UNDERSTANDING THE ATTITUDES AND PERCEPTIONS OF STUDENTS ON THE ADOPTION OF ELECTRIC VEHICLES (EVS): A CASE STUDY OF STUDENTS AT TRENT UNIVERSITY

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ABSTRACT

The widespread adoption of electric vehicles (EVs) is crucial for reducing transportation-related emissions and achieving sustainability goals. However, a significant research gap exists regarding specific consumer groups, such as university students, and their attitudes toward EV adoption, as they represent a demographic influential in shaping future adoption patterns. This research uses a quantitative approach to explore Trent University students' attitudes and perceptions toward EV adoption.

A survey of 154 students examined the factors influencing their willingness to adopt EVs. Various quantitative data analyses, including cross-tabulation tables and chi-square tests, were employed to investigate the relationships between socio-demographic, social, environmental, and economic factors and students' willingness to adopt EVs. The findings indicate that while socio-demographic factors do not significantly influence willingness to adopt EVs, factors such as first-hand experience, knowledge about EVs, social influence, upfront costs, charging infrastructure, and government incentives significantly impact students' willingness to adopt EVs.

The study revealed that although students recognize the benefits of electric vehicles (EVs), such as reduced emissions, lower operating costs, enhanced energy efficiency and health advantages, key barriers to student EV adoption include high upfront costs, limited charging infrastructure, concerns about driving range and charging time, and a need for more knowledge and awareness. The findings of this study fill a significant research gap and add to the existing literature on EV adoption. The insights generated can inform targeted strategies by policymakers, educational institutions, and EV manufacturers to promote widespread EV adoption among students.

Keywords: Electric Vehicles, Internal Combustion Engine Vehicles, Zero-emission vehicles, sustainable transportation, attitudes, perceptions, University students, consumer behaviour.

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Chapter 1: Introduction

1.1 Background

Climate change presents one of the most urgent global challenges we face today. Climate change is the long-term alteration of global weather patterns due to human activities (Tordoni et al., 2022). The phenomenon is characterized by the increasing concentration of greenhouse gases (GHGs), primarily carbon dioxide (CO_2), in the atmosphere. This increase in GHGs has been linked to rising temperatures, resulting in severe environmental, social, and economic consequences, including rising sea levels, extreme weather conditions, ecosystem disruptions and threats to human health (Nwaka, 2015; Puas, 2021).

Road transport plays a significant role as one of the primary sources of greenhouse gas (GHG) emissions (Dietrich et al., 2023). Approximately 25% of global CO_2 emissions are estimated to emanate from transportation activities (Wang et al., 2022; Shao & Zheng, 2023). As the world population continues to grow, the demand for transportation will continue to increase, triggering higher emissions from fossil fuel-powered vehicles. In Canada, the transportation sector, consisting of road, rail, and air carriage, is responsible for 22% of the country's total emissions, ranking as the second-largest contributor to greenhouse gas (GHG) emissions. This amounts to approximately 150 megatonnes of carbon dioxide released annually (Liu et al., 2021). Specifically, road transport alone contributes a significant portion of emissions within the transportation sector, accounting for 84% of the sector's total emissions (Shamsi et al., 2022).

Recent studies have pointed out that the emissions of CO_2 from vehicles contribute to climate change and have detrimental effects on air quality, resulting in air pollution and posing substantial risks to human health and the environment (Kawamoto et al., 2019; Sirithian et al., 2022). Carbon dioxide released into the atmosphere interacts with other pollutants, such as nitrogen oxides and volatile organic compounds, exacerbating respiratory problems, worsening existing respiratory conditions, and increasing the risk of cardiovascular diseases (Sirithian et al., 2022). The adverse effects of vehicle emissions on air quality and human health underscore the importance of adopting sustainable and low-carbon alternatives in the transportation sector to mitigate climate change and improve air quality (Fussey & Dalby, 2022; Verma, 2023). Therefore, implementing such alternatives is crucial for reducing the adverse impacts of transportation emissions.

Given the urgency to address these environmental challenges, adopting electric vehicles (EVs) has gained significant attention as a promising solution to global CO_2 emissions. EVs produce zero tailpipe emissions during operation, effectively reducing greenhouse gas emissions and mitigating CO_2 released into the atmosphere (Dulău, 2023; Holland et al., 2022).

Building upon the need for sustainable transportation solutions, the advantages of EVs become increasingly apparent. EVs are widely recognized as a more sustainable alternative to internal combustion vehicles (ICVs) due to their zero tailpipe emissions, contributing to reduced air pollution and lower energy consumption (IEA, 2020; Ma et al., 2012). Moreover, EV ownership offers various benefits, including the convenience of home charging and cost savings resulting from lower maintenance expenses than ICVs (Shahan, 2015). In addition, adopting EVs is crucial in improving air quality, reducing dependence on fossil fuels, and aligning with ongoing efforts to decarbonize the transportation sector and achieve sustainability goals (Wang, 2023).

Transitioning to low-carbon transportation systems is of paramount importance, as highlighted by international bodies such as the United Nations Framework Convention on Climate Change (UNFCC), the Intergovernmental Panel on Climate Change (IPCC), and the International

Energy Agency (IEA) (Camarasa et al., 2022; Paulo et al., 2020). In line with global efforts, the Paris Agreement, signed by 195 countries, established goals to limit global warming to below 2 degrees Celsius above pre-industrial levels and strive for a more ambitious target of 1.5 degrees Celsius (Zheng et al., 2022; Zisarou, 2022). A shift towards sustainable transportation is necessary to achieve these goals, with electric vehicles playing a pivotal role in decarbonizing the road transport sector (Axsen et al., 2020; Bi et al., 2023). In Canada, reducing emissions is a crucial objective under the Paris Agreement, and electric vehicles can significantly contribute to meeting this target. The country has developed a comprehensive 2030 Emissions Reduction Plan to lower emissions by 40 percent below the 2005 levels, estimated at 747 megatonnes of CO2 equivalent, by 2030 and net-zero emissions by 2050 (Transport Canada, 2021).

In recent years, Canada has witnessed a surge in zero-emission vehicle sales, with 503,177 sold between the first quarter of 2017 and the third quarter of 2023. Quebec emerged as the leader with 210,167 sales, followed closely by Ontario with 133,868 and British Columbia with 126,325 (Statistics Canada, 2023). This increase aligns with Canada's push for reduced emissions, evidenced by implementing a zero-emission vehicle infrastructure program to achieve 100% zero-emission vehicle sales by 2035 (Transport Canada, 2021). The Government's recent announcement of the Electric Vehicle Availability Standard reflects a proactive approach to support the national target of achieving 100% zero-emission vehicle sales by 2035. The government's commitment includes financial incentives, subsidies, and infrastructure provisions to encourage electric vehicle adoption. However, the success of these initiatives relies heavily on raising awareness, knowledge, and public confidence in electric vehicle usage and leveraging Canada's robust automotive industry and sustainable electricity production positions the country as a potential global leader in electric vehicle adoption (Mordue & Sweeney, 2019).

