunities in the EV value chain. Government agencies related to transportation, energy, and the environment will provide critical perspectives on policy drivers and initiatives regarding electric mobility. The users of electric vehicles can provide insights into their attitudes and preferences towards electric vehicles, as well as the challenges and opportunities for their adoption.

3.7.4.2. Data Source

The data sources for this study will be importers and sellers of EV users, who are located in Addis Ababa. Moreover, those responsible government officials and respective concerned officer of sector offices will be considered for the study. Reports and strategies such as the Climate Resilient Green Economy Strategy, the transport policy as well as other documents. Business data from the entities that are operating in Ethiopia, such as car importers collected data on their operations.

3.7.4.3. Data Presentation

The data presentation for the study will include a combination of tables and charts. The qualitative analysis has been presented in a narrative form, with quotes and examples from respondents to illustrate the themes identified in the data. Finally, the literature review presented alongside the analysis to provide a more complete picture of the challenges facing stakeholders in the electric vehicle importation sector. The literature review highlighted global best practices and case studies from other countries where similar issues were found and how they were resolved. The descriptive tables summarized key findings and patterns in the data in a structured and organized manner incorporating tables presenting demographic information, thematic categories, or frequency counts.

3.7.4.3. Reliability and Validity Test

Several strategies were used to strengthen the validity and reliability of both the qualitative and quantitative components of this mixed methods study on electric vehicle adoption in Ethiopia.

For the qualitative component, data triangulation, member checking, and an audit trail promoted validity. Data triangulation involved collecting interview data from diverse perspectives, including consumers, dealerships, government agencies, and fleet managers. Comparing these different viewpoints provided corroborating evidence and shed light on contrasting opinions (Carter et al., 2014). Member checking improved accuracy by having participants review

synthesized interview themes and provide feedback. Maintaining an audit trail documented all stages of qualitative analysis through memos on coding choices and rationale.

Reliability of the qualitative data was strengthened through consistent use of a semi-structured interview guide for all participants, independent double coding of transcripts, and explicitly defining codes linked to examples in a codebook. Using the same interview guide standardized the topics covered in each discussion. Independent coding by multiple analysts with cross-checks for consistency improved inter-rater reliability. Clearly defining codes and providing examples reduced ambiguity and confusion when assigning data extracts to codes.

For the quantitative survey, expert review and confirmatory factor analysis bolstered validity. Having experts critique the survey design, wording, and flow ensured it adequately measured the intended constructs. Confirmatory factor analysis mathematically checked how well the survey measured factors like adoption intent and attitudes. Reliability was assessed through calculating Cronbach's alpha for internal consistency of scales and test-retest reliability with a subset of respondents.

Integrating these thorough validity and reliability procedures throughout the research process maximized the rigor and trustworthiness of the mixed methods findings on EV adoption challenges and opportunities in Ethiopia.

3.8. Ethical Consideration

This study was conducted in a manner that is consistent with ethical issues which needs to be considered while conducting a research. Ethics has become a cornerstone for conducting effective and meaningful research. It is true that all of the respondents will be selected based on their consent. Before administering the interview or questioner the researcher will ask the respondent consent or interest of participation. Based on this context, the researcher needs to consider the ethical values of the community on which the research will be conducted. All issue concerning the respondents will be based on confidentiality and transparency.

3.9. Operational Definition of Variables

Market

The number of electric vehicles sold in Ethiopia each year, the average price of electric vehicles in the country, the number of charging stations and, the range of electric vehicles available (Reshetko et al., 2020).

Technology

The availability and affordability of electric vehicle technology (Agrawal, 2020).

Lack of Infrastructures

The availability and quality of infrastructure to support electric vehicles (Yanying, 2016)

Inadequate policies and government supports

The government's policies and programs to support the adoption of electric vehicles such as lack of clear policy to use electric vehicles and lack of regulations to build and expand charging stations (Hodge et al., 2020).

Lack of finance and resources

The availability of finance and resources to support the purchase and operation of electric vehicles (Alanazi, 2023). The availability of loans for electric vehicles, the availability of leasing options for electric vehicles and the cost of electricity in Ethiopia (Mengesha, 2022).

Green mobility

A non-motorized methods of transportation such as walking, using bikes, electric vehicles and car sharing (Kumar, 2011).

Electric vehicles adoption in Ethiopia

The number of electric vehicles registered and the number of electric vehicles sold in Ethiopia.

CHAPTER FOUR

Results and Discussion

This chapter presents findings and discussion of the study area based on the data collected. The primary objective of this chapter is to present the findings related to awareness, challenges, and prospects of adopting electric vehicles (EVs) in Ethiopia. The data is analyzed in qualitative approach. As the study is exploring the challenges it focuses on qualitative approach, which describes the findings from the collected data through interviews and questionnaires with key stakeholders involved in the Electric Vehicles (EVs) ecosystem in Ethiopia.

4.1. Challenges of adopting of electric vehicles

4.1.2. Consumers perception towards electric vehicle

Replacing gasoline and diesel vehicles with electric vehicles is a significant strategy for mitigating transportation emissions (Cornell, 2017). While in Ethiopia five industrial forklifts were imported in 2018 as part of the adoption to electric vehicles. Korenti Motors PLC is the company to import EVs in 2019. The company waited for seven months to receive the first batches of electric vehicles.[1] Back then, some EV buyers were aware the vehicles as they decided to buy the vehicles immediately after grasping the information. On the other hand, EVs as rickshaws or three-wheel vehicles and even for them it was hard to believe as they first observed the electric vehicles. Michael Ashenafi, General Manager of Korenti Motors, among the respondents, pointed out:

"E-Mobility will develop an appropriate transportation system for users since it contributes to a healthy, carbon-free environment. As gasoline prices are rising on a routine basis and air pollution from fuel-powered vehicles is such a difficult issue at the moment the adoption of electric vehicles should have to be considered as an option."

Even so, there are still people, who ponder that the technology is too early to adopt even at an international level, Michael Ashenafi, General Manager of Korenti Motor, importer of EVs, described. On the other hand when deciding between buying an EV and a conventional Internal Conventional Engines (ICE), consumers consider vehicle's characteristics at purchase time including cost, performance, the driving range and their awareness level.
Similarly, there are set of perceived challenges faced by owners of electric vehicles in Ethiopia. The findings of this study shows that the main challenges are in the first place are high upfront cost of electric vehicles, which is responded by 25% of the respondents, who expressed concerns about the expensive cost of electric vehicles. Limited charging infrastructure is being identified

[1]Interview with Mr. Michael Ashenafi, General Manager of Korenti Motors, electric vehicles importer Company, 8 June, 2023.

by 16.7% of respondents as a major conundrum to adopt the vehicles. In the same vein, 16.67% of respondents also expressed lack of awareness and knowledge among the population as a limiting factor, which hinders the adoption of EVs. The first EV charging station was opened in December 2021 by Marathon Motors Engineering PLC. The company also launched its second model of EV, the Hyundai Kona SUV, which can run up to 300 kilometers on a single charge. Ethiopia has a relatively low car ownership rate, which could create an opportunity for EV adoption among new car buyers who are looking for more affordable and environmentally friendly options.

For 8.3% of the respondents on the other hand high import taxes levied on electric vehicles is currently blamed as a major factor for high price in local market that discourages potential buyers to acquire the vehicles. Last but not least, 12.5% of the respondents identified high import taxes, limited charging infrastructure, inadequate policies such as lack of clear policy to embolden the use EVs and absence of regulations to build and administer charging infrastructures, high upfront cost of electric vehicles, and low-level awareness regarding the vehicles as major bottlenecks in adopting the vehicles. Among the limiting factors of the adoption of electric vehicles in Ethiopia is buyers range anxiety. The average range of most of EVs is about 150 miles (242kms), which is not that much satisfactory for many people who need to travel long distance. Michael Ashenafi, General Manager of Korenti Motors, Electric Vehicles Importer Company, who has been interviewed for this study, however rejected the range anxiety challenge. “There are electric vehicles that can travel 1000 km in a single charge,” he said.

4.2.2. Charging infrastructures

There are the absence of enough charging stations for electric vehicles, a factor, which is slowing down the vehicles adoption rate. This factor also makes it difficult for EV owners to charge their vehicles when they are away from home. On the contrary, a data obtained from the Ministry of Transport and Logistics generated another response. An expert of the Ministry explained that Addis Ababa has 42 EV charging stations located across market centers, hotels, and around the vicinity of vehicles importers such as Green Tech Ethiopia and Hyundai Motors PLC. A data from the respondent further explained that two investors exhibited their appetite to build extra charging stations in Addis Ababa — Utopia Technology PLC has already granted a patent for EV charging station technology by the Ethiopian Intellectual Property Office.[2]

The number of vehicles charged up by the electrical charging stations are estimated based on the common operating time of the station, as well as the length of time required to fill up or charge the considered vehicle. According to IEA (2022), countries with relatively small EV stocks tend to have low EV to charger ratios as initial infrastructure deployment may precede EV sales. Ethiopia is endowed with immense renewable energy potential, capable of generating over 60,000 MW of electricity from hydropower, solar, wind, and geothermal sources (Azerefegn et al., 2019). This study indicates that the hydropower dominates the country's electricity

[2] Interview with Mr. Yizengaw Yitayew, Senior Climate Change Expert, Ministry of Transport and Logistics, June 29, 2023

generation, contributing 89% of the total output, with an installed capacity of 4284 MW. According to Yizengaw Yitayew, Senior Climate Change Expert, Ministry of Transport and Logistics, among the respondents for this study any public charging station requires basic infrastructural components; the first is installation of a transformer, substation equipment, and safety equipment. Secondly, 33/11 KV cables and associated equipment for line and meters, thirdly, civil works and installations, and last but not least is land space for charging vehicles and entry or exit of vehicles. Anticipating a surge in the global electric vehicle (EV) market, Ethiopia is embracing a green economy approach by promoting pro-green investments through subsidies. In line with this commitment, Ethiopia launched the "Light to All" National Electrification Program in November 2017 to achieve universal electricity access by 2025 (Mondal et al., 2018).

Among the importers of electric vehicles, Marathon Motors Engineering, the pioneer company which introduced the Hyundai Kona SUV EV and an accompanying charging station. This launch aligns with the company's "Leading the way to Zero Emission" initiative, aiming to create a pollution-free environment. Notably, this marks the second EV model launched by Marathon, following the Hyundai Ioniq in July 2020. A crucial aspect of this endeavor is determining the charging station's capacity. Given the variations in charging capacity and socket types among EVs, each vehicle's requirements must be assessed individually. For instance, the Kona SUV, Ethiopia's sole EV model, boasts a 42 kWh battery capacity, a 300 km range, and zero CO_2 emissions. EV demand fluctuates based on the number of EVs arriving at the station, their battery capacities, and their current charge levels. To account for these factors, the initial assumption is that the cars will be fully charged upon arrival. Furthermore, a maximum of four cars are expected during peak hours (early morning, midday, and after work), while the minimum hourly arrival is two cars. This translates to an energy demand ranging from 84 kWh to 172 kWh per hour for the charging station. However, EV users, who have been took part in the survey of this study complained over lack of charging infrastructures in the city. Their complaint has also been supported by an expert from a policy maker institution. Unlike successful nations such as China, Europe, and the United States, Ethiopia failed to enforce standards such as the charging types and systems. Electric vehicle batteries can only be charged with Direct Current (DC) power, but the electricity supplied through household outlets is Alternative Current (AC) power.[3] As Daniel Jemal, Technology Expert at the Ministry of Innovation and Technology puts it:

"Ethiopia lacks specific and comprehensive policies and regulations for EVs and EV charging stations, such as standards, codes, licenses, permits, incentives, or penalties. The existing policies and regulations are mainly focused on ICE vehicles and fuels, which could create uncertainty and inconsistency for EVs and EV charging stations."[4]

When it comes to a risk associated with home charging stations, which took 12 to 21 hours to recharge the vehicles contrary to the fast public charging stations that can recharge 80 percent of the battery in 20 to 40 minutes and fully charged in 80 to 90 minutes.[4] The lithium-ion battery

[3] Interview with Daniel Jemal, Technology Expert, Ministry of Innovation and Technology, July 17, 2023.