Despite government initiatives promoting EV adoption, consumer perceptions and preferences play a significant role in widespread adoption. Overcoming barriers such as charging infrastructure concerns, range anxiety, limited consumer knowledge and the dominance of gasoline-powered vehicles requires concerted efforts to increase consumer acceptance and achieve sustainable transportation goals (Rezvani et al., 2015; Sovacool et al., 2019). By connecting government initiatives, consumer perceptions, and EV adoption barriers, a comprehensive strategy can be developed to accelerate the transition to a more sustainable transportation system in Canada. This entails addressing the concerns highlighted by the Honourable Steven Guilbeault, Minister of Environment and Climate Change, in the announcement of the Electric Vehicle Availability Standard, ensuring that Canadians not only have access to clean, zero-emissions vehicles but are also equipped with knowledge and confidence to embrace this transformative shift in the automotive industry.

The transition towards widespread electric vehicle adoption is linked to the pursuit of sustainable development, encompassing social, economic, environmental, and cultural dimensions. Adopting EVs can improve public health by reducing air pollution and mitigating the adverse effects of vehicle emissions on respiratory and cardiovascular conditions (Fussey & Dalby, 2022; Verma, 2023). Also, adopting EVs can foster a sense of community engagement and collective responsibility in addressing climate change and promoting social cohesion.

From an economic perspective, the adoption of EVs presents opportunities for innovation, job creation and economic growth within the emerging sustainable transportation industry. As consumer demand for EVs increases, new markets and supply chains will emerge, driving economic diversification and competitiveness. Furthermore, the long-term cost savings associated with EV ownership, including lower maintenance and fuel costs, can contribute to household financial stability and economic resilience (Xue et al. (2021).

Environmentally, the widespread adoption of EVs is a crucial step towards decarbonizing the transportation sector and mitigating the impacts of climate change by reducing greenhouse gas emissions and air pollution. Additionally, the transition aligns with global efforts to achieve the Paris Agreement's goals and support Canada's commitment to reducing emissions and achieving net-zero targets.

Adopting EVs can foster a shift to a more sustainable lifestyle and values, promoting environmental consciousness and responsible consumption patterns. As EVs become more mainstream, they can contribute to a cultural change toward prioritizing sustainability and environmental stewardship. Furthermore, integrating EVs into urban planning and infrastructure can shape more livable and sustainable communities, aligning with cultural values of quality of life and well-being. This research highlights that adopting electric vehicles is a technological shift and a comprehensive approach to achieving sustainable development across all pillars, ensuring a healthier, more prosperous, and environmentally responsible future.

1.2 Problem statement

The existing literature on EV adoption in Canada has primarily focused on investigating the perspectives and behaviours of the public as consumers (Abotalebi et al., 2019; Kitt, 2019; Mohamed et al., 2016; Singh et al., 2021). However, there is a significant gap in our understanding of specific consumer groups such as students, immigrants, Indigenous communities, and young people. By considering these multifaceted aspects and focusing on these consumer groups, we can better understand the factors influencing EV adoption in Canada and address gaps in the literature.

For several reasons, university students are an essential demographic to study in this context. Firstly, they represent a crucial group of early adopters and potential influencers of EV adoption. As they transition from academic environments to the workforce and society, their attitudes and behaviours towards sustainable transportation choices will impact the future of mobility. Secondly, university students are generally more open to embracing new technologies and engaging in sustainable practices than other demographic groups. Therefore, studying their perceptions and attitudes toward EVs can provide valuable insights into the future adoption patterns of the wider population.

Understanding university students' perceptions of electric vehicles is also important for assessing their awareness and knowledge of this emerging technology. We can identify gaps in awareness and educational needs by exploring their knowledge of EVs, understanding of benefits and limitations, and familiarity with basic technologies. This research will contribute to designing targeted educational campaigns that bridge these gaps and increase students' general knowledge and understanding of electric vehicles.

Therefore, the rationale of this research is premised on the need to fill gaps in the literature by focusing on specific consumer groups; thus, university students can inform policies and interventions that promote sustainable transportation practices among the student population.

1.3 Research objectives

The specific objectives of this research are:

- To analyze the trends in the number of ZEVs registered in Canada and its provinces.
- To ascertain the benefits and barriers to electric vehicle adoption among university students.

- To identify the key factors contributing to electric vehicle adoption among university students, such as economic, environmental, and social factors.

1.4 Research questions

Demographic characteristics, socio-cultural aspects, economic considerations, and other variables significantly shape university students' decisions regarding electric vehicle adoption. In this regard, the study's aim can be achieved by responding to the following questions.

- What are the trends in the registration of ZEVs in Canada and its provinces?
- What are the benefits and barriers to electric vehicle adoption among students?
- What key factors contribute to electric vehicle adoption among students, explicitly examining economic, environmental, and social factors?
- What factors influence the adoption of electric vehicles among students?

1.5 Positionality

In Conducting research, it is crucial to acknowledge the researcher's position, including their social identity, to prevent personal biases from affecting the research process (Bourke, 2014; Muhammad et al., 2014). In this study, my position as a Ghanaian graduate student in sustainability studies at Trent University, Peterborough, Canada, may influence my perspective on university students' perceptions and attitudes toward electric vehicle adoption.

My prior experience with the Ghana Forestry Commission has provided me with firsthand exposure to the environmental consequences of carbon emissions and unsustainable practices. This experience has strengthened my commitment to transitioning to cleaner and more sustainable transportation, such as electric vehicles, to mitigate climate impacts. Furthermore, my interdisciplinary study of natural resource management has deepened my understanding of ecological implications associated with different energy sources, including fossil fuels commonly used in transportation. This knowledge has fostered an appreciation for the potential of electric vehicles in reducing greenhouse gas emissions and promoting environmental sustainability.

However, it is crucial to recognize that my cultural background and limited exposure to Canadian university culture may introduce certain limitations. For instance, my unfamiliarity with Canadian university students' specific attitudes, beliefs, and behaviours and the socio-economic and infrastructural disparities between Ghana and Canada could hinder a comprehensive interpretation of students' perceptions and attitudes toward electric vehicle adoption. I will adopt a reflective approach to address these concerns to ensure that my biases and cultural background do not influence the study. This involves recognizing and critically examining my positionality, social identity, and cultural practices to minimize potential bias and enhance the credibility of the research findings. Through this approach, I aim to collect meaningful and reliable information on university students' perceptions and attitudes regarding electric vehicle adoption, considering the socio-environmental implications and contextual factors.

1.6 Thesis structure

This thesis comprises six chapters. After this introduction, Chapter Two conducts a critical review and analysis of existing literature on the primary themes central to this thesis: understanding students' attitudes and perceptions towards adopting electric vehicles (EVs). This review synthesizes the research literature to identify key themes and concepts in developing the study's conceptual framework. By exploring factors influencing consumer preferences and motivations for EV adoption, this section established a link between these factors to understand the determinants shaping students' attitudes toward EV adoption, including social, economic, practical, and environmental influences.

Chapter Three presents the conceptual framework as a standalone chapter. It delves into factors influencing EV adoption, particularly students' attitudes and perceptions, incorporating themes from an extensive literature analysis on EV adoption and the theory of planned behaviour (TPB). Chapter Four describes the research design and methods to address the research questions. This chapter is divided into two main sections: the first outlines the study area and target group, while the second details the data collection and analysis methods.

Chapter Five presents the research results. The primary research question explored is: What factors influence the adoption of electric vehicles among students? Additionally, themes such as the benefits of EV adoption, barriers to adoption, and key contributing factors are analyzed based on survey responses in this section. Chapter Six concludes the thesis by summarizing key findings and outlining their implications. Furthermore, it suggests directions for future studies and addresses the research limitations.

1.7 Significance of the study

This study addresses a significant research gap by examining university students' attitudes and perceptions toward adopting electric vehicles (EVs). The insights generated can contribute new ideas to the existing literature on EV adoption, potentially leading to innovative solutions for promoting sustainable transportation practices. Beyond its immediate focus, this research holds a broader scholarly benefit. It presents an opportunity to advance interdisciplinary research at the intersection of environmental science, psychology, and transportation. This can lead to a more comprehensive understanding of the challenges related to EV adoption and enable the development of more effective interventions.

The outcomes of this study will benefit various stakeholders. Policymakers can gain valuable insights into students' EV attitudes, helping them to design policies that encourage adoption and expedite the shift toward sustainable transportation systems. Industry players, such as auto manufacturers and technology firms, can leverage the understanding of consumer preference and potential adoption barriers to guide their product development and marketing strategies.

Furthermore, this research can support advocacy campaigns by environmental groups and sustainability initiatives. By shedding light on the attitudes of the younger generation, who are the future agents of change towards EVs, the findings can help nurture a sustainable culture and promote environmentally friendly behaviours. Ultimately, the increased awareness and acceptance of EVs among students, because of this study, can contribute to a wider societal shift towards cleaner transport options. This can lead to reduced greenhouse gas emissions and mitigate climate impacts at both the local and global levels.

Chapter 2: Literature Review

2.1 Introduction

The adoption of electric vehicles (EVs) represents a pivotal and sustainable shift in the automotive industry, with far-reaching implications for the environment and energy consumption. Understanding consumers' preferences and motivations for adopting EVs is crucial, especially among the student demographic, since they increasingly seek eco-friendly, cost-effective transportation solutions. To address this knowledge gap, this literature review synthesizes existing studies that explore consumer perceptions and attitudes toward EV adoption, examining key determinants such as purchase price, travel range, convenience of use, charging infrastructure, renewable energy sources, and the influence of social factors.

Furthermore, this review also examines how essential government policies and financial incentives are in advancing the EV revolution. Targeted subsidies, tax credits, and exemptions from congestion fees can significantly alter the calculus for students considering EVs. Simultaneously, this study delves into the significance of expanding charging infrastructure, combating range anxiety, and addressing misconceptions, recognizing that a well-informed student demographic is pivotal to realizing the potential of EVs. Through a thorough analysis of these themes, this literature review aims to shed light on the complex web of factors influencing students' perceptions and intentions regarding adopting electric vehicles.

2.2 Factors influencing consumer preferences and motivating factors for electric vehicles (EVs) adoption

This section delves into the complex and multifaceted factors influencing consumer preferences and motivating factors for adopting electric vehicles (EVs). Understanding the relationship between these factors is essential as the automobile industry transitions toward sustainable mobility options. Some important factors that provide opportunities and challenges to widespread EV adoption include the purchase price, cost of ownership, availability of charging stations, range anxiety, convenience of use, and willingness to pay (WTP). These factors do not exist in isolation but rather impact one another, shaping the decisions of consumers and policymakers.

I. Purchase price

Higher initial costs for electric vehicles (EVs) than traditional combustion engines (ICEVs) are a considerable obstacle. This perception of cost discourages consumers from adopting EVs, as evidenced by various studies (Brinkmann & Bhatiasevi, 2021; Guno et al., 2021; Yu et al., 2023). It also significantly impacts geographical regions with lower purchasing power, such as poor countries or communities requiring interventions to make EVs more financially viable (Yu et al., 2023).

Financial barriers pose significant challenges to adopting electric vehicles (EVs). One aspect of this challenge is the overall cost of EV ownership, including purchase, maintenance, and battery expenditures. Despite higher upfront costs, Palmer et al. (2018) argue that owning an EV during its lifespan is cheaper than owning an internal combustion engine vehicle (ICEV). This cost advantage is due to lower operational and maintenance costs, emphasizing the long-term financial benefits of EV ownership.

Nevertheless, the initial cost of an electric vehicle remains a considerable barrier to mainstream adoption. Hirdue et al. (2011) report that consumers are willing to invest more in EVs for desirable features. The study stressed the need to substantially reduce battery costs for EVs to compete in the market without relying on subsidies. This dual challenge of high initial cost and the imperative of decreasing battery cost illustrates the complexities of resolving financial barriers while fostering wider EV acceptance.

The high upfront cost of purchasing an electric vehicle (EV), as reported by Palmer et al., 2018 can partially be offset by government incentives to promote wider adoption of EV technology (Bockarjova & Steg, 2014; Broadbent et al., 2017). Incentives, such as tax credits and rebates, effectively narrow the price gap between EVs and internal combustion engine vehicles (ICEVs), making EVs more desirable and accessible to consumers. These policies are intended to reduce the financial burden associated with EV adoption, thereby encouraging their adoption (Gomes et al., 2020).

Further exploring the role of incentives, Thananusak et al. (2020) emphasize the importance of tax rebates, subsidies, and VAT exemptions in lowering the upfront cost of EV adoption. Such incentives enhance the financial appeal of EVs and consequently increase adoption rates. These sentiments are echoed by Javadnejad (2023), who highlights those incentives, such as tax rebates and subsidies, as factors influencing consumers to choose EVs over ICEVs. Similarly, Abas et al. (2019) stressed the necessity of government incentives in lowering the acquisition cost of EVs, a substantial contributor to their life cycle expenditure. Direct subsidies emerge as a potent tool for promoting EV use.

II. Range anxiety

Range anxiety, a prominent concern among electric vehicle (EV) drivers, refers to the apprehension and discomfort that arises as an EV's battery charge approaches depletion and is accompanied by uncertainties about locating a charging station or reaching a destination before the battery depletes (Avci et al., 2015; Christidis & Focas, 2019; Daubitz & Kawgan-Kagan, 2015; Morrissey et al., 2016; Steinstraeter et al., 2021). EV buyers are especially concerned about the limited driving range of EVs, which frequently ranges from 160 to 320 kilometres per charge (Cui et al., 2022). The fear of being stranded due to a drained battery and the inconveniences of finding infrastructure contribute to range anxiety, a long-standing concern in the electric vehicle (EV) landscape. Historically, range anxiety has influenced travel behaviour and consumer perceptions of EVs. In the past, it limited the annual mileage of EVs, leading to shorter trips (Tran et al., 2021). However, it is important to note that the landscape of EV technology and infrastructure has evolved significantly over the years.

More recent studies (Hossain et al., 2022; Kim et al., 2022; Raja et al., 2021) reveal that advances have been made to address range anxiety and increase the practicality of EVs for daily use. While Wang and Yan's (2015) analysis highlighted the long-standing concerns of range anxiety that have persisted for decades, it is crucial to note that substantial changes have occurred since then. Over the years, EV manufacturers have significantly advanced battery technology, enhancing EV range and efficiency. Moreover, the charging infrastructure has expanded, becoming more accessible and convenient for EV users. In this evolutionary context, Hossian et al. (2022) and Kim et al. (2022) provide insights into the shifting environment of EVs and how range anxiety, although historically a limiting factor, is being mitigated by technological advancements. This transition from historical challenges to modern advancements accentuates the continual revolution in EV perceptions and practicability.