[4] Interview with Daniel Jemal, Technology Expert, Ministry of Innovation and Technology, July 17, 2023.

powers electric vehicles battery, which designed to be as lightweight as possible while having high energy storage capacity, it is liable to damage through overheating or when subjected to high temperatures through a thermal runaway. While traditional car fires can occur from short circuits, lithium-ion batteries pose a unique danger due to their flammable electrolyte. This liquid can ignite spontaneously, creating an intense fireball that burns much hotter and releases hazardous gases. This makes lithium-ion battery fires particularly difficult to extinguish and potentially more dangerous than typical car fires.[5]

To the contrary, electric vehicles are advantageous in many aspects. For instance, for developing countries such as Ethiopia EVs are being-cost effective and leveraging economical merits in terms of transport costs including the expense of imported oil, which is $4 billion in a year.[6] If Ethiopia uses at least one-third of that expense in agriculture, infrastructure, and hospital, among other developmental activities, that would be bring great achievements for the country. The adoption of EVs will also play a significant role to the national saving and investment in other development areas. Knowledge and technology transfer is big plus in this aspect. In 2040, most of the developed nations are envisioning to go electric. Electric vehicles importers and assemblers stress that even if Ethiopia is among the list of emerging markets, Africa including Ethiopia should be leapfrogging and not more to be a dumping ground for the used vehicles from the developed world. [7]

4.2.3. Lack of foreign currency and banks loan

The adoption of EVs in Ethiopia is a recent phenomenon in the country, and there is lack of spare parts hampering its adoption rate to the lowest level. For instance, a tax for a head light is more than 36,000 Birr plus the standards to levy a tax on spare parts is not clear. For a two side mirror of electric vehicle they will tax you more than a price of used Corolla engine.[8] Despite the hopeful plans many of the challenges to adopt electric vehicles are associated with lack of foreign currency. There are domains of these challenges and most of the problems synergies with that of shortage of foreign currency. Policy makers such as Ministry of Transport and Logistics argue in favor such a problem.[9]

Furthermore, banks are not generous to provide foreign currency—they attribute the electric vehicle importation as non-priority item. The regulatory body will not allow them to provide foreign currency for importation of electric vehicles.[10] Until recently, the exporters used to take a

[5] Interview with Daniel Jemal, Technology Expert, Ministry of Innovation and Technology, July 17, 2023.

[6] Interview with Sitra Ali, CEO of Green Tech Africa, Electric vehicles importer, August 21, 2023.

[7] Interview with Sitra Ali, CEO of Green Tech Africa, Electric vehicles importer, August 21, 2023.

[8] Interview with Mr. Michael Ashenafi, General Manager of Korenti Motors, electric vehicles importer Company, 8 June, 2023.

[9] Interview with Mr. Michael Ashenafi, General Manager of Korenti Motors, electric vehicles importer Company, 8 June, 2023.

[10] Interview with Mr. Michael Ashenafi, General Manager of Korenti Motors, electric vehicles importer Company, 8 June, 2023.

slice of 20% of the foreign currency (US Dollar) from the product and services exported, 10% belongs to the bank, which facilitated the Letter of Credit (LC) and the rest 70% will be surrendered to the National Bank of Ethiopia (NBE), which poses a severe shortage of foreign currency. The aforementioned factor is forcing importers to look after the parallel market for their foreign currency needs and later legalizing it in the banks. The banks are even not willing to provide us the foreign exchange we set aside in a diaspora account[11].

However, with the basic motive of curbing inflation the NBE changed its monetary policy. Accordingly, the obligation of exporters engaged in key export businesses to transfer foreign currency has been changed from 70/30 to 50/50. The banks will now deposit 50 percent of the total the National (Central) Bank. 4 So far, the researcher doesn't observe the real effects of the policy adjustment by the central bank on solving the shortage of foreign currency. Yet still the foreign currency shortage is unresolved problem.

The other problem mentioned by Mr. Michael Ashenafi, General Manager of Korenti Motors, electric vehicles importer Company is a wrong perception among the Revenue and Customs Commission Officials which claims that importers are cheaters. Though importers exhibited real manufacturers invoice to these officials the authorities have been refusing to accept the evidence. Spare parts for EVs are expensive because of using the scarcity of imports due to high tax rate levied on it and the demand and supply of the vehicles. Lack of spare parts and risks associate with electric vehicles poses a challenge in the insurance market despite its high purchasing cost. Settling claims for electric cars is challenging due to a limited supply of spare parts and a lack of skilled mechanics. This lack of availability creates a high-risk situation. Electric car insurance premiums are noticeably higher than those for gas-powered vehicles. On average, they cost around 25% more, amounting to 1.5 to 2 percent of the vehicle's market value, plus any additional fees. Insurance companies fear the highest cost of EV batteries.

4.2.4. Challenges of EV maintenance

With regard to EVs maintenance it is at zero level in Ethiopia due to lack of expert knowledge. However, the vehicles require less maintenance than the most common ICEs. Light, starter motor, alternator's rate of failure is very limited one than the mechanical one. EVs require much less maintenance cost and time.[12]. Michael Ashenafi, General Manager of Korenti Motors further complained over lack of vertical integration, which incorporates charging stations, EVs maintenance, is lacking in the field. The services in principle are supposed to be given at the same time. Or, the must be a specialization in each sector. He added:

"There's no research so far conducted on the coordination among different organizations is planned through preparation of concept notes and budgets."

[11] National Bank of Ethiopia Monetary Policy Statement Premiered on August 11, 2023. https://www.youtube.com/watch?v=R740oUM0-Pw

[12] Interview with Mr. Michael Ashenafi, General Manager of Korenti Motors, electric vehicles importer Company, 8 June, 2023.

Meanwhile, a great milestone to emerging markets and economies such as Ethiopia is that it is launching construction of EV charging stations, which is expected to be cost effective adding the late-comers advantage unlike the developed world—which moved 30 years of progress. Carbon emission and the extreme weather condition impacts such as drought and flood everywhere. The area is already built up what is needed for the developing nation like Ethiopia is embrace the technology of EVs—the effects must be measured on its impacts after 50 or 100 years ahead.
Ethiopia is emerging market, which makes it the lucky nation to more adopt the technology. With the aim of curbing the environmental pollution the Ministry of Transport and Logistics (MoTL) has approved a law that enforces to limit emission of hydrogen, methane, hydrocarbon, nitric oxide, and Carbon dioxide (CO_2). A draft implementation directive is also to be amended by the MoTL. Emission standard for ICE has already been approved for the emission of hydrogen, methane, hydrocarbon, nitric oxide, CO2, standard and the Ministry of Transport and Logistics (MoTRI) is drafting implementation directive to implement the standard.

According to the data obtained from MoTRI up to February 2023, over 7100 electric and hybrid vehicles have been imported. The government has made it clear that it has an intention of expanding the vehicles across the street of the country in the ten years perspectives plan. The plan pointed out that 148,000 electric vehicles and 4850 electric buses for mass transportation will be imported (Ministry of Transport, 2020). There is not that much price difference between the two —importing electric vehicles and that of the ICEs, according to the Ministry. An importer of EVs who interviewed for the purpose of this study, who is a Mechanical Engineer, elaborated that Ethiopia has an untapped potential for renewable sources of power such as hydro, geothermal, solar, and wind power generation. Additionally, the electric power tariff is the cheapest compared to other nation. Even researches revealed this fact. Electric power generation, transmission and distribution costs in Ethiopia were, on average, about $0.09 kWh, but the tariff for electricity was set between $0.04 and $0.06 per Kilo Watt Hour (kWh). There are some electric vehicle assemblers in Ethiopia. The following table on the next page depicts the production capacity and their locations.

Table 1. EV importers and assemblers in Ethiopia

No	Manufacturer's name	Types of product	Annual production capacity		Location
			Unit of Measurement	Quantity	
1	Marathon Motors Engineering PLC	Automobiles	Pieces	10,000	Addis Ababa
2	Belayneh Kindie Metal Engineering Complex	Mini bus and light vehicles	Pieces	1,000	Gelan and Debre Birhan Cities
3	Rose three-Wheeler Assembly	Electric Three wheels	Pieces	750	Bishoftu

Source: Manufacturing Industry Development Institute (MIDI) of the Ministry of Industry. Illustration: by the Researcher.

4.3. Prospects of EVs adoption

Despite the challenges, EVs adoption has potential prospects in the foreseeable future (Greschak et al., 2022). This fact also holds true for Ethiopia (Ethiopian Transport Master Plan, 2022). Additional to the laws and regulations that gave a green light to the adoption of electric vehicles in Ethiopia, the national Transport Policy (2020) and the Green Climate Resilient Economy Strategy (EPA, 2011) envision building sustainable transport systems such as green mobility or carbon free sources of transportation. Electrification of the transport sector, adoption of mass transportation, and adoption of Non-motorized transportation or encouraging riding a bike and walking are the three strategies to implement such an initiative. Furthermore, the Ministry of Transport and Logistics is drafting a strategy of electric vehicles/renewable energy, law that dictates the electric vehicles price, a directive to permit construction of EVs charging stations and that of charging payments.[13] As part of the Non-Motorized transport schemes, electric bikes sharing scheme has been implemented after the government imported 300 electric bikes. For the purpose of expanding non-motorized transport in Addis Ababa the government imported 300 e-bikes. This project is part and parcel of the Meskel Square Construction Mega Project, supervised by the Addis Ababa City Administration. The first pilot project to test the bicycles launched in April 2023 was held until May, 2023 with 30 e-bikes at five locations in the city; Piazza to Meskel Square, Bole Customs area - Roba Gerji, Furi - Haile Garment, Lebu - Jemo and Urael to Wello Sewer. [14]

Yizengaw Yitayew, Senior Climate Change Expert, Ministry of Transport and Logistics said that along with other stakeholders or policymakers studied the experience of eight countries including China, India, the Netherlands, Sweden, the United States of America, and United Kingdom to avoid the tax rates levied on electric vehicles. Nevertheless of the prospects of EVs adoption there's no policy or implementation manual for the adoption of EVs and the Ministry said it is drafting EVs strategy. Electric vehicles (EVs), whether imported or assembled in Ethiopia, are now exempt from Value Added Tax (VAT), excise tax, and surtax, thanks to a new regulation by the Ministry of Finance (Bogale, 2023). "However, the vehicles aren't free of charge at all," explained Michael Ashenafi, General Manager of Korenti Motors. There are currently taxes being levied on electric vehicles. Electric vehicles (EVs) that are assembled entirely in Ethiopia are exempt from customs duty, while those that are partially assembled in Ethiopia are subject to a 5% customs duty. EVs that are manufactured abroad are subject to a 15% customs duty tax rate.

On the financial and other sort of incentives to encourage local electric vehicles assembly, respondents prefer sets of incentives. Among these respondents 29.17% indicated that tax rebates

[13] Interview with Mr. Yizengaw Yitayew, Senior Climate Change Expert, Ministry of Transport and Logistics, June 29, 2023

[14] Interview with Bethelhem Tadesse, Non- Motorized Transport Expert at Addis Ababa Transport Bureau, August 17, 2023.

–will have a significant factor in their decision to adopt electric vehicles; while 30% of the respondents have chosen attractive government support and incentives to flourish the developing electric vehicles sector. Another alternative policy is the advancement of or importation of technology to modernize EVs, and 10% of the respondents believed that more technological advancement is the major associated factor to boost the adoption level of electric vehicles in Ethiopia. Last but not least, 15% of the respondents stressed the need to secure bank loans with low interest rate to purchase electric vehicles. In addition to the benefits, there are still some barriers to adopt at a faster phase. The following table compares the barriers and benefits of electric vehicles adoption.

Electric vehicle market in Ethiopia has lots of prospect and challenge. In latter's case, besides the importation of the vehicles, retrofitting efforts have also been launched. In line with this effort, retrofitting using Hydrogen as a source of power is being implemented. Green Tech Africa, the supplier of the vehicles, is also working to implement hydrogen retrofitting for electric vehicles, which involves a process by which a gasoline-powered vehicle is converted to run on hydrogen fuel cells. This process involves replacing the gasoline engine with a hydrogen fuel cell stack, as well as installing a hydrogen storage tank and a hydrogen fuel injector. Hydrogen retrofit is a relatively new technology, and it is not yet widely available.[15] However, there are several companies that are working on developing hydrogen retrofitting kits for electric vehicles. These kits are expected to become more widely available in the coming years, as the demand for hydrogen fuel cells grows. The technology is somewhat costly for many drivers.

Hydrogen retrofitting of electric vehicles in Ethiopia is a relatively new concept, but there is some interest in the technology. Hydrogen fuel cell electric vehicles (FCEVs) offer several advantages over traditional battery electric vehicles (BEVs), including longer range, faster refueling, and the potential for zero-emissions transportation. However, Fuel Conventional Electric Vehicles (FCEVs) are also more expensive than Battery Electric Vehicles (BEVs), and the hydrogen refueling infrastructure is not yet as well-developed. As a result, hydrogen retrofitting of electric vehicles could be a way to bridge the gap between BEVs and FCEVs. There are several companies that are developing hydrogen retrofitting kits for electric vehicles. Yizengaw Yitayew, Senior Climate Change Expert at the Ministry of Transport and Logistics explained the prospects of hydrogen retrofitting as follows:

"The cost of hydrogen retrofitting kits varies depending on the vehicle and the kit. However, the cost is typically less than the cost of purchasing a new FCEV. There are several benefits to hydrogen retrofitting of electric vehicles. First, it can help to reduce emissions. Hydrogen fuel cells produce no emissions, so retrofitting an electric vehicle with a hydrogen fuel cell can make it a zero-emissions vehicle. Second, hydrogen retrofitting can extend the range of electric vehicles. The range of an electric vehicle is limited by the size of its battery. However, hydrogen fuel cells do not have this limitation, so retrofitting an electric vehicle with a hydrogen fuel cell can significantly extend its range. Third, hydrogen retrofitting can make electric vehicles more convenient."