Considering the pivotal role that range anxiety plays in shaping consumer choices, stakeholders must take decisive action to mitigate its impact and promote greater EV adoption. One key strategy in alleviating this concern is the expansion and enhancement of accessibility to charging infrastructure. To reduce the anxiety that EV drivers frequently feel as their battery charge nears exhaustion, an expanded and easily accessible charging network is essential. When EV owners have confidence in the availability of charging stations, especially during longer journeys, their concerns about getting stranded or facing inconveniences related to charging diminish significantly (White et al., 2022).

As the charging infrastructure continues to expand and evolve, EV owners gain greater confidence and the feasibility of extended journeys. They can plan routes with charging stations strategically positioned along the way, minimizing travel inconveniences. Hossian et al. (2019) speculate that advancements in battery technology to increase battery life offer another promising solution to range anxiety. By enhancing the capacity and efficacy of EV batteries, manufacturers can extend the driving range of electric vehicles, reducing the need for frequent recharging and further alleviating range anxiety. Candra (2022) mentions that the combined efforts of expanding charging infrastructure and improving battery life help consumers make more informed decisions about electric vehicles by addressing practical needs and alleviating the psychological burden of range anxiety.

III. Convenience of use

The convenience of use is a pivotal factor that can either facilitate or hinder the adoption of electric vehicles (EVs). According to research, consumer intentions to adopt EVs are influenced by convenience (Kopplin et al., 2021; Madina et al., 2016; Mishra & Malhotra, 2019; Sintov & Schultz, 2015; White & Sintov, 2017). Charging an EV without interfering with daily activities is a crucial convenience aspect. White and Sintov (2017) found that consumers who had to change their daily routines for EV charging expressed frustration and mobility restrictions. In contrast, consumers with access to public charging stations or other options to charge at work were more willing to pay for EVs. This emphasizes how the ease of charging options can significantly impact EV adoption.

Charging time is another essential component of convenience. Salah and Kama (2016) noted that the time required to charge fully can significantly influence the practicality of EVs. Longer charging times may inconvenience consumers, especially when they need to continue their journeys quickly. As a result, developing fast charging capabilities and extensive access to charging infrastructure is essential to ensure that EVs are not just convenient but also competitive with ICEVs in addressing customers' mobility demands.

Another dimension of convenience involves the availability and accessibility of charging infrastructure. Studies have found that the convenience of charging infrastructure, such as the availability of charging stations and ease of locating them, significantly impacts EV adoption (Lee et al., 2020). Consumers place a high value on the convenience of quickly and easily charging their vehicles without struggling with range anxiety or having to embark on an extended journey to find a charging station.

In addition to charging convenience, consumers often assess the overall convenience of electric vehicles versus their counterparts ICEVs. This more prominent convenience factor includes critical aspects such as acceleration, efficiency, and operational cost, all influencing consumer decisions. Madina et al. (2016) point out that EVs consistently display lower lifetime operational costs than ICEVs due to reduced maintenance requirements and energy consumption. Dioha et al. (2022) concurs that EVs have a distinct advantage in terms of efficiency, as they convert a higher proportion of energy from the power source into vehicle movement. This efficiency is consistent with sustainability goals and translates more into kilometres travelled per unit of energy spent. Alongside this, EVs deliver rapid acceleration because electric motors generate quick torque. This feature not only improves the driving experience but also contributes to improved road safety, allowing for swift, responsive maneuvers.

Furthermore, it is essential to note the contribution of convenience-focused policies to promoting EV adoption. Consumers' intentions to adopt EVs have improved due to convenience-focused policy measures, such as spreading awareness of EVs and advancing infrastructure development (Yang & Tan, 2019). Financial subsidy policies have also played a crucial role in enhancing the convenience of EV adoption. Studies by Xue et al. (2021) and Li. Et al. (2019) confirm that financial subsidy policies, including operational and purchase subsidies, have a similar impact in accelerating EV adoption. These policies have made EVs more convenient and financially enticing to customers by lowering EV ownership's upfront and operational expenses.

IV. Availability of charging stations

The availability of charging stations is a pivotal factor influencing the adoption of electric vehicles (EVs). Bockarjova and Steg (2014) suggest that a country's well-developed charging infrastructure, established before introducing electric vehicles (EVs) to the market, is closely associated with higher rates of EV adoption. This fundamental infrastructure is essential for addressing range anxiety, a significant barrier to EV adoption, and enhancing convenience for potential EV owners.

Moreover, the absence or shortage of charging infrastructure can worsen the issue, affecting recharging and essential support services for EV owners. Guno et al. (2021) establish that the availability of nearby mechanics and repair shops specializing in EVs, as well as stores supplying compatible auto parts, is vital for a seamless ownership experience. Addressing the complex issues related to the development and deployment of charging infrastructure is essential to fostering the broad adoption of EVs. Key considerations include cost, availability, and the need for standardization. Governments can play a pivotal role in promoting the availability of charging infrastructure by providing incentives, embracing innovative technologies, and encouraging collaboration among stakeholders. Ullah (2022) mentions that strategic planning and deployment of charging stations, considering factors such as expanding the charging infrastructure network and locating charging stations in high-demand areas, can enhance accessibility and encourage EV adoption.

V. Preference for renewable energy sources

The preference for renewable sources is a foundational element influencing the widespread adoption of electric vehicles (EVs). Will and Schuller (2016) assert that merging EVs with renewable energy sources, which promotes sustainability at its core, is a critical factor in the acceptance and integration of EVs. Notably, the alignment between EVs and renewable energy significantly shapes individuals' intentions to embrace EVs, making renewable energy a vital catalyst for EV adoption, as highlighted by (Chen et al., 2016). The synergy between EVs and renewable energy is further strengthened when the charging ecosystem is considered. Choosing energy sources to recharge EVs is a seamless way to advance sustainable practices and reduce greenhouse gas emissions. The integration of EVs and renewable energy within a smart grid context is particularly noteworthy, as it has the potential to reduce carbon dioxide emissions and enhance environmental sustainability substantially. This harmonious convergence illustrates how EVs can function as mobile energy storage units, providing a workable energy management and pollution reduction solution.

However, it is imperative to recognize that promoting wide-scale EV adoption goes beyond the mere availability of renewable energy sources. While the availability of renewable energy undoubtedly plays a crucial role, Ortar and Ryghaug (2019) report that addressing the complex dynamics of EV adoption holistically requires complementary strategies and interventions. Their insights shed light on the need to view EV adoption within a broad framework, including energy sources, infrastructure, economic considerations, and consumer behaviour. Similarly, the empirical findings from Gu and Pan (2023) discuss the complex interplay between consumer preferences for renewable energy and the spread of environmentally friendly technologies, particularly electric vehicles and home renewable energy equipment. Drawing from their results, the attractiveness of renewable energy sources as influential factors in adopting environmentally friendly solutions like solar panels and heat pumps becomes evident.

Moving beyond these insights, EV adoption gains further depth through research in distinct geographical contexts. For instance, a study by Aravindan et al. (2022) examined the factors influencing EV adoption in India. The study results reveal that consumer preferences are crucial, and the collaborative efforts between the public and private sectors play an equally pivotal role. It was concluded that barriers to a widespread switch to EVs include limited public-private partnerships and lukewarm consumers' acceptance of renewable energy, particularly solar energy. Their result supports the idea that consumer sentiment and partnership dynamics interact intricately to shape the trajectory of EV adoption and prompts us to consider the multifaceted nature of EV adoption, extending beyond individual choices to encompass a broader ecosystem of stakeholders.