[15] Interview with Sitra Ali, CEO of Green Tech Africa, Electric vehicles importer, August 21, 2023.

Not everyone buys an EV for the same reason. A driver, who is respondent for this study described it as the culmination of years of choosing increasingly eco-friendly vehicles. Drivers started with smaller cars, switched from gas to diesel, and finally landed on an electric car. For them, it was a natural step in a long journey towards sustainable transportation. While environmental concerns were a big motivator for everyone, the real driving force was breaking free from dependence on fossil fuels.

High upfront cost of electric vehicles is another theme emerging from interviews. While EVs may sting the wallet upfront, their daily running costs are surprisingly kind. This, combined with their overall value, was a big draw for participants. They saw EVs as a smart investment in the long run, even considering the higher initial price tag. From among the participants in this study, users of electric vehicles are categorized into either environmentally conscious and were concerned about fuel efficiency.

Meanwhile, it was recently that a company that convert petrol vehicles to electric engines has expressed interest to work in industrial parks. The company is planning to convert petrol three-wheeled and four-wheeled vehicles to electric systems and announced its plan to officials of the Industrial Parks Development Corporation.[16] As a policy implementer IPDC praised the plan and pledged to back the success of the investment as it has a paramount importance to the economy of the country. The company has an initial plan to convert 1000 three-wheeled and 200 four-wheeled vehicles to electric systems within a year by opening a huge assembly workshop in industrial parks. Towards this end, Clark (2018) found out that the widespread adoption of electric vehicles is being held back by the lack of a convenient and affordable charging infrastructure. Drivers are concerned about running out of power while on the road, even though this is a rare occurrence. As similar survey indicated the development of a reliable and accessible charging network is essential for the success of electric vehicles. There are several different charging technologies available, but there is no one-size-fits-all solution. The ideal charging infrastructure will vary depending on the needs of different drivers and communities.

Regarding EVs maintenance issue in the country it is at zero level in Ethiopia due to lack of expert knowledge. However, the vehicles require less maintenance than the most common ICEs. Light, starter motor, alternator's rate of failure is very limited one than the mechanical one. Reduced maintenance cost and time requires for the vehicles. EVs require service in every 15,000kms whereas gasoline powered vehicles need a service in 5,000kms. A local EVs importer known as Korenti Motors has been purchasing practical simulators for the maintenance of EVs. The maintain center is currently providing training in real vehicles with the aim of bridging the gap in the area. Fresh graduates in engineering fields will be the beneficiaries ahead. The vehicles can remotely be controlled and assisted by the assembler or importer companies and a trend to change the situation has already launched.
Korenti Motors, an electric vehicle importer, complained over lack of vertical integration, which incorporates charging stations, and EVs maintenance, is lacking in the field. The services in principle are supposed to be given at the same time. Or, there must be a specialization in each

[16] Industrial Parks Development Corporation. https://ipdc.gov.et/news/post/107/ Retrieved on August 13, 2023.

sector. In the meantime it was recently that the feasibility study is on the pipeline to establish EVs charging stations across major regional cities of Ethiopia at a cost of $10,000. The study is being conducted by the Global Green Growth Institute Ethiopia Office (GGGI-Ethiopia) and donors are the main source of finance. This feasibility study has been made mainly to resolve the range anxiety challenge.

EV adoption looks more promising as international partners are willing to back the development of the technology in Ethiopia. The proof for this fact is that the World Bank gave the green light to the purchase of four electric vehicles to the Ministry of Transport and Logistics at a cost of $11 million after a discussion with the NBE. This move is expected to ease lack of foreign currency, a major factor that choked the country's EVs adoption level. The Ministry also envisioned that importers can also create an association to enable importation of EVs through tax free modality, especially for mass transportation services including that of cross-country buses with zero tax tariff.

Meanwhile, the global growth of electric vehicles (EVs) has the potential to benefit from opportunities in large-scale supply from original equipment manufacturers (OEMs) and improvements in battery cost efficiency. In 2019, initial results showed that there were 7.2 million EVs in possession, accounting for a 2.5% share of passenger vehicles. Despite the challenges posed by the Covid-19 pandemic, the EV market experienced significant growth by the end of 2020, with global sales increasing by 43% from 2.1 million in 2019 to 3.1 million in 2020 (IEA, 2020). Similar report outlined that currently, there are over 10 million EVs in operation worldwide. Based on forecasts, it is expected that cumulative EV sales will surpass 125 million by 2030.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

The conclusion and recommendation chapter of this thesis synthesizes the main findings of the research and provide recommendations for policymakers and stakeholders to promote the adoption of electric vehicles (EVs) in Ethiopia. The conclusion reflects on the overall implications of the research findings for policymakers and stakeholders. It will discuss the key lessons learned from the Ethiopian case study and identify the most promising strategies for promoting the adoption of EVs in other developing countries.

5.1. Conclusion

This research delves into the obstacles preventing widespread electric vehicles and the prospects of deploying the vehicles pinpoints critical areas for achieving transportation electrification goals. A thorough analysis of what hinders EV adoption identifies key elements crucial for advancing vehicle electrification. The major objective of this study is to explore is to assess the challenges and opportunities associated with adopting electric vehicles in Ethiopia as a pathway towards green mobility. Furthermore, assessing the challenges faced by electric vehicle importers and assemblers are among the main aim of this study. Exploring the prospects for policies and strategies to promote electric vehicle adoption in Ethiopia are also answered by this study. To collect and analyze the data, both primary and secondary data used. Primary data collection methods are interviews and questionnaires whereas secondary resources such as scientific articles, MA Thesis and PhD Dissertations, and organizational reports and government documents were employed.

As it is an observable fact, the vehicle manufacturing industry is currently experiencing a transformation, marking a historic milestone. This shift, as it was discussed in this study, is the amalgamation of factors, including a growing demand for environmentally friendly vehicles and the implementation of regulatory measures to control emissions. As a result, the industry is increasingly focusing on the production of zero-emission vehicles, specifically those powered by electricity or electric vehicles. While EVs may bear a resemblance to traditional internal combustion engine vehicles (ICEVs) in terms of their appearance, they differ in terms of their internal components. EVs require batteries, additional wiring, and simpler electric motors, whereas ICEVs have more complex engines and require starters, fuel tanks, exhaust pipes, and gears. Consequently, the production of EVs may require fewer labor inputs and components compared to the intricate supply chain involved in manufacturing ICEVs. Furthermore, the rise of EVs will have a positive impact on energy markets. The increased adoption of EVs will lead to a higher demand for electricity, necessitating the construction of more power plants and the development of higher-capacity transmission lines. On the other hand, the demand for gasoline

and diesel refining and filling stations will decrease as EVs reduce reliance on these traditional fuels.
Similar to any transformation the shift towards an electricity-powered transportation industry will have both positive and negative consequences. The whooping adoption of EVs will lead to job losses in the oil industry, gas stations, and potentially the auto maintenance and mechanic sectors, as EVs require significantly less maintenance compared to traditional gasoline and diesel vehicles. However, there will be new job opportunities created in the auto industry, particularly in manufacturing, research and development, and battery production. Moreover, the installation and maintenance of electric vehicle supply equipment (EVSE) will also generate indirect employment. Apart from job creation, it is worth noting that EVs offer cost advantages in terms of maintenance and operation. Also, the adoption of electric vehicle could clear the field for harnessing the potential of renewable energies such as geothermal, solar and wind power generation alternatives in addition the hydroelectric power generation in Ethiopia, a country with a potential of generating approximately eleven huge hydropower dams with an annual energy production capacity of 14, 296.7 Gigawatt hour (GWh).

The broader implications of electric vehicle adoption for green mobility are significant. EVs have the potential to transform the transportation sector and reduce reliance on fossil fuels. Various nations are shifting their face towards EVs to diversity their economy to a sustainable development and reduce their dependence on oil. Both importers and exporters of oil are craving to slash the use of oil for ICEs, which are not environmentally and economically viable. Most of the countries are also planning to shift to greener energy solution from 2025 to 2030. In this regard, the sooner Ethiopia shifts the gear, the better it would be for its growth and environmental protection. For instance, 200 states and non-state actors have pledged to a transition into EVs by the year 2040. If well implemented such pledged will cut environmental and health costs that arises from pollution, let alone the economic advantages. The coming years ahead are expected to be a tipping point for the adoption of electric vehicles because the more people who do it, the more other people will want to do it. There will be an increased demand to build charging points and other infrastructures for them and that will make other people more likely to buy electric cars so it is a snowball effect in Ethiopia’s case. Companies are clambering to take the lead with billions in investments and promises make the switch in a bid to accelerate the transition to sustainable transport. Nations are expected to ban diesel cars into their cities after 2025. Furthermore, it is expected to see such sort of tightening of the regulation around fossil fuel cars in the future.

The rising uptake of EVs will challenge the world’s crave for oil. It could spark a global shift from countries that have enjoyed the influence that oil has bought. The control of oil has been terrifically important during the 20th century but it is going to become much less important. Beyond oil, attention will turn to lithium electric-car batteries which rely in the mineral cobalt. There is almost unstoppable momentum behind the electric vehicle and eventually the internal combustion engine will go out. When it comes to the cars that most people drive, electric cars really are the future. Meanwhile, Ethiopia’s lack of existing infrastructure allows it to leapfrog directly to new technologies like electric vehicle charging stations, bypassing the need to update old systems. This latecomer advantage offers Ethiopia a unique opportunity to lead in EV development and avoid becoming a dumping ground for used gasoline cars.

Another merit of EVs are much quieter than gasoline-powered vehicles, which can reduce noise pollution and improve the quality of life for people who live near busy roads through expansion of charging stations. EVs can help to reduce our dependence on imported oil and make Ethiopia's energy system more resilient. In addition to these direct benefits, EV adoption can also have a number of indirect benefits for green mobility. For example, EVs can help to promote the development of renewable energy sources and smart grid technologies. EVs can also be used to support new mobility services, such as shared mobility and carpooling. Overall, the broader implications of electric vehicle adoption for green mobility are very positive. EVs have the potential to make our transportation system more sustainable and efficient, while also reducing our impact on the environment. Nations that have been competing in terms of vehicles importation are dominated the market race due to a whooping sale of electric vehicles across the globe.

EVs can be used to support smart grid technologies. Smart grids can manage the flow of electricity between different sources and consumers. This can help to integrate EVs into the grid more efficiently and reduce the risk of blackouts. These vehicles can be used to provide shared mobility services, such as car sharing and ride-hailing. This can help to reduce the number of cars on the road and make transportation more efficient. EV adoption is still in its early stages in Ethiopia, but it is growing smoothly. By investing in EVs and supporting infrastructure, Ethiopia can create a more sustainable and equitable transportation system for the future. Auto makers are bullish on the future of electric vehicles despite the fact that its adoption rate is low across Ethiopia. With regard to the cost electric vehicles are so much expensive than the conventional diesel power vehicles but EV advocates are urging buying to focus on longer term savings such as less maintenance costs.

5.2. Recommendations

The switch to electric vehicles, EVs, is key to cutting transport emissions and getting to net zero. Ethiopia in this regard is moving slowly in terms of adoption of the vehicles. Accelerating RV adoption means removing some key barriers. This study pinpointed two obstacles that hold back electric vehicle adoption: high purchase prices and sparse charging infrastructure. These can be categorized into affordability and charging access factors. To this end the government must improve consumer confidence of the people to by electric vehicles by implementing policies in addition to the emption of VAT, excise and sur tax from electric vehicles. Customs taxes or flat tax rate of 15%, which is currently being levied on EVs must also be exempted to encourage more and more adoption of the vehicles. In Ethiopian case, the government should also work hard in policy formulation and policy execution in the adoption of electric vehicles. Developing a very strong science and technology ecosystem is a forefront factor for the success of EVs adoption. It is also advisable for the government to massively subsidize the EVs sector to scale the adoption level up. The most important component in an electric vehicle is the battery and this too requires a very high degree of scientific expertise as well as manufacturing capability. To modernize the battery's life, the government should also maximize its ability to not only articulate and formulate detailed long term policies but to actually implement them.