Anastasiadou and Gavanas (2022) contribute to the discussion with a thorough review using the PESTLE (Political-Economic-Technological-Legal-Environmental) framework to understand the complex factors influencing EV adoption. Their insightful analysis highlighted the importance of consumer preferences for renewable energy sources and the current environmental context as powerful catalysts for EV adoption. Consumers increasingly prioritize eco-friendly choices, so the automotive industry may witness a growing shift toward EVs. The findings buttress the crucial role that environmental awareness and preference for renewable energy motivate consumers to adopt EVs.

Additionally, it is equally compelling to consider how policies can influence the trajectory of EV adoption within the context of renewable energy. Broadbent et al. (2017) speculate that policies that enable the seamless integration of renewable energy into the current grid create a favourable environment for the proliferation of EVs. They further claim that incentives, like tax credits and rebates strategically extended to encourage the installation of renewable energy systems, have a double effect by simultaneously promoting both renewable energy and EVs.

VI. Willingness to pay

Recent studies have demonstrated that willingness to pay (WTP) is a critical factor in influencing the adoption of electric cars (Galati et al., 2022; Wolff & Madlener, 2019). It can serve as both a motivator and a potential barrier, and understanding its complexities is essential for the electric vehicle (EV) market's growth. Individuals with a higher WTP for electric vehicles are more inclined to adopt them. These people value the advantages of EVs, such as their decreased environmental impact, lower operating costs, and technological advancement (Hackbarth & Madlener, 2013; Noppers et al., 2014; Wolf & Seebauer, 2014). Their willingness to pay a premium for EVs reflects their commitment to sustainable transportation and understanding of the long-term advantages. However, WTP can also pose a hurdle to adoption. As discussed extensively by (Gorlin et al., 2015; Moons & Pelsmacker, 2015; Şimşekoğlu & Klöckner, 2019), potential buyers who may not be financially prepared for the initial investment may be turned off by the higher upfront cost of EVs compared to conventional internal combustion engine vehicles. In addition, people who value short-term financial gains more than long-term benefits might be reluctant to pay the premium for EVs.

Practical and symbolic characteristics heavily influence the adoption of electric vehicles (EVs). White and Sintov (2017) report on the connection between climate change concerns and willingness to pay for EVs. With references to the discoveries made in this research, it implies that buyers of EVs are more likely to be environmentally conscious consumers who believe EVs help them reduce their carbon footprint. In essence, EVs represent a commitment to climate change mitigation for these consumers.

Building on the role of environmental concerns in EV adoption, Habla et al. (2020) explored the importance of consumer perceptions and willingness to pay for EVs. Considering the outcomes ascertained, consumers' opinions about EVs in general, including their perceived value, performance, and the benefits they offer, significantly impact their decision to adopt these vehicles. Consumers must perceive EVs as practical, cost-effective, and environmentally friendly options to overcome the WTP barrier. Addressing WTP as a barrier to EV adoption involves implementing strategies that make electric vehicles more financially appealing to a broader range of consumers. Government incentives, such as subsidies and tax credits, play a pivotal role in lowering the high initial cost of EVs. With the help of these financial aid programs, an EV's initial purchase price may be comparable to that of an ICEV. This approach efficiently appeals to consumers prioritizing immediate financial savings over long-term benefits.

VII. Influence of social norms

A critical factor in the adoption of electric vehicles is social influence. Liao et al. (2017) argue that a person's social network positively impacts the promotion of EVs. Reflecting the outcome of this scholarly inquiry, stress the importance of social norms by showing that preference for EVs increases as their market share increases. When more people within a social network adopt EVs, it encourages others to follow suit. White and Sintov (2017) also affirm the importance of social norms in shaping EV adoption. They indicate that social pressure can be created by seeing friends and peers use EVs, influencing people's intentions to adopt this technology. This social influence extends to symbolism and self-identity, where the perception of EVs as symbols of environmentalism and social innovation plays a critical role.

The impact of social capital on the adoption of electric vehicles (EVs) has been explored. In a study on how EVs affect social capital, Muthuri et al. (2009) identified three (3) sources of social capital: opportunity, motivation, and ability. They found that engaging with EVs offered individuals and communities a distinctive way to build social capital. This was particularly evident in the context of collaboration and value creation. As more people adopt EVs, it encourages a sense of community where people work together to develop charging infrastructure, share information, and even carpool initiatives. The creation of shared value and mutual benefits due to these cooperative efforts increased social capital within these EV-centric communities.

Secondly, the study explains the motivational aspect of social capital. The widespread use of EVs motivated individuals and communities to adopt sustainable practices and environmental responsibility. People who chose EVs gained from the economic advantages of electric mobility and helped achieve a common environmental objective. This shared motivation was pivotal in enhancing social capital as people united in pursuing a common objective, further stressing the potential of EV adoption to promote a sense of corporate social responsibility.

In addition to the influence of social capital, other social factors are essential in the adoption of EVs. Mishra and Malhotra (2019) discovered that social externalities like peer pressure and neighbourhood effects significantly impact consumers' intentions to buy electric vehicles. The adoption of EVs is also influenced by interpersonal influence, which plays a significant role in the choice-making process for "green" vehicle technology. These social factors also interact with other also interact with other aspects that influence EV adoption. For instance, Tu and Yang (2019) note that consumers with higher education levels and modern values will likely buy EVs. Social influences, including norms and peer pressure, can amplify the impact of other factors, such as price and technical attributes, on consumers’ intentions to adopt EVs.

Buhmann and Rialp Criado (2023) delved into the role of status and reputation in shaping consumer preferences for electric vehicles. Their findings revealed that associated status and reputation influence consumers' inclination to purchase EVs. This aligns with previous research (Goldenberg et al., 2001), emphasizing the significance of social norms and perceived status in adopting new technologies. Thus, promoting EV adoption should focus on environmental benefits and technological advancements and emphasize the social status and reputation of owning such vehicles.

Moving the discussion to the international context, Zhang et al. (2022) investigated the impact of collectivism on Chinese consumers’ willingness to adopt electric vehicles (EVs). Drawing upon the research’s conclusion, personal beliefs and societal norms play a pivotal role in influencing the purchasing decisions of Chinese consumers when it comes to EVs. In essence, individuals in collectivist societies like China may be more inclined to adopt EVs if doing so aligns with their values and is endorsed by the broader social norms. In a complementary vein, Liao et al. (2017) conducted a thorough literature review focusing on the preferences of Chinese consumers regarding EVs. Their analysis provided additional insights into the significance of social and personal norms in influencing Chinese consumers’ preferences for EV adoption. Guided by the information ascertained, how normative factors consistently shape consumer attitudes and intentions about EV adoption is evident.

Moving beyond the Chinese context, focusing on the UK specifically, Pettifor et al. (2017) explored the dynamics of social influence in the global diffusion of alternative fuel vehicles. In concordance with the insights generated from this study, when considering electric vehicles as a secondary rather than a primary one, worries about the unfavourable symbolic implications of owning one are less significant. The interaction between social norms and the real-world circumstances surrounding vehicle use provides insightful information about how consumers view EV ownership.