On the other hand, EV sellers should have to minimize the cost of EVs to make them much affordable than ICEs. The limited availability of charging stations is a major stumbling block for many people considering making the switch to EVs. Consumers worry about getting stranded with a dead battery before reaching their destination or finding a station. To solve the shortage of charging infrastructures installation of accessible chargers that offer the right speed of charging (ultrafast charger) to meet drivers needs is recommendable. Gradually, the government should either allow importation of super batteries for EVs or craft a policy, which favors its production locally. These batteries are improving the charging time and much greater driving range. These batteries often called solid-state batteries are transforming the innovative approach of the EV industry since 2020. Furthermore, initiatives such interest-free loans for the purchase of EVs focusing on this segment can be effective in encouraging people to make the switch. Beyond financial discounts, various non-financial incentives can encourage EV adoption, such as dedicated parking spots, green zones, registration and license benefits, fast-lane access, and even relaxed traffic restrictions for electric vehicles should have to be implemented. In the meantime, expansion of the wireless charging pad without a need to lift a finger or get out of the vehicles. Also, a solution to the range anxiety is not putting batteries into cars that can hold more charges; it is more of charging infrastructure itself contribute to extending the driving range of vehicles. The battery is the biggest or certainly a chunk of the cost of EVs; hence if there are smaller batteries which cost less the price of EVs down. Also, as an alternative source of energy integration of solar energy for charging EVs is among the ideal methods to be implemented.

The EV revolution is not only about sleek cars and futuristic designs; it is about building a robust ecosystem that supports their seamless integration into our lives. And at the heart of this ecosystem lies the charging infrastructure – the essential network of power stations that keeps EVs juiced and ready to roll. To encourage the development of this crucial infrastructure, many governments are turning to a powerful tool: incentives. Subsidies and tax breaks become the magic sparks that ignite the construction of charging stations. These incentives in forms of grant or discounts applied to the hefty costs of installing chargers, making them more palatable for individuals, businesses, and even public authorities. By lowering financial barriers, these incentives pave the way for a diverse network of charging options, from sleek urban stations to strategically placed chargers along highways. But the impact of these incentives goes beyond mere numbers. They send a powerful signal – a government actively supporting the EV transition and acknowledging the critical role of charging infrastructure. This creates a ripple effect, attracting private investments, emboldening entrepreneurs, and fostering a collaborative environment where everyone, from individual homeowners to major energy companies, feels empowered to contribute to the charging network. Charging infrastructure incentives are not just financial levers; they are catalysts for a transportation revolution. By removing financial roadblocks and sending a clear message of support, governments can electrify the landscape, one charging station at a time. Policy makers should guide the country towards a future where finding a charge is as effortless as finding a gas station, and the hum of electric engines becomes the new soundtrack of Ethiopia's cities. This government's effort should be accompanied by policy push for EV chargers in such a way that new rules are being made to require buildings, like businesses and homes, to have a minimum number of EV charging stations. This will gradually boost the total number of charging points available for electric cars. The rising tide of electric vehicles will lift overall electricity demand, demanding upgrades to our energy

infrastructure to keep pace with this electrifying transformation. With electric vehicles hitting the fast lane, the electricity needs will race alongside. To ensure a smooth ride, Ethiopia must invest in bolstering our energy infrastructure for a seamless transition to a greener source of energy.

Widespread EV adoption takes more than willing buyers. Suppliers need to invest in innovation, and policies must pave the way for a significant shift towards electric vehicles. Getting folks pumped about EVs is just one piece of the puzzle. Manufacturers need to invest in cutting-edge technology, and supportive regulations are crucial to accelerate the electric vehicle revolution. Consumer enthusiasm for EVs is fantastic, but it is not enough. We need suppliers to invest in new technology and supportive policies to smooth the transition to a future dominated by electric vehicles.

Genuine policy, legal frameworks, investment, and users-based incentives should be crafted and implemented. There are gaps in this regard. This is beside the fact that the government has come a half way in this regard at least slashing the sort of taxes previously levied on EVs. The increasing popularity of EVs is a positive sign. The government or the National Bank of Ethiopia should incorporate electric vehicles in the priority imports list item and must accordingly supply the foreign currency in a bid to expand EVs adoption. The number of EVs on the road is increasing, which is a positive sign for the future of green mobility. This hike is being driven by a number of factors, including the declining cost of batteries, the increasing range of EVs, and the availability of government incentives. The industry needs investment and users-based incentives to help the sector grow. Creating an enabling environment for the adoption of electric vehicles by the Ministry of Transport and Logistics, and allocating more foreign currency to import EVs should have to be given a priority.

Collaboration between the government, private sector, and international organizations is also very crucial. This can involve partnerships with automobile manufacturers to establish local assembly plants for electric vehicles, creating job opportunities and boosting the economy. Additionally, international organizations can provide technical expertise and financial support to accelerate the adoption of electric vehicles in Ethiopia. Moreover, integrating electric vehicle adoption into broader sustainable development strategies is necessary. This includes incorporating green mobility initiatives into urban planning, transportation policies, and energy sector reforms. By aligning these efforts, Ethiopia can create a holistic approach to green mobility that addresses not only the environmental benefits but also the social and economic aspects.

On the financial side, there must be financial incentives offered by the government through making subsidies, grants, and tax break approaches are most effective in lowering the price tag.
While the technological advancements of electric vehicles are undeniable, their transition from niche market to mainstream phenomenon hinges on more than just sleek designs and impressive performance. A crucial factor in driving EV adoption is the narrative woven by governments and authorities through their communication and education efforts. This study fact dives deep into this realm, meticulously assessing the extent to which various localities leverage information sharing and guidance to nudge citizens towards embracing the electric revolution. This study recognizes the transformative power of effective communication in shaping public perception and influencing decisions. In the context of EV adoption, policymakers have the delicate task of

not only highlighting the environmental and economic benefits of this technology but also dispelling lingering doubts and concerns. Engaging educational campaigns can break down technical jargon, clarify misconceptions about range and charging infrastructure, and showcase the practical advantages of EVs for everyday usage. By comparing policies across different regions, this research sheds light on the diverse approaches employed by governments to educate and inform their citizens. The government should expand spectrum of strategies, ranging from informative websites and targeted social media campaigns to community workshops and school outreach programs. Each initiative, when crafted thoughtfully and delivered with clarity, can contribute to building a knowledge base and fostering a more receptive environment for EV uptake. This research underscores the significant influence policymakers can wield through their communication and education efforts. By crafting compelling narratives, dispelling anxieties, and offering practical guidance, they can cultivate a public that is not only aware of the rationale behind the EV push but also empowered to make informed decisions about their own mobility choices. Ultimately, the success of the electric vehicle revolution rests not just on technological advancements but also on the effectiveness of the persuasive tapestry woven by communication and education.

5.3. Recommendations for future researches

This section provides further ideas or course of action to improve the productivity of the electric vehicle sector based on the findings and conclusion of this study. First of all, exploring the scalability of manufacturing is necessary. Future studies should focus on exploring the opportunities or potentials to produce electric vehicles super batteries in Ethiopia. This includes the feasibility manufacturing process, identifying the potential challenges, and development of strategies to solve these problems. Understanding the scalability of solid-state batteries will be crucial for their widespread adoption in the electric vehicle industry.

On the other hand, conducting researches on the specific needs and preferences of Ethiopian EV users will be important. This would help to develop more effective policies and programs to promote the adoption of EVs in Ethiopia.

Thirdly, future researches should investigate the impact of government policies and regulations on EV adoption in Ethiopia, which would help to identify and address any policy barriers to EV adoption.

Another area of research will be assessing the feasibility and cost-effectiveness of different EV charging infrastructure solutions in Ethiopia. This would help to develop a sustainable and affordable charging infrastructure network for EVs in the country. Furthermore, a study on the role of the private sector in promoting EV adoption in Ethiopia should also be conducted. This would help to identify and support private sector initiatives that can accelerate the adoption of EVs in the country.

Annex 1. Questionnaire

1. What is your awareness of electric vehicles as a form of green mobility?
2. Have you ever considered purchasing an electric vehicle?
3. if not, what factors have held you back from making such a purchase?
4. How familiar are you with the charging infrastructure for electric vehicles in your area?
5. What policies do you think the government should implement to promote the adoption of electric vehicles?
6. Do you think high import taxes have hindered the supply and demand of electric vehicles in Ethiopia?
7. What do you think is the role of the private sector in promoting the use of electric vehicles?
8. How do you think public transportation can integrate electric vehicles?
9. What are the major challenges that need to be addressed for timely adoption of green mobility in Ethiopia?
10. What are some solutions that can accelerate the growth of green mobility in Ethiopia?
1. What is your level of awareness of electric vehicles as a form of green mobility?
a) Very aware
b) Somewhat aware
c) Slightly aware
d) Not at all aware

2. Have you ever considered purchasing an electric vehicle?
a) Yes, I am interested and have already done research
b) Yes, but I need more information before deciding
c) No, but I am open to the idea
d) No, I am not interested
3. if not, what factors have held you back from making such a purchase?
Please rank the following factors from 1-5, with 1 being the most important factor and 5 being the least:
a) Cost of purchase
B) Limited charging infrastructure
c) Battery range limitation
d) Lack of available models in Ethiopia
e) Other (please specify):

4. How familiar are you with the charging infrastructure for electric vehicles in your area?
a) Very familiar
b) Somewhat familiar
c) Slightly familiar
d) Not at all familiar
5. What policies do you think the government should implement to promote the adoption of electric vehicles?
6. How do you think high import taxes have impacted the supply and demand of electric vehicles in Ethiopia?
a) Positively

b) Negatively
c) No impact
d) Unsure

7. What do you think is the role of the private sector in promoting the use of electric vehicles?

8. How do you think public transportation can integrate electric vehicles?
a) Gradual replacement of all buses with electric buses
b) Integration of a mix of traditional and electric buses
c) Supportive policies for private sector to provide electric vehicles for hire services
d) Other (please specify):

9. What are the major challenges that need to be addressed for timely adoption of green mobility in Ethiopia?

10. What are some recommended solutions that can accelerate the growth of green mobility in Ethiopia?
Section 1: Respondent's Background
1. What is your age?
2. What is your gender?
3. What is your occupation?
4. What is your highest level of education completed?

Section 2: Awareness of Electric Vehicles
5. Have you ever heard of electric vehicles (EVs) before?
6. How would you rate your knowledge about electric vehicles?

Section 3: Purchase Intention and Perceived Barriers
7. Have you ever considered purchasing an electric vehicle?
8. If not, what factors have held you back from considering an EV? (Select all that apply)
   A. High purchase cost
   B. Limited driving range
   C. Lack of charging infrastructure
   D. Limited availability of models
   E. Uncertainty about reliability
   F. Other (Please specify) _____
9. Would you consider purchasing an EV in the future? Why or why not?

10. What types of financial incentives do you think would encourage you to purchase an electric vehicle? (Select all that apply)
   A. Tax rebates
   B. Lower import taxes
   C. Lower interest rates on loans for EVs
   D. Free parking for EVs
   E. Other (Please specify) _____

Section 4: Charging Infrastructure

11. How familiar are you with charging infrastructure for electric vehicles?
12. Do you live in an area where there are public charging stations for electric vehicles?
13. In your opinion, how important are charging stations in promoting the adoption of electric vehicles?

Section 5: Government Policies and Support

14. Do you think the government should provide incentives to promote the adoption of electric vehicles?
15. If yes, what types of incentives do you think would be most effective in promoting the adoption of electric vehicles? (Select all that apply)

A. Lower import taxes
B. Subsidies for EV purchases
C. Tax breaks for EV owners
D. Funding for charging infrastructure
E. Other (Please specify) _____

16. What other government policies do you think could help promote the adoption of electric vehicles in Ethiopia?

Section 6: Role of Private Sector

17. What role should the private sector play in promoting the use of electric vehicles in Ethiopia?
18. In your opinion, what would be the most effective way for private companies to promote the use of electric vehicles?

Section 7: Integration into Public Transportation

19. Do you think electric vehicles can be integrated into public transportation in Ethiopia?
20. If yes, how do you think this integration should be implemented?
21. Do you think electric vehicles would be a viable alternative for public transportation? Why or why not?

Section 8: Challenges and Prospects for Green Mobility in Ethiopia

22. What are, in your opinion, the major challenges that need to be addressed for timely adoption of green mobility in Ethiopia? (Select all that apply)

A. Lack of public awareness
B. Limited charging infrastructure
C. High import taxes on EVs
D. High upfront cost of EVs
E. Inadequate policies and government support for EVs
F. Other (Please specify) _____

23. What are some recommended solutions that can accelerate the growth of green mobility in Ethiopia?

Thank you for participating in this survey!

Annex 2. Interview

For Importers

-How many EVs do you import in a month and year?
-How frequently do you access Letter of Credit (LC) from National Bank of Ethiopia (NBE?)
-Which type of EV has more demand, fully electric or dual (vehicles which can use both electric and fuel—Hybrid)
-What are the incentives provided for EVs import, compared to fuel vehicles?
-Could you tell me the Ratio of imported EVs versus sales?
-How do you select the EV suppliers abroad?

- For Assemblers

-What are the incentives provided for EVs assembly compared to fuel vehicles?
-Does Ethiopia have potential for Completely Knocked Down (CKD) or Semi-Knocked Down (SKD) in EVs assembly?
-Ratio of EVs assembled versus sales?
-To indicate the level of challenges in the following questions;
-Are there sufficient legislations, manuals and standards to guide and inspect the manufacturing, assembly and after sales services of EVs?
-Do you think fuel car assemblers and importers are lobbying government, to get favourable policies at the expense of EV assemblers?
-Do you recruit local skills or import expats?
-Do you think local higher education institutions are producing sufficient professionals on green mobility?

Challenges:-

- Power outage --frequent -less than three days per week -rarely -never
- LC approval --once a year --more than twice a year --anytime request
- Skill upgrading -available -scarce --we have training
- Finance -from banks --green funds --own pocket
- Land -easily accessible -difficult to access - lease cost share to investment

For EV Users

-What are challenges faced during accessing licenses, title deeds, parking space, driving of EVs?
-How frequently EVs need maintenance, which part? –Battery -motor –wheels?
-Are EV spare parts and maintenance providers available at your nearby?
-Compare price of EVs with fuel vehicles. Do you find EVs affordable?
-Do you find loan providers for EV?
-Do you find EV charging stations at least at every 100 kilometer distance?
-why did you preferred to purchase EV over fuel car
-Do you charge at home or at public space? How much do you pay to charge at public space?
-To which public institution do you go, in case of problems related with EV?

For policy makers
Which public institution fully owns the adoption of EVs

Ministry of Industry, Ministry of Trade and Regional Integration, Ministry of Transport, Ministry of Finance, Environmental Protection Authority and Ministry of Innovation and Technology.

- From which policy perspective EVs are approached largely.
- From environmental perspective ---from power usage (cost of fuel importation)

How government persuades car importers and assemblers to change from fuel to EVs importation and assembly?

- When will government plan to convert all public transport vehicles from fuel to EVs?
- What is the impact of using fuel cars, on the economy?
- How ready is government to allocate budgets for EV R&D?
- Does government has planned to make some of the local universities to specialize in green mobility?
- Which country Ethiopia select to emulate, in terms of EVs and green mobility?

Annex 3. List of interviewees

Name	Affiliated organization	Position
Bethelhem Tadesse	Addis Ababa Transport Bureau	Non- Motorized Transport Expert
Daniel Jemal	Ministry of Innovation and Technology	Technology Expert
Michael Ashenafi	Korenti Motors, Electric Vehicles importer Company	General Manager
Sitra Ali	Green Tech Africa, Electric Vehicles Importer Company	CEO
Yizengaw Yitayew	Senior Climate Change Expert	Senior Climate Change Expert

References

Abbasi, H. A., Johl, S. K., Shaari, Z. B. H., Moughal, W., Mazhar, M., Musarat, M. A., Rafiq, W., Farooqi, A. S., & Borovkov, A. (2021). Consumer motivation by using unified theory of acceptance and use of technology towards electric vehicles. *Sustainability (Switzerland)*, *13*(21), 1–22. https://doi.org/10.3390/su132112177

Adhikari, M., Ghimire, L. P., Kim, Y., Aryal, P., & Khadka, S. B. (2020). Identification and analysis of barriers against electric vehicle use. *Sustainability (Switzerland)*, *12*(12), 1–20. https://doi.org/10.3390/SU12124850

Adjei-Ampomah, F. (2020). Electric Vehicles Transition in Developing Countries; a Case Study of Nairobi- Kenya.

African Development Bank Group. (2021). *African Development Bank Group*.

Agrawal, R. (2020). Global Perspective on Electric Vehicle 2020. *International Journal of Engineering Research And*, *V9*(01), 2018–2021. https://doi.org/10.17577/ijertv9is010005

Agunbiade, O., & Siyan, P. (2020). Prospects of Electric Vehicles in the Automotive Industry in Nigeria. *European Scientific Journal ESJ*, *16*(7), 201–215. https://doi.org/10.19044/esj.2020.v16n7p201

Ahmed, E., Douma, & Alzayani. (2021). Electric vehicles revolution: The future, challenges, and prospects in the Arab countries. *Global Journal of Engineering and Technology Advances*, *6*(3), 081–087. https://doi.org/10.30574/gjeta.2021.6.3.0040

Ajanovic, A. (2015). The future of electric vehicles: Prospects and impediments. *Wiley Interdisciplinary Reviews: Energy and Environment*, *4*(6), 521–536. https://doi.org/10.1002/wene.160

Al-Shaiba, A., Wilson, A., & Cochrane, L. (2023). The enablers, opportunities and challenges of electric vehicle adoption in Qatar: A systematic review of the literature and assessment of progress toward transportation transformation targets. *PLOS Climate*, *2*(9), e0000271. https://doi.org/10.1371/journal.pclm.0000271

Alanazi, F. (2023). Electric Vehicles: Benefits, Challenges, and Potential Solutions for Widespread Adaptation. *Applied Sciences (Switzerland)*, *13*(10). https://doi.org/10.3390/app13106016

Ali, S. (2021). An Overview on Why Electric Cars are the Future of Transportation.

Alotaibi, S., Omer, S., & Su, Y. (2022). Identification of Potential Barriers to Electric Vehicle Adoption in Oil-Producing Nations—The Case of Saudi Arabia. *Electricity*, *3*(3), 365–395. https://doi.org/10.3390/electricity3030020

Alyamani, R., Pappelis, D., & Kamargianni, M. (2023). Modeling the Determinants of Electric Vehicle Adoption: A Saudi Perspective. *King Abdullah Petroleum Studies and Research Center*, *October*. https://doi.org/10.30573/KS--2023-DP20

Ambak, K., Harun, N. E., Rosli, N., Daniel, B. D., Prasetijo, J., Abdullah, M. E., & Rohani, M. M. (2016). Driver intention to use electric cars using technology acceptance model. *ARPN Journal of Engineering and Applied Sciences*, *11*(3), 1524–1528.

Ana Filipa De Castro, M. O. R. (2020a). Electric Cars Impact in the Economic Growth and the CO2: Case of European Union.

Ana Filipa De Castro, M. O. R. (2020b). Electric Cars Impact in the Economic Growth and the CO2: Case of European Union.

Anderson, E. G., Bhargava, H. K., Boehm, J., & Parker, G. (2022). Electric Vehicles Are a Platform Business: What Firms Need to Know. *California Management Review*, *64*(4), 135–154. https://doi.org/10.1177/00081256221107420

Anenberg, S. C., Miller, J., Henze, D., & Minjares, R. A. Y. (2019). Pollution-related health impacts of transportation sector emission in 2010 and 2015. *ICCT, Clim. Clean Air Coal.*, 1–55.

Arnob, A. (2023). Effect of electric vehicle sales on the price of oil Item Type Senior Project Effect of electric vehicle sales on the price of oil [State University of New York at Plattsburgh]. http://hdl.handle.net/20.500.12648/7099

Arroyo-Arroyo, F., & Vesin, V. (2022). Pathways to Electric Mobility in the Sahel. *Pathways to Electric Mobility in the Sahel*. https://doi.org/10.1596/37046

Aruna Ponnupandian, V. P. (2021). Evolution and Recent Advancements in Electric Vehicle (EV) Technology. *Springer Nature Singapor*, *May*, 91–109. https://doi.org/10.1007/978-981-16-0719-6

Asbury, A., Bruffey, C., Clinard, R., Bowles, B., Wu, L., Ju, W., & Innovations, A. E. (1884). *Electric Vehicles*. 1–7. https://web.eecs.utk.edu/~kaisun/Backup/ECE421_Fall2014/Group 5 - Electric Vehicles - Final.pdf

Azerefegn, T. M., Bhandari, R., & Ramayya, A. V. (2019). Techno-economic analysis of grid-integrated PV / wind systems for electricity reliability enhancement in Ethiopian industrial Park . Techno-economic analysis of grid-integrated PV / wind systems for electricity reliability enhancement in Ethiopian industr.

Baatar, B., Heckmann, K., Hoang, T., Jarvis, R., & Sakhiya, P. (2019). Preparing Rural America for the Electric Vehicle Revolution. *Washington, DC*, 1–27. https://epm.ucdavis.edu/sites/g/files/dgvnsk296/files/inline-files/Preparing Rural America for the Electric Vehicle Revolution.pdf

Bael, C. Van. (2011). Högskolan i Halmstad Katholieke Hogeschool Kempen Electric vehicles Market study and simulations Christof Van Bael.

Bauer, G., Hsu, C. W., & Lutsey, N. (2021). When might lower-income drivers benefit from electric vehicles? Quantifying the economic equity implications of electric vehicle adoption. *Working Paper*, *February*, 1–21. https://theicct.org/sites/default/files/publications/EV-equity-feb2021.pdf

Bawa, A., & Nwohu, M. N. (2023). Investigating the Penetration Rate of Electric Vehicle in Developing Countries: Nigeria as A Case Study. *Lecture Notes in Engineering and Computer Science*, *2245*, 105–109.

Bekiaris, E., Tsami, M., & Panou, M. (2017). A Greening Mobility" framework towards sustainability. *Transportation Research Procedia*, *24*, 131–136. https://doi.org/10.1016/j.trpro.2017.05.078

Berry, S. T., Kersley, L., Moen, J., & Denig, W. F. (2013). Creating the Clean Energy Economy. *International Economic Development Council*, *18*(1), 74–80.

Bhuvaneswara, M. and V. (2022). A Review of Electric Vehicle Technology Development. *International Journal of Research Publication and Reviews*, *04*(01), 1806–1812. https://doi.org/10.55248/gengpi.2023.4149

Bogale, S. (2023, July 22). *The Reporter*. https://www.thereporterethiopia.com/35612/

Breschi, V., Ravazzi, C., Strada, S., Dabbene, F., & Tanelli, M. (2023). Driving electric vehicles' mass adoption: An architecture for the design of human-centric policies to meet climate and societal goals. *Transportation Research Part A: Policy and Practice*, *171*, 103651. https://doi.org/10.1016/j.tra.2023.103651

Bridi, R. M., & Al Hosani, N. (2020). An analysis of potential adopter attitudes regarding electric vehicles: The case of university students in the United Arab Emirates. *Acta Universitatis Carolinae, Geographica*, *55*(1), 38–48. https://doi.org/10.14712/23361980.2020.4

Broadbent, G. H., Metternicht, G., & Drozdzewski, D. (2019). An analysis of consumer incentives in support of electric vehicle uptake: An Australian case study. *World Electric Vehicle Journal*, *10*(1), 1–15. https://doi.org/10.3390/wevj10010011

Bushnell, J. B., Muehlegger, E., & Rapson, D. S. (2022). *Nber Working Paper Series Energy Prices and Electric Vehicle Adoption*. http://www.nber.org/papers/w29842.ack

Butt, M. H., & Singh, J. G. (2023). Factors affecting electric vehicle acceptance, energy demand and CO2 emissions in Pakistan. *Green Energy and Intelligent Transportation*, *2*(3), 100081. https://doi.org/10.1016/j.geits.2023.100081

Campi, V. (2020). Implementation of a System to Find Suitable Charging Stations for Electric Cars (Vol. 101, Issue 1).

Candra, C. S. (2022). Evaluation of Barriers to Electric Vehicle Adoption in Indonesia through Grey Ordinal Priority Approach. *International Journal of Grey Systems*, *2*(1), 38–56. https://doi.org/10.52812/ijgs.46

Cao, J., Chen, X., Qiu, R., & Hou, S. (2021). Electric vehicle industry sustainable development with a stakeholder engagement system. *Technology in Society*, *67*, 101771. https://doi.org/10.1016/j.techsoc.2021.101771

Caperello, N. D., & Kurani, K. S. (2012). Households' Stories of Their Encounters With a Plug-In Hybrid Electric Vehicle. *Environment and Behavior*, *44*(4), 493–508. https://doi.org/10.1177/0013916511402057

Carter, N., Bryant-Lukosius, D., Dicenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, *41*(5), 545–547. https://doi.org/10.1188/14.ONF.545-547

Castillo, Singh, V., Singh, V., & Liébana-Cabanillas, F. (2023). Factors affecting adoption intention of electric vehicle: a cross-cultural study. In *Environment, Development and Sustainability* (Issue 0123456789). Springer Netherlands. https://doi.org/10.1007/s10668-023-03865-y

Chidambaram, K., Ashok, B., Vignesh, R., Deepak, C., Ramesh, R., Narendhra, T. M. V., Muhammad Usman, K., & Kavitha, C. (2023). Critical analysis on the implementation barriers and consumer perception toward future electric mobility. *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering*, *237*(4), 622–654. https://doi.org/10.1177/09544070221080349

Chien, Y. S., Liang, J. K., & Lu, C. C. (2023). Investigating Factors that Influence the Intention to Use Electric Scooter Sharing in a Market with Multiple Service Providers: Combined UTAUT2 and Brand Attitude. *Transportation Research Record*. https://doi.org/10.1177/03611981231185142

Collett, K. A., Hirmer, S. A., Dalkmann, H., Crozier, C., Mulugetta, Y., & McCulloch, M. D. (2021). Can electric vehicles be good for Sub-Saharan Africa? *Energy Strategy Reviews*, *38*(July), 100722. https://doi.org/10.1016/j.esr.2021.100722