Shifting the focus to Indonesia, Maso and Balqiah (2022) meticulously analyzed the factors affecting consumers' intentions to buy electric vehicles. Their research unveiled how strongly subjective norms, perceived behavioural control and perceived value affected consumers' intentions to buy electric vehicles. This noteworthy revelation underscores the complexity of the factors influencing consumer attitudes toward EV adoption, with social norms playing a significant role in addition to other factors. Similarly, Bhat and Verma (2021) examined the factors affecting Indian consumers' adoption of electric vehicles. Drawing on their findings, it sheds light on the critical role social values, such as those related to social influence and social image, play in consumers purchasing electric vehicles. This study aligns with and supports the idea that social norms and visibility significantly influence consumer behaviour toward EV adoption.

2.3 Role of government policies and financial incentives in promoting EV adoption

Government policies and financial incentives to promote electric vehicles (EVs) are critical in steering the transition to sustainable transportation. These steps are critical for addressing EV adoption issues and providing consumers with the confidence and assurance they need to transition away from conventional internal combustion engine vehicles. Addressing uncertainties entails developing an ecosystem that alleviates concerns about charging infrastructure availability, range anxiety and initial costs. Governments may create an environment where potential EV adopters feel more comfortable accepting this new technology by building a dependable charging network and offering information campaigns to dispel common misconceptions. Furthermore, targeted subsidies, tax credits or grants, and incentives such as exempting EV owners from congestion charges all play an essential part in reducing the economic barriers to EV adoption. Governments can drastically reduce the price premium often accompanying EV purchases by providing financial assistance or reduced costs. These incentives make EVs more affordable and level the playing field regarding overall ownership expenses between EVs and traditional vehicles.

I Subsidies, incentives, and grants

An increasing number of studies have been conducted to understand how government policies and incentives affect the adoption of electric vehicles (Abas et al., 2019; Javadnejad, 2023; Xue et al., 2021). Building on this understanding, Zheng et al. (2018) explored the manufacturing decisions and government subsidies for EVs in China, which aimed to maximize social welfare with the context of various factors. In delving into the deep dynamics of government subsidies and their effects on EV adoption, the study reveals that these incentives play a critical role in boosting EV adoption in China. Considering these findings, policy interventions can accelerate growth in the EV sector.

Transitioning to a more quantitative perspective, Javadnejad (2023) enhanced the understanding of the impact of policies on EV diffusion. The study thoroughly examined correlations between specific factors and EV sales and emphasized the need for a tailored policy mix. This balance, tailored to each country's specific circumstances, was a crucial driver of effective EV adoption. According to the report, Norway's success in obtaining high EV adoption was attributed to a combination of tax credits, direct aid subsidies, economic affluence, and robust charging infrastructure. Per the profound insights gained, the usefulness of a comprehensive policy strategy in encouraging EV adoption is pivotal.

Broadening the discussion, Rapson and Muehlegger (2021) delved into the economics of EVs and policy design. They stressed the capacity of EV policies to adjust regional variation and the dynamic nature of marginal benefits. This comprehensive examination emphasizes the significance of aligning incentives with broader societal gains, a critical strategic move for developing an ecosystem favourable to mass EV adoption. Taormina and Ainpudi (2021) addressed the international dimension of policy, shedding insights into the roles of research funding and consumer incentives in influencing the global EV market. While admitting the positive impacts of these incentives, their research also revealed the need for solid data to quantify their effects on EV uptake. This reinforced the complexities of policy creation and the vital importance of well-informed strategies.

A comprehensive understanding of the barriers to EV adoption is critical for effective policy formulation. Kumar et al. (2020) shed light on the challenges to EV adoption in India. These include infrastructure limitations, high upfront costs, and consumer concerns. Addressing these issues requires collaborative efforts involving the government, industries, and communities. This is where the sharing economy model gains prominence, fostering collaboration in EV infrastructure and utilization. Moving beyond challenges, the role of government interventions emerges as a significant accelerator for EV adoption. Li et al. (2019) investigated China's successful approach, revealing the effectiveness of governmental incentives such as eliminating restrictions, subsidies, and tax exemptions. This is consistent with the findings of Xue et al. (2021), who found that tax reduction policies, charger density and household income positively influence

EV adoption across 20 countries. The symbiotic relationship between government policies, public incentives and market forces fosters EV growth.

The global perspective also extends to specific regions, providing vital insights into the power of government policies. In Malaysia, Muzir et al. (2020) discuss the significance of government policies, incentives, and the sharing economy in navigating the challenges of EV adoption. Similarly, Kotb and Shamma (2022) examined Egypt's specific setting and highlighted policy action and financial incentives as pivotal drivers in propelling EV purchase intentions. The study by Mishra et al. (2021) gives further insights into the essential role of government regulations in shaping the evolution and standardization of charging station infrastructure in the landscape of EV proliferation. Regarding the exploration, there is a need for supportive governmental frameworks to drive charging station improvement. The research emphasizes the link between legislative initiatives and developing an effective charging ecosystem. Drawing upon the research conclusion, it is imperative for favourable regulations to ensure a comprehensive and consistent charging station network, allowing for easy EV integration.

Likewise, Ramachandaramurthy et al. (2023) dive deeply into EV users' social acceptance and preferences, indicating the significant influence of government initiatives such as tax subsidies, reduced traffic and parking fees, infrastructural support, and road tax exemptions. These well-structured incentives emerge as critical factors in the decision-making process for adopting EVs.

2.4 Importance of charging infrastructure

The development of charging infrastructure is vital in creating the landscape for adopting electric vehicles (EVs). As the global shift to sustainable mobility gains traction, the accessibility, reliability, and expansiveness of charging facilities emerge as pivotal determinants. This analysis evaluates how a robust charging network catalyzes a sustainable automobile's future and sheds light on its functions, challenges, and implications.

I. Charging infrastructure as a barrier

The need for charging infrastructure is a crucial impediment to the broad adoption of electric vehicles (EVs), and it is a multidimensional issue that requires a comprehensive understanding. Wolbertus et al. (2018) address the chicken-or-egg paradox to get to the core of the matter. Considering the findings presented in this research, the profitability of charging infrastructure firms depends on a substantial number of EVs on the market. In contrast, the shortage of charging stations hampers the EV industry’s development. This deep interdependence emphasizes the need to achieve a critical mass of EVs on the road to stimulate investment in charging infrastructure. It reinforces the challenging equilibrium necessary for long-term development and emphasizes the symbiotic nature of the EV ecosystem.

Expanding on this perspective, it is critical to note that government support for charging infrastructure development significantly impacts the EV environment. Hu & Zhang (2021) report on the role of charging infrastructure development in driving EV adoption rates. The authors argue that the impact of charging station investments goes beyond tax benefits in promoting EV purchasing. Importantly, their research established a direct correlation between the availability of charging infrastructure and the rates of municipal and regional EV adoption. Gleaning from collected data points out the critical importance of charging infrastructure as a driver of individual and localized EV market growth.