Cornell, R. (2017). The Environmental Benefits of Electric Vehicles as a Function of Renewable Energy. 2–185. http://nrs.harvard.edu/urn-3:HUL.InstRepos:33826493

Creswell, J. W. (2009). Research Design Qualitative, Quantitative, and Mixed-Methods Approach. In *Sage Publications, Inc.* (Vol. 4, Issue 11). https://doi.org/10.1128/microbe.4.485.1

Creswell, J. W. (2013). Qualitative Inquiry and Research Design: Choosing Amnong Five Approaches (Third Edit). Sage Publications.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, *13*(3), 319–339. https://doi.org/10.2307/249008

Degirmenci, K., & Breitner, M. H. (2018). Consumer purchase intentions for electric vehicles: Is green more important than price and range? – Authors' reply. *Transportation Research Part D: Transport and Environment*, *65*, 846–848. https://doi.org/10.1016/j.trd.2017.07.024

Deka, C., Dutta, M. K., Yazdanpanah, M., & Komendantova, N. (2023). Can gain motivation induce Indians to adopt electric vehicles? Application of an extended theory of Planned Behavior to map EV adoption intention. *Energy Policy*, *182*(July), 113724. https://doi.org/10.1016/j.enpol.2023.113724

Delbeke, J., Runge-Metzger, A., Slingenberg, Y., & Werksman, J. (2019). The paris agreement. *Towards a Climate-Neutral Europe: Curbing the Trend*, 24–45. https://doi.org/10.4324/9789276082569-2

Dhar, S., Pathak, M., & Shukla, P. R. (2017). Electric vehicles and India's low carbon passenger transport: a long-term co-benefits assessment. *Journal of Cleaner Production*, *146*, 139–148. https://doi.org/10.1016/j.jclepro.2016.05.111

Dioha, M. O., Lukuyu, J., Virgüez, E., & Caldeira, K. (2022). Guiding the deployment of electric vehicles in the developing world. *Environmental Research Letters*, *17*(7). https://doi.org/10.1088/1748-9326/ac765b

Du, H., Liu, D., Sovacool, B. K., Wang, Y., Ma, S., & Li, R. Y. M. (2018). Who buys New Energy Vehicles in China? Assessing social-psychological predictors of purchasing awareness, intention, and policy. *Transportation Research Part F: Traffic Psychology and Behaviour*, *58*, 56–69. https://doi.org/10.1016/j.trf.2018.05.008

Dua, R., Hardman, S., Bhatt, Y., & Suneja, D. (2021). Enablers and disablers to plug-in electric vehicle adoption in India: Insights from a survey of experts. *Energy Reports*, *7*, 3171–3188. https://doi.org/10.1016/j.egyr.2021.05.025

Dütschke, E., & Peters, A. (2016). Why Are Individuals Likely To Change To Sustainable Modes of Transport Like Carsharing and Electric Vehicles ? An Empirical Analysis. *4th European Conference on Behaviour and Energy Efficiency (Behave 2016), September*, 8–9.

Eden Teshome. (2022). *Will Electric Vehicles Arrive Sooner? 106*. https://ethiopianbusinessreview.net/will-electric-vehicles-arrive-sooner/

Egnér, F., & Trosvik, L. (2018). Electric vehicle adoption in Sweden and the impact of local policy instruments. *Energy Policy*, *121*, 584–596. https://doi.org/10.1016/j.enpol.2018.06.040

Endale, A. (2023, May 6). EV assembly nears completion, costs nearly 1 billion birr. *The Reporter*. https://www.thereporterethiopia.com/33753/#:~:text=However%2C EV importers%2C assemblers and,mobility%2C are among the bottlenecks.

Eneizan, B. (2019). The adoption of electrics vehicles in Jordan based on theory of planned behavior. *American Journal of Economics and Business Management*, *2*(2), 1–14. https://doi.org/10.31150/ajebm.vol2.iss2.64

EPA. (2011). Ethiopia ' s Climate- Resilient Green Economy Strategy Agriculture. *Federal Democratic Republic of Ethiopia*, 1–14. http://www.uncsd2012.org/content/documents/287CRGE Ethiopia Green Economy_Brochure.pdf

Eticha, T. C. (2023). Evaluation of Electric Vehicle-Dependent Strategy in Addis Ababa , Ethiopia Transport System. 2023.

Faizah Mashahadi, R. M. & J. S. (2023). Development in Electric Vehicle Intention and Adoption: Integrating the Extended Unified Theory of Acceptance and Use of Technology (UTAUT) and Religiosity. *Information Management and Business Review*, *15*(3), 173–182. https://www.researchgate.net/publication/374907933_Development_in_Electric_Vehicle_Intention_and_Adoption_Integrating_the_Extended_Unified_Theory_of_Acceptance_and_Use_of_Technology_UTAUT_and_Religiosity/link/6535160b1d6e8a707044f6f4/download

Faizal, M., Feng, S. Y., Zureel, M. F., Sinidol, B. E., Wong, D., & Jian, G. K. (2019). A review on challenges and opportunities of electric vehicles (EVs). *Journal of Mechanical Engineering Research and Developments*, *42*(4), 130–137. https://doi.org/10.26480/jmerd.04.2019.130.137

Fetene. (2016). Theoretical and Experimental Analysis Consumer Behavior towards Scheduling and Pricing of Electric Cars Recharging : Theoretical and Experimental Analysis PhD Dissertation.

Gebrehiwot, M., & Bossche, A. Van Den. (2014). Electric Vehicle Possibilities using Low Power and Light Weight Range Extenders. *European Electric Vehicle Congress*, *3*, 1–12.

Geng, L. (2021). The Adoption of Electric VehiclesChallenges and Issues for a Future Research Agenda. 23(1), 17–22. https://doi.org/10.9790/487X-2301061722

Globisch, J., Dütschke, E., & Wietschel, M. (2018). Adoption of electric vehicles in commercial fleets: Why do car pool managers campaign for BEV procurement? *Transportation Research Part D: Transport and Environment*, *64*(November 2017), 122–133. https://doi.org/10.1016/j.trd.2017.10.010

Greschak, T., Kreider, M., & Legault, N. (2022). *Consumer Adoption of Electric Vehicles an Evaluation of local Programs in the United States* (Issue April) [University of Michigan]. Consumer Adoption of Electric Vehicles - UMICH

Growth, G. G. (2022). A Review of GGGI Members ' E-Mobility Policy Measures. 26.

Gyimesi, K., & Viswanathan, R. (2011). The shift to electric vehicles; Putting consumers in the driver's seat. In *IBM Institute for business value*. http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=XB&infotype=PM&appname=GBSE_GB_TI_USEN&htmlfid=GBE03454USEN&attachment=GBE03454USEN.PDF

Haghani, M., Sprei, F., Kazemzadeh, K., & Shahhoseini, Z. (2023). Trends in electric vehicles research. *Transportation Research Part D*, *123*(July), 103881. https://doi.org/10.1016/j.trd.2023.103881

Hannah, R. (2020). Sector by sector: where do global greenhouse gas emissions come from? *Our World in Data*, 1–9.

Hansson, P. (2022). *E-vehicles exempted from tax in Ethiopia – IGE fellow wrote proposal*. Environment for Development. https://www.gu.se/en/news/e-vehicles-exempted-from-tax-in-ethiopia-ige-fellow-wrote-proposal

Hardman, S., & Tal, G. (2021). Understanding discontinuance among California's electric vehicle owners. *Nature Energy*, *6*(5), 538–545. https://doi.org/10.1038/s41560-021-00814-9

Haustein, S., & Jensen, A. F. (2018). Factors of electric vehicle adoption: A comparison of conventional and electric car users based on an extended theory of planned behavior. *International Journal of Sustainable Transportation*, *12*(7), 484–496. https://doi.org/10.1080/15568318.2017.1398790

Hazel Kaya, P. (2015). Joseph a. Schumpeter's Perspective on Innovation. *International Journal of Economics, Commerce and Management United Kingdom*, *III*(8), 25–37. http://ijecm.co.uk/

He, S. Y., Sun, K. K., & Luo, S. (2022). Factors affecting electric vehicle adoption intention: The impact of objective, perceived, and prospective charger accessibility. *Journal of Transport and Land Use*, *15*(1), 779–801. https://doi.org/10.5198/jtlu.2022.2113

Helwig, N. E., Hong, S., & Hsiao-wecksler, E. T. (2013). *Overcoming Barriers to Electric-Vehicle Deployment*. The National Academies Press.

Hodge, C., Neill, B. O., & Coney, K. (2020). Effectiveness of Electric Vehicle Policies and Implications for Pakistan. *Https://Www.Nrel.Gov/Docs/Fy20Osti/76875.Pdf*, *July*.

Hossain, M. S., Kumar, L., Islam, M. M., & Selvaraj, J. (2022). A Comprehensive Review on the Integration of Electric Vehicles for Sustainable Development. *Journal of Advanced Transportation*, *2022*. https://doi.org/10.1155/2022/3868388

Hwang, I., & Lee, J. (2021). Technology Risk Model Development and Application to Green Vehicle Purchases. *American Journal of Industrial and Business Management*, *11*(01), 32–41. https://doi.org/10.4236/ajibm.2021.111003

IEA. (2020). Global EV Outlook 2020: Technology Report. *Global EV Outlook 2020: Technology Report*, *June*, 39–85.

IEA. (2022). Global EV Outlook 2022 - Securing supplies for an electric future. *Global EV Outlook 2022*, 221. https://www.iea.org/reports/global-ev-outlook-2022%0Ahttps://iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf

IEA. (2023). Global EV Outlook 2023.

Ivanova, D., Yeralina, E., & Shatila, K. (2023). Strategies for sustainable transportation in road way system in urban areas. *E3S Web of Conferences*, *389*. https://doi.org/10.1051/e3sconf/202338905001

Jamaludin, N. F., Hashim, H., Ho, W. S., Lim, L. K., Binti Sulaiman, N. S., Demoral, A., Tirta, A., Kresnawan, M. R., Safrina, R., & Rosalia, S. A. (2021). Electric Vehicle Adoption in ASEAN; Prospect and Challenges. *Chemical Engineering Transactions*, *89*(October), 625–630. https://doi.org/10.3303/CET2189105

Jin Lim, Y., Perumal, S., & Ahmad, N. (2019). Social Cognitive Theory in Understanding Green Car Purchase Intention. *International Journal of Economics and Management Studies*, *6*(4), 16–24. https://doi.org/10.14445/23939125/ijems-v6i4p104

Johansson, L., Al-Attar, M., Adi, D., Johansson, L., Al-Attar, M., Adi Tutor, D., & Wilde Björling, M. (2022). An Exploration of the Factors Influencing EV Adoption in Sweden Title: An Exploration of the Factors Influencing EV Adoption in Sweden: How Consumer Perceptions are Impacted upon Adoption of EV. May.

Joshi, W. (2022). Fundamentals of Electric Vehicles. *National Renewable Energy Laboratory*, *November*.

Joshi, Y., & Rahman, Z. (2015). Factors Affecting Green Purchase Behaviour and Future Research Directions. In *International Strategic Management Review* (Vol. 3, Issues 1–2). Holy Spirit University of Kaslik. https://doi.org/10.1016/j.ism.2015.04.001

Kabadayı, E. T., Dursun, İ., Alan, A. K., & Tuğer, A. T. (2015). Green Purchase Intention of Young Turkish Consumers: Effects of Consumer's Guilt, Self-monitoring and Perceived Consumer Effectiveness. *Procedia - Social and Behavioral Sciences*, *207*, 165–174. https://doi.org/10.1016/j.sbspro.2015.10.167

Kah, M. (2018). Electric Vehicles and their Impact on Oil Demand: Why Forecasts Differ. *Columbia Center on Global Energy Policy*, *July*, 1–14. https://energypolicy.columbia.edu/sites/default/files/pictures/CGEP_Electric Vehicles and Their Impact on Oil Demand-Why Forecasts Differ.pdf

Karimi, S., Liobikienė, G., & Alitavakoli, F. (2022). The Effect of Religiosity on Pro-environmental Behavior Based on the Theory of Planned Behavior: A Cross-Sectional Study Among Iranian Rural Female Facilitators. *Frontiers in Psychology*, *13*(February). https://doi.org/10.3389/fpsyg.2022.745019

Kennedy, D., & Philbin, S. P. (2019). Techno-economic analysis of the adoption of electric vehicles. *Frontiers of Engineering Management*, *6*(4), 538–550. https://doi.org/10.1007/s42524-019-0048-x

Khalili, S., Rantanen, E., Bogdanov, D., & Breyer, C. (2019). Global transportation demand development with impacts on the energy demand and greenhouse gas emissions in a climate-constrained world. *Energies*, *12*(20), 2019. https://doi.org/10.3390/en12203870

Khazaei, H., & Tareq, M. A. (2021). Moderating effects of personal innovativeness and driving experience on factors influencing adoption of BEVs in Malaysia: An integrated SEM–BSEM approach. *Heliyon*, *7*(9), e08072. https://doi.org/10.1016/j.heliyon.2021.e08072

Kim, S., Lee, J., & Lee, C. (2017). Does driving range of electric vehicles influence electric vehicle adoption? *Sustainability (Switzerland)*, *9*(10). https://doi.org/10.3390/su9101783

Krishna, G. (2021). Understanding and identifying barriers to electric vehicle adoption through thematic analysis. *Transportation Research Interdisciplinary Perspectives*, *10*(January), 100364. https://doi.org/10.1016/j.trip.2021.100364

Kristos. (2022, December). Analysis: Skepticism, higher prices drag government's effort to encourage use of EVs in Ethiopia, as a new directive set to tackle infrastructure issues. *Addis Standrard*. https://addisstandard.com/analysis-skepticism-higher-prices-drag-governments-effort-to-encourage-use-of-evs-in-ethiopia-as-a-new-directive-set-to-tackle-infrastructure-issues/

Kubański, M. (2020). Prospects for the Use of Electric Vehicles in Public Transport on the Example of the City of Czechowice-Dziedzice. *Transportation Research Procedia*, *44*(2019), 110–114. https://doi.org/10.1016/j.trpro.2020.02.016

Kuhudzai. (2022). *All EVs in Ethiopia Now Exempted From VAT, Surtax, and Excise Tax*. Clean Tech in CA. https://cleantechnica.com/2022/10/10/all-evs-in-ethiopia-now-exempted-from-vat-surtax-15-for-skd-cbu-respectively/

Kumar, E. (2011). *Green Mobility*. *May*.