Kong et al. (2018) advise that from a technological standpoint, combining charging infrastructure with smart grids is a forward-thinking approach. The conclusions drawn from this analysis show how increased charging infrastructure improves EV owner convenience and decreases queue times, enabling more regulated charging techniques consistent with time-of-use power pricing. This techno-strategic synchronization aligns with Bowen et al.'s (2022) emphasis on well-modelled fast charging stations, contributing to a more efficient charging experience. These technological advancements in charging accessibility provide a holistic solution to facilitate a smooth transition to EVs. Similarly, Sunddararaj et al. (2021) broaden the scope by delving into the complex factors influencing EV adoption, including integrating charging infrastructure with the grid. Their study highlights the importance of charging infrastructure accessibility, battery charging time, and distance per charge. This comprehensive viewpoint underlines the interconnected nature of numerous factors influencing EV adoption trends.

Understanding the temporal aspect of charging infrastructure development is equally vital. Dijk et al. (2022) report on the influence of early charging infrastructure supply on cumulative EV sales over time. A significant link, emphasizing the importance of initial network infrastructure investments in supporting the EV market, is in concordance with the insights generated from this study. Reflecting on the study's outcomes, this temporal insight echoes the significance of early-stage infrastructure development in creating an environment favourable to EV adoption.

II. Impact of inadequate charging infrastructure on adoption rate

Examining available studies reveals that charging infrastructure is critical in defining the trajectory of electric vehicle (EV) adoption. Illmann and Kluge (2020) contribute to this discussion by utilizing German data to examine the link between public charging facilities and EV diffusion. Findings reveal a correlation between increased public charging infrastructure availability and monthly EV registrations. This empirical conclusion underpins the significance of robust charging infrastructure in accelerating the transition to electric mobility. A complementary study by Jayasingh et al. (2021) further affirms the integral role of adequate charging infrastructure in fostering greater EV adoption. This cumulative evidence suggests that investments in charging infrastructure can significantly accelerate EVs' widespread acceptance and integration into our transportation systems.

Building on the discourse, Ullah et al. (2022) explore deeper insights into the narrative, outlining key barriers to smooth EV integration. They cited prolonged charging periods, limited driving range and inadequate charging infrastructure as significant obstacles. In these three challenges, charging infrastructure emerges as the key to resolution. These findings are consistent with previous studies (Guno et al., 2021), echoing the urgency of establishing a robust and easily accessible charging network to overcome these barriers and promote greater EV adoption.

The significance of charging infrastructure in EV adoption is a pivotal factor impacting the pace and magnitude of the shift to electric mobility. Maso and Balqiah (2022) address the critical importance of charging infrastructure availability, directly impacting the growth of EV adoption. Guided by the information ascertained, inadequate charging stations reduce consumer flexibility and convenience, reducing the appeal of electric vehicles. This insight resonates with Candra’s (2022) examination of EV adoption barriers in Indonesia, where a lack of charging infrastructure, range anxiety and governmental disincentives combine to form a composite challenge. Despite the different contexts, both studies emphasize the critical significance of charging infrastructure in shaping the course of EV adoption.

Azarova et al. (2020) contribute to the discussion by focusing on charging-related issues and the importance of charging infrastructure in EV adoption. Drawing from the findings reveals the areas for improvement in existing public and private charging infrastructure business models and advocates for community-financed solutions. The study emphasizes the need for innovative approaches to infrastructure development and the importance of accessible and adequate charging stations in mitigating adoption barriers and increasing EV penetration rates.

Building on this understanding, Straka et al. (2020) revisit the chicken-and-egg dilemma of charging infrastructure and EV uptake. The report stresses how insufficient charging infrastructure creates a feedback loop that EV drivers are hesitant to adopt due to limited charging stations while charging infrastructure providers remain reluctant to invest without a significant EV fleet. This cyclical challenge highlights the importance of strategically addressing charging infrastructure to break the deadlock and accelerate widespread EV adoption.

Furthermore, these studies collectively reinforce the view that adequate charging infrastructure is more than just a logistical issue but a primary driver of EV adoption. They all emphasize the need to invest in charging infrastructure to alleviate the barriers and accelerate the transition to electric mobility. The fundamental significance of charging infrastructure in shaping the trajectory of EV adoption is a consistent thread throughout these studies.

III. Addressing convenience and range anxiety through infrastructure expansion

Range anxiety, a significant psychological problem caused by the short driving range of electric vehicles (EVs) and the lack of charging infrastructure, has attracted substantial research attention. Pevec et al. (2020) used a survey-based evaluation to determine the factors influencing this anxiety. They discovered an intriguing correlation between standard gas station infrastructure and the anticipated EV charging station network by comparing the perspectives of present and future EV owners. Considering the findings, a seamless transition from gas stations to convenient and strategically located charging stations could be pivotal in reducing range anxiety.

However, despite the potential solution proposed by Pevec et al. (2020), range anxiety is still prevalent in rural areas, as discussed by Steadman and Higgins (2022). Incorporating the insights garnered, it becomes evident that achieving an excellent electric vehicle (EV) driving range on a single charge and ensuring a critical density of charging stations are essential. Connecting these ideas and reducing range anxiety in rural areas demands a dual approach: improving technology for more extended EV travel on the one hand and strengthening charging infrastructure on the other.

In line with addressing charging infrastructure and range anxiety issues, Yu et al. (2023) concentrated on calculating the best number of price schemes while considering user range concerns. Considering the outcomes ascertained, it is necessary to understand and regulate this psychological component when making charging station deployment and price decisions. In a broader context, the research contributes to boosting EV adoption and tailoring charging infrastructure to alleviate range anxiety concerns.

In addition to the discourse, Sierpiński et al. (2020) contributed to alleviating range anxiety by providing decision-making support for local authorities. Their study concentrated on the optimal placement of EV charging stations in cities. The research emphasized limiting range anxiety by carefully selecting charging station locations. By strategically situating these stations in easily accessible areas and guaranteeing safe minimum energy for complete travel, they provided a realistic solution to drivers' concerns.

Raboaca et al. (2020) developed an innovative approach to reduce range anxiety based on convenient charging. Their optimization technique for temporary mobile charging station placements introduced the concept of flexible and temporary charging options. By proposing that these stations be temporarily stationed at various locations for specific periods, EV drivers could have convenient access to charging stations, thereby reducing the burden of range anxiety. This study bridges the gap between dynamic charging infrastructure and the psychological needs of EV drivers.

Continuing the exploration of solutions for range anxiety, Huang et al. (2016) provided insight into the design of electric vehicle charging networks. Their study stressed the importance of charging station placement in reducing range anxiety. The results resonated with the broader subject of boosting EV drivers' confidence by advocating for installing more charging stations in strategic areas. This is consistent with the notion that a well-organized and readily available charging network can significantly alleviate the psychological worries of range restrictions.

Chakraborty et al. (2022) also introduced a unique approach to tackling range anxiety by expanding the conversation around charging infrastructure. Their idea for charging en route solutions for battery electric vehicles recognizes the need for convenient and faster charging stations. Furthermore, their study highlighted the importance of local power systems to manage the extra load from charging. In tackling the multidimensional issue of range anxiety, this holistic perspective stresses the dynamic relationship between technical improvements and infrastructure issues.