Le, T. T., Jabeen, F., & Santoro, G. (2023). What drives purchase behavior for electric vehicles among millennials in an emerging market. *Journal of Cleaner Production*, *428*(October), 139213. https://doi.org/10.1016/j.jclepro.2023.139213

Lee, H., & Clark, A. (2018). Charging the Future: Challenges and Opportunities for Electric Vehicle Adoption. *SSRN Electronic Journal*, *January 2018*. https://doi.org/10.2139/ssrn.3251551

Leeuw, E. D. De, Hox, J. J., Dillman, D. A., Harkness, J. A., & Harkness, J. A. (2023). *International Handbook of Survey Methodology*. https://www.routledgehandbooks.com/doi/10.4324/9780203843123.ch4%0D

Lévay, P. Z., Drossinos, Y., & Thiel, C. (2017). The effect of fiscal incentives on market penetration of electric vehicles: A pairwise comparison of total cost of ownership. *Energy Policy*, *105*(March), 524–533. https://doi.org/10.1016/j.enpol.2017.02.054

Lewis, H., Park, H., & Paolini, M. (2012). *Frontier battery development for hybrid vehicles*. *6*(Suppl 1), 1–13.

Li, W., Long, R., Chen, H., Chen, F., Zheng, X., & Yang, M. (2019). Effect of Policy Incentives on the Uptake of Electric Vehicles in China. *Sustainability*, *11*(12), 3323. https://doi.org/10.3390/su11123323

Lim, Y. J., Perumal, S., & Ahmad, N. (2019). *Social Cognitive Theory in Understanding Green Car Purchase Intention*. *April*. https://doi.org/10.14445/23939125/IJEMS-V6I4P104

Ling, Z., Cherry, C. R., & Wen, Y. (2021). Determining the factors that influence electric vehicle adoption: A stated preference survey study in Beijing, China. *Sustainability (Switzerland)*, *13*(21), 1–22. https://doi.org/10.3390/su132111719

Ethiopian Transport Master Plan, (2022).

Lukuyu, J., Shirley, R., & Taneja, J. (2022). The Drivers of Africa's Electric Vehicle Future Might Be Different Than You Think. 1–12.

Macdonald, C. (2012). Understanding Participatory Action Research: a Qualitative Research Methodology Option. 13(2), 34–50.

Magnusson, A. T. (2011). Socio-economic factors influencing the electric vehicle buying process in Iceland Acknowledgment.

Mali, B., Shrestha, A., Chapagain, A., Bishwokarma, R., Kumar, P., & Gonzalez-Longatt, F. (2022). Challenges in the penetration of electric vehicles in developing countries with a focus on Nepal. *Renewable Energy Focus*, *40*(March), 1–12. https://doi.org/10.1016/j.ref.2021.11.003

Manjula. B. C, Shilpa. B. S, & Sundaresh. M. (2022). A Study on Barriers to Adoption of Electric Vehicles. *East Asian Journal of Multidisciplinary Research*, *1*(7), 1303–1316. https://doi.org/10.55927/eajmr.v1i7.802

Mao, Y., Mei, Q., Jing, P., Wang, X., Xue, Y., & Zha, Y. (2023). Uncovering the behavioral determinants behind private car purchase intention during the new normal of COVID-19: An empirical investigation in China. *Mathematical Biosciences and Engineering*, *20*(4), 7316–7348. https://doi.org/10.3934/mbe.2023318

Mastoi, M. S., Zhuang, S., Munir, H. M., Haris, M., Hassan, M., Usman, M., Bukhari, S. S. H., & Ro, J. S. (2022). An in-depth analysis of electric vehicle charging station infrastructure, policy implications, and future trends. *Energy Reports*, *8*, 11504–11529. https://doi.org/10.1016/j.egyr.2022.09.011

McCord, M. (2006). Technology acceptance model. *Handbook of Research on Electronic Surveys and Measurements*, 306–308. https://doi.org/10.4018/978-1-59140-792-8.ch038

McElgunn, J. (2018). Consumer awareness of electric vehicles and global purchasing patterns. In *Creative Matter*. https://creativematter.skidmore.edu/econ_studt_schol/81/

Mei, O. J., Ling, K. C., & Piew, T. H. (2012). The antecedents of green purchase intention among malaysian consumers. *Asian Social Science*, *8*(13), 248–263. https://doi.org/10.5539/ass.v8n13p248

Mei, Y., Li, B., Wang, H., Wang, X., & Negnevitsky, M. (2022). Multi-objective optimal scheduling of microgrid with electric vehicles. *Energy Reports*, *8*, 4512–4524. https://doi.org/10.1016/j.egyr.2022.03.131

Mengesha, S. (2022). Forex crunch pushes Marathon Motors to discontinue electric car assembly. *The Reporter*.

Michael, L. K., K V, S., Hungund, S. S., & Fernandes, M. (2022a). Factors influencing adoption of electric vehicles–A case in India. In *Cogent Engineering* (Vol. 9, Issue 1). https://doi.org/10.1080/23311916.2022.2085375

Michael, L. K., K V, S., Hungund, S. S., & Fernandes, M. (2022b). Factors influencing adoption of electric vehicles–A case in India. *Cogent Engineering*, *9*(1). https://doi.org/10.1080/23311916.2022.2085375

Ministry of Transport. (2020). *Ethiopian Transport Master Plan*. ethiotransport.gov.et/userfiles/media/default/files/summary-report-221109-201100.pdf

Mondal, A. H., Bryan, E., Ringler, C., Mekonnen, D., & Rosegrant, M. (2018). Ethiopian energy status and demand scenarios: Prospects to improve energy efficiency and mitigate GHG emissions. *Energy*, *149*, 161–172. https://doi.org/10.1016/j.energy.2018.02.067

Moons, I., & de Pelsmacker, P. (2012). Emotions as determinants of electric car usage intention. *Journal of Marketing Management*, *28*(3–4), 195–237. https://doi.org/10.1080/0267257X.2012.659007

Morimoto, M. (2015). Which is the first electric vehicle? *Electrical Engineering in Japan (English Translation of Denki Gakkai Ronbunshi)*, *192*(2), 31–38. https://doi.org/10.1002/eej.22550

Morton, C., Anable, J., & Brand, C. (2014). Uncertainty in the Demand for Electric Vehicles: An analysis of its location and governmental response. *Universities' Transport Study Group, January*, 1–12. http://aura.abdn.ac.uk/handle/2164/3259

Muehlegger, D. S. R. E. (2020). *The Economics of Electric Vehicles* (Issue July).

Mulugeta, D., & Munir, S. (2022). Car Dilemma to Go Electric: Missing the Combustion. *Addis Fortune, VOL 23, NO 1161*.

Muna, Y. B., & Kuo, C. C. (2022). Feasibility and Techno-Economic Analysis of Electric Vehicle Charging of PV/Wind/Diesel/Battery Hybrid Energy System with Different Battery Technology. *Energies*, *15*(12). https://doi.org/10.3390/en15124364

Negussie & Demie. (2015). Climate change , Impact , vulnerability and Adaptation in Ethiopia Review . Climate Change Impact , Vulnerability and Adaptation Strategy in Ethiopia Review. *Journal of Environment and Earth Science*, *5*(21), 45–56.

Nilufar, A. (2021). Analysis of Consumer Perception Regarding the Electric Vehicle Market. Instituto Universitario De Lisbao.

Ninh, T. (2013). Why should transportation companies join Public Private Partnership (PPP) proposed by the public sector to support the implementation process of Freight Electric Vehicles (FEVs) in Copenhagen municipality ? International Business Economics Department. AALBORG UNIVERSITY.

Nosova, M. V, Seredina, V. P., Alekseyev, V. V, Vizgirda, A. S., & Nefedyev, D. I. (2018). Electric cars. Advantages and disadvantages. *Journal of Physics: Conference Series*, 2–6. https://iopscience.iop.org/article/10.1088/1742-6596/1015/5/052029/meta

Olabi, A. G., Abdelkareem, M. A., Wilberforce, T., Alkhalidi, A., Salameh, T., Abo-Khalil, A. G., Hassan, M. M., & Sayed, E. T. (2022). Battery electric vehicles: Progress, power electronic converters, strength (S), weakness (W), opportunity (O), and threats (T). *International Journal of Thermofluids*, *16*(September), 100212. https://doi.org/10.1016/j.ijft.2022.100212

Özdemir, N., & Barutçu, S. (2022). Comparing Technology Acceptance for Electric Vehicles – A Comparative Study in Turkey and Germany. 898–917.

Pappis, I., Sahlberg, A., Walle, T., Broad, O., Eludoyin, E., Howells, M., & Usher, W. (2021). Influence of Electrification Pathways in the Electricity Sector of Ethiopia. *Energies*, *14*(1209), 1–36.

Parajuly, K., Ternald, D., & Kuehr, R. (2020). the Future of Electric Vehicles and Material Resources. In *UNU/UNITAR - SCYCLE (Bonn) & UNEP-IETC (Osaka)*. www.unu.edu

Patil, P. (2022). An Empirical Study of the Factors Influencing the Adoption of Electric Vehicles. *Contemporary Issues in Behavioural and Social Science*, *4*, 1–13.

Patton, M. Q. (2002). *Qualitative Research and Evaluation Methods (3rd ed.)* (Third Edit, Vol. 3, Issue 2). Sage Publications, Inc. https://doi.org/10.1177/1035719X0300300213

Paula, A., & Maia, S. (2022). Climatescope: Electrified Transport Factbook.

Pelyhe, D. (2011). How can Electric Vehicles become the Dominant Design? Daniel Pelyhe.

Pevec, D., Babic, J., Carvalho, A., Ghiassi-Farrokhfal, Y., Ketter, W., & Podobnik, V. (2019). Electric vehicle range anxiety: An obstacle for the personal transportation (r)evolution? *2019 4th International Conference on Smart and Sustainable Technologies, SpliTech 2019*, *i*. https://doi.org/10.23919/SpliTech.2019.8783178

Plananska, J., & Ehrenzeller, B. (2021). *Consumer Adoption of Electric Vehicles*. *5136*, 1–200.

Planning, R., Africa, S., Planning, R., & Africa, S. (2023). reviewed paper The Role of Electric Vehicles in Greening the Environment: Prospects and Challenges Oluwayemi-Oniya Aderibigbe, Trynos Gumbo. September, 777–786.

Preedakorn, K., Butler, D., & Mehnen, J. (2023). Challenges for the Adoption of Electric Vehicles in Thailand: Potential Impacts, Barriers, and Public Policy Recommendations. *Sustainability (Switzerland)*, *15*(12). https://doi.org/10.3390/su15129470

Priessner, A., Sposato, R., & Hampl, N. (2018). Predictors of electric vehicle adoption: An analysis of potential electric vehicle drivers in Austria. *Energy Policy*, *122*(July), 701–714. https://doi.org/10.1016/j.enpol.2018.07.058

Qian, L., & Yin, J. (2017). Linking Chinese cultural values and the adoption of electric vehicles The mediating role of ethical evaluation. August. https://doi.org/10.1016/j.trd.2017.07.029

Quak, H., Nesterova, N., & Van Rooijen, T. (2016). Possibilities and Barriers for Using Electric-powered Vehicles in City Logistics Practice. *Transportation Research Procedia*, *12*(June 2015), 157–169. https://doi.org/10.1016/j.trpro.2016.02.055

Qureshi, H. A. (2018). Theoretical Sampling in Qualitative Research: A Multi-Layered Nested Sampling Scheme. *International Journal of Contemporary Research and Review*, *9*(08), 20218–20222. https://doi.org/10.15520/ijcrr/2018/9/08/576

Raines, G. B. (2009). Electric Vehicles: Technology, Research and Development. Nova Science Publishers, Inc.

Raj, P. (2019). Assessing the Monetary Value of Vehicle-to-Grid considering Battery Degradation : Agent-Based Approach Assessing the Monetary Value of Vehicle-to-Grid considering Battery Degradation : Agent-Based Approach.

Rajper, S. Z., & Albrecht, J. (2020). Prospects of electric vehicles in the developing countries: A literature review. *Sustainability (Switzerland)*, *12*(5). https://doi.org/10.3390/su12051906

Raza, M. Y. (2023). Fuels substitution possibilities, environment and the technological progress in Bangladesh's transport sector. *Heliyon*, *9*(2), e13300. https://doi.org/10.1016/j.heliyon.2023.e13300

Reshetko, N., Vakulenko, S., Kakhrimanova, D., Belozerov, V., & Gašparík, J. (2020). Analysis of the electric vehicle market and the company's competitive development strategy on it (on the example of "Faraday Future"). *MATEC Web of Conferences*, *329*, 01016. https://doi.org/10.1051/matecconf/202032901016

Rezvani, Z., Jansson, J., & Bodin, J. (2015). Advances in consumer electric vehicle adoption research: A review and research agenda. *Transportation Research Part D: Transport and Environment*, *34*, 122–136. https://doi.org/10.1016/j.trd.2014.10.010

Robinson, D. (2018). Electric vehicles and electricity. *The Oxford Institute for Energy Studies*, *June*, 1–19.

Robinson, J., & Erickson, L. E. (2016). Infrastructure for Charging Electric Vehicles. *Solar Powered Charging Infrastructure for Electric Vehicles*, 35–51. https://doi.org/10.1201/9781315370002-5

Rogers. (2006). Detailed review of Roger's Diffusion of innovations theory and educational technology. *The Turkish Online Journal of Educational Technology*, *5*(2), 14–23. https://files.eric.ed.gov/fulltext/ED501453.pdf

Rogers, E. M. (1983). *Difussion of Innovations*. 105–117. https://doi.org/10.4324/9781315263434-16

Rovňák, M., Kalistová, A., Štofejová, L., Benko, M., & Salabura, D. (2022). Management of Sustainable Mobility and the Perception of the Concept of Electric Vehicle Deployment. *Polish Journal of Management Studies*, *25*(2), 266–281. https://doi.org/10.17512/pjms.2022.25.2.17

Sadeghian, O., Oshnoei, A., Mohammadi-ivatloo, B., Vahidinasab, V., & Anvari-Moghaddam, A. (2022). A comprehensive review on electric vehicles smart charging: Solutions, strategies, technologies, and challenges. *Journal of Energy Storage*, *54*, 1–44. https://doi.org/10.1016/j.est.2022.105241

Salari, N. (2022). Electric vehicles adoption behaviour: Synthesising the technology readiness index with environmentalism values and instrumental attributes. *Transportation Research Part A: Policy and Practice*, *164*(July), 60–81. https://doi.org/10.1016/j.tra.2022.07.009

Sato, T., & Saijo, M. (2016). How can we facilitate the diffusion of electric vehicles in Japan' Consumer characteristics and perceived innovation attributes. *IC3K 2016 - Proceedings of the 8th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management*, *3*(Ic3k), 70–81. https://doi.org/10.5220/0006068200700081

Seign, R., & Bogenberger, K. (2012). Prescriptions for the Successful Diffusion of Carsharing with Electric Vehicles. *Conference on Future Automotive Technology - Focus Electromobility*, 18–19.

Setiawan, A. D., Zahari, T. N., Purba, F. J., Moeis, A. O., & Hidayatno, A. (2022). Investigating policies on increasing the adoption of electric vehicles in Indonesia. *Journal of Cleaner Production*, *380*(P2), 135097. https://doi.org/10.1016/j.jclepro.2022.135097

Seuwou, P., Chrysoulas, C., Banissi, E., & Ubakanma, G. (2020). Measuring Consumer Behavioural Intention to Accept Technology: Towards Autonomous Vehicles Technology Acceptance Model (AVTAM). *Advances in Intelligent Systems and Computing*, *1159 AISC*, 507–516. https://doi.org/10.1007/978-3-030-45688-7_51

Sierzchula, W., Bakker, S., Maat, K., & Van Wee, B. (2012). The competitive environment of electric vehicles: An analysis of prototype and production models. *Environmental Innovation and Societal Transitions*, *2*, 49–65. https://doi.org/10.1016/j.eist.2012.01.004

Soltani, A., Allan, A., & Nguyen, H. A. (2019). Developing a behavioural model for modal shift in commuting. *Lecture Notes in Geoinformation and Cartography*, *July*, 347–371. https://doi.org/10.1007/978-3-030-19424-6_19

Steven Wicks. (2013). *Automotive IQ Report Cost & Sustainability Concerns in Automotive Battery Pack Creation*. https://www.automotive-iq.com/industry-reports/reports/report-cost-sustainability-concerns-in-automotive-battery-pack-creation?ty-ur

Stockkamp, C., Schäfer, J., Millemann, J. A., & Heidenreich, S. (2021). Identifying factors associated with consumers' adoption of e-mobility—a systematic literature review. *Sustainability (Switzerland)*, *13*(19). https://doi.org/10.3390/su131910975

Sundarakani, B., Rajamani, H. S., & Madmoune, A. (2023). Sustainability study of electric vehicles performance in the UAE: moderated by blockchain. *Benchmarking*. https://doi.org/10.1108/BIJ-10-2021-0624

Taghizad-Tavana, K., Alizadeh, A., Ghanbari-Ghalehjoughi, M., & Nojavan, S. (2023). A Comprehensive Review of Electric Vehicles in Energy Systems: Integration with Renewable Energy Sources, Charging Levels, Different Types, and Standards. *Energies*, *16*(2). https://doi.org/10.3390/en16020630

Tiwari, V., Aditjandra, P., & Dissanayake, D. (2020). Public Attitudes towards Electric Vehicle adoption using Structural Equation Modelling. *Transportation Research Procedia*, *48*(2018), 1615–1634. https://doi.org/10.1016/j.trpro.2020.08.203

Toolib, S. N., Hanafi, W. N. W., Daud, S., & Afsarizal, H. A. (2023). Factors Influencing Electric Vehicle Adoption: A Conceptual Paper. *Proceedings of the International Symposium & Exhibition on Business and Accounting 2022 (ISEBA 2022), 28 September 2022, Malaysia*, *1*, 849–857. https://doi.org/10.15405/epfe.23081.77

Tran, M. K., Sherman, S., Samadani, E., Vrolyk, R., Wong, D., Lowery, M., & Fowler, M. (2020). Environmental and Economic Benefits of a Battery Electric Vehicle Powertrain with a Zinc–Air Range Extender in the Transition to Electric Vehicles. *Vehicles*, *2*(3), 398–412. https://doi.org/10.3390/vehicles2030021

Tschiesner A. (2020). The road ahead for e-mobility. In *McKinsey & Company*. https://doi.org/10.4324/9780429321214-18

Tu, J. C., & Yang, C. (2019). Key factors influencing consumers' purchase of electric vehicles. *Sustainability (Switzerland)*, *11*(14). https://doi.org/10.3390/su11143863

Uddin, S. M. F., & Khan, M. N. (2016). Green Purchasing Behaviour of Young Indian Consumers: An Exploratory Study. *Global Business Review*, *17*(6), 1469–1479. https://doi.org/10.1177/0972150916660440

UK Department for Transport. (2021). Transport and Environment Statistics 2021 Annual Report. *Transport and Environment Statistics*, *May*.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/984685/transport-and-environment-statistics-2021.pdf

Varalakshmi, Bajpai, P. A., Reddy, P. K., & K, D. L. (2022). Prospects of Electric Vehicles in India. *International Journal for Research in Applied Science and Engineering Technology*, *10*(8), 1414–1423. https://doi.org/10.22214/ijraset.2022.46430

Vegh, J., Jenkins, J., & Claes, M.-T. (2022). *The Future of Mobility*. *April*, 93–120. https://doi.org/10.4018/978-1-6684-3749-0.ch006

Venkatesh, V., Thong, J. y. ., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology by Viswanath Venkatesh, James Y.L. Thong, Xin Xu :: SSRN. *MIS Quarterly*, *36*(1), 157–178. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2002388

Verma, M., Verma, A., & Khan, M. (2020). Factors Influencing the Adoption of Electric Vehicles in Bengaluru. *Transportation in Developing Economies*, *6*(2), 1–10. https://doi.org/10.1007/s40890-020-0100-x

Veza, I., Abas, M. A., Djamari, D. W., Tamaldin, N., Endrasari, F., Budiman, B. A., Idris, M., Opia, A. C., Juangsa, F. B., & Aziz, M. (2022). Electric Vehicles in Malaysia and Indonesia: Opportunities and Challenges. *Energies*, *15*(7), 1–24. https://doi.org/10.3390/en15072564

Villareal, A. (2011). The social construction of the market for electric cars in France: Politics coming to the aid of economics. *International Journal of Automotive Technology and Management*, *11*(4), 326–339. https://doi.org/10.1504/IJATM.2011.043165

Viola, F. (2021). Electric vehicles and psychology. *Sustainability (Switzerland)*, *13*(2), 1–26. https://doi.org/10.3390/su13020719

Viswanath, Venkatesh, J. Y. L. T. and X. X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. 157–178.

Wang, J., Zhou, W., Su, C., & Kong, L. (2019). *Electric Vehicles Factors Influencing the Purchase Willingness towards Electric Vehicles in China*. *June*, 1–60. https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1331425&dswid=-1322

Wang, S., Fan, J., Zhao, D., Yang, S., & Fu, Y. (2016). Predicting consumers' intention to adopt hybrid electric vehicles: using an extended version of the theory of planned behavior model. *Transportation*, *43*(1), 123–143. https://doi.org/10.1007/s11116-014-9567-9

Wattana, B., & Wattana, S. (2022). Implications of electric vehicle promotion policy on the road transport and electricity sectors for Thailand. *Energy Strategy Reviews*, *42*(October 2021), 100901. https://doi.org/10.1016/j.esr.2022.100901

White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT consumer behaviors to be more sustainable: A literature review and guiding framework. *Journal of Marketing*, *83*(3), 22–49. https://doi.org/10.1177/0022242919825649

Wikström, M. (2015). Doctoral thesis, Electric vehicles in action.

Xinhua. (2023). Ethiopia embarks on e-mobility transition amid rising fuel prices, quest for green development. *Xinhua*. https://english.news.cn/africa/20220730/2f84ef1df8a6470e803bd93d472010fd/c.html

Yang, Y., & Tan, Z. (2019). Investigating the Influence of Consumer Behavior and Governmental Policy on the Diffusion of Electric Vehicles in Beijing, China. *Sustainability (Switzerland)*, *11*(24). https://doi.org/10.3390/su11246967

Yanying, L. (2016). Infrastructure to Facilitate Usage of Electric Vehicles and its Impact. *Transportation Research Procedia*, *14*, 2537–2543. https://doi.org/10.1016/j.trpro.2016.05.337

Yeğin, T., & Ikram, M. (2022). Analysis of Consumers' Electric Vehicle Purchase Intentions: An Expansion of the Theory of Planned Behavior. *Sustainability (Switzerland)*, *14*(19). https://doi.org/10.3390/su141912091

Yong, T., & Park, C. (2017). A qualitative comparative analysis on factors affecting the deployment of electric vehicles. *Energy Procedia*, *128*, 497–503. https://doi.org/10.1016/j.egypro.2017.09.066

Yousif, R. O., & Alsamydai, M. J. (2019). Perspective of technological acceptance model toward electric vehicles. *International Journal of Mechanical and Production Engineering Research and Development*, *9*(5), 873–884. https://doi.org/10.24247/ijmperdoct201977

Zhan, Q. (2022). What Predicts Intention to Purchase New Energy Vehicles Between Males and Females in China: Using Extended Theory of Planned Behavior. 79–91. https://doi.org/10.2991/978-2-494069-31-2_11

Zhang, B. S., Ali, K., & Kanesan, T. (2022). A model of extended technology acceptance for behavioral intention toward EVs with gender as a moderator. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.1080414

Ziefle, M., Beul-Leusmann, S., Kasugai, K., & Schwalm, M. (2014). Public perception and acceptance of electric vehicles: Exploring users' perceived benefits and drawbacks. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *8519 LNCS*(PART 3), 628–639. https://doi.org/10.1007/978-3-319-07635-5_60