IV. Role of fast-charging stations in reducing range anxiety

The transformative potential of fast charging stations in alleviating range anxiety has been the focal point of several in-depth studies. The Safe-Range-Inventory (SRI) study conducted in Germany investigated the practical benefits of fast charging stations on people's concerns about range anxiety (Carbon & Gebauer, 2017). According to this comprehensive study, fast charging stations significantly decrease the prevalence of range anxiety among electric vehicle (EV) owners. The ease of quickly replacing battery charge via fast charging stations eliminates the persistent fear of being stranded due to a depleted battery, making EVs more enticing and practical for daily use.

A similar study by Salah and Kama (2016) spotlighted the critical impact of fast-charging station accessibility in effectively reducing range anxiety. The findings emphasized the importance of strategic density and accurate positioning of fast charging stations in reducing range anxiety issues. According to the report, by seamlessly integrating fast charging infrastructure into common travel routes and ensuring convenient accessibility, EV users may confidently embark on their journey without the looming anxiety of running out of battery capacity. Fast charging stations expedite charging capabilities and add to this sense of assurance, making the shift to electric vehicles seamless and anxiety-free.

In a broader context, Khalid et al. (2021) investigated the numerous characteristics of fast EV charging stations, going beyond simple range anxiety to address the delicate interplay with grid dynamics and the necessity for standardized charging infrastructure. This exploration stressed the importance of developing a solid and efficient charging infrastructure to support the widespread adoption of EVs. Fast charging stations are critical infrastructural components in this paradigm. Notably, these stations help to eliminate range anxiety by providing EV users with swift and easily accessible charging options, allowing for a smooth transition from conventional vehicles to EVs.

The collective findings from these studies point to a symbiotic relationship between fast charging stations and reducing range anxiety. The psychological obstacles associated with restricted driving range are efficiently eliminated by strategically situating fast charging stations and improving their accessibility. As EVs become more integrated into users' daily routines, fueled by the trust established by fast charging options, the adoption rate for these eco-friendly vehicles increases rapidly.

2.5 Perceptions and misconceptions about EVs

Rezvani et al. (2015) explored EV adoption research, unveiling a significant stumbling block-perception. This foundational study shed light on unravelling the complex web of consumer perceptions surrounding EVs. These perceptions, often obscured by misconceptions, erect significant barriers to the smooth integration of EVs into the automotive landscape. Misconceptions ranging from concerns about driving range to uncertainty about charging infrastructure hinder the transition toward EV predominance. The authors' call for a paradigm shift highlights the importance of honest information transmission and educational measures to dispel these myths, paving the way for effective EV adoption methods.

Venturing further into the dynamics of EV adoption, Shetty et al. (2020) explored the emerging markets of Asia, characterized by their unique complexities. Incorporating the insights garnered, it sheds light on a complex but critical challenge: the perceptions and attitudes around the functional features of EVs. This intricate barrier focuses on the essence of EVs, including performance, charging efficiency, and driving experience. The study reveals that potential buyers' skepticism toward these fundamental attributes is a substantial barrier to EV adoption. This comprehensive analysis of perceptions offers the automobile sector crucial information about its target audience's preferences and reservations. By leveraging these insights, manufacturers can develop initiatives that debunk misconceptions and highlight the inherent benefits of EVs, fostering an environment conducive to their mainstream assimilation.

Shifting the focus to the vibrant streets of Shenzhen, China, Wang et al. (2017) conducted a study to uncover the complicated network of EV adoption barriers. According to the research, two significant obstacles were identified: the public's perception of the benefits of EVs and the availability of charging infrastructure. The study vividly demonstrated how misconceptions can erode the attractiveness of EVs, ranging from concerns about their environmental benefits to incorrect assumptions about cost-effectiveness. The study's emphasis on financial incentives' crucial role highlights the symbiotic link between policy measures and perceptions. This underscores the pivotal role of policy and economic strategies in reshaping perceptions and nudging consumers toward embracing EVs.

In a complementary exploration, the research by Purwanto and Primarini (2022) adds to our understanding of factors influencing EV adoption. The findings reveal that perception, personal green self-identity and societal norms influence an individual's willingness to adopt EVs. The perception of EVs as environmentally friendly and a sense of personal identity connected with green actions strongly affect their adoption. Furthermore, societal norms impact how people perceive EVs and their acceptance of this eco-friendly mode of transportation.

Adding to this complex narrative, cultural and social factors significantly influence perceptions and misconceptions about EVs, which might differ across collectivist and individualistic cultures (Zhang et al., 2022). These cultural misconceptions and language barriers often contribute to misunderstandings about EVs. Understanding how cultural and social factors impact perceptions and misconceptions is critical for developing practical solutions to address these barriers. Recognizing the impact of culture on how EVs are perceived allows for efforts to bridge cultural barriers and develop a more realistic understanding of electric vehicles.

Furthermore, it is imperative to acknowledge infrastructure's pivotal role in shaping perceptions and misconceptions about EVs, particularly regarding range anxiety. The availability and accessibility of charging stations emerge as essential components in reducing range anxiety and boosting public perception of EVs (Morrisey et al., 2016). Misconceptions regarding charging infrastructure, such as concerns about availability and accessibility, can influence how people perceive EVs' efficiency. Numerous studies have continuously identified a lack of charging infrastructure as a significant barrier hampering EV adoption (Bhat & Verma, 2021). Addressing these misconceptions through improved infrastructure can positively influence the perception of EVs as a viable and convenient mode of transportation, hence increasing their adoption.

2.6 Impact of firsthand and driver satisfaction on EV

The importance of firsthand experience and driver satisfaction in the context of electric vehicles has garnered considerable attention from researchers (Bühler et al., 2014; Hinnüber et al., 2019; Selim et al., 2021; Wang et al., 2022). In practical terms, Hinnüber et al. (2019) conducted a field study that provided valuable insights into the influence of a short test drive in a battery electric vehicle (BEV). After this brief firsthand experience, the remarkable finding was a substantial 41% increase in the chance of considering a BEV for the next car purchase. This unambiguously demonstrated the importance of real encounters in shaping people's willingness to adopt electric vehicles. Such experiences provide a concrete taste of what driving an EV entails, removing any possible barrier or uncertainty that existed before the encounter.

Similarly, Bühler et al. (2014) conducted a study in Berlin, Germany, involving 79 participants in a 6-month field trial with EVs. The study’s findings highlight the importance of real-world experience in shaping participants’ perceptions of EVs. The narratives of driver experiences support the insights, with benefits such as the convenience of charging at home or public stations and significant cost savings compared to traditional fuelling methods (Graham-Rowe et al., 2012). These firsthand experiences demonstrate the transformative potential of driver experience in shaping attitudes.

Supporting this perspective, Selim et al. (2021) investigated the complex interactions between driving experiences and users’ perceptions of EVs. The study revealed a critical link between direct experiences, the ease of observing EVs and the opportunity to test them out. This connection increased customer adoption of EVs by stressing the tangible impact of firsthand experiences. Potential EV users may see, touch, and experience the benefits of EVs directly due to these encounters, leading to a more positive perception and acceptance. These experiences serve as catalysts for breaking down barriers and fostering a deeper understanding of EVs' practical advantages.

Additionally, Ghotge et al. (2022) contribute further to the discourse of firsthand experiences and their influence on driver preferences and decisions. In alignment with the study, EV user preferences can change after firsthand experiences, including shifts in driving range and top speed. A noteworthy finding was that a three-month interaction with an EV resulted in user willingness to pay changes, demonstrating the transforming impact of long-term firsthand experiences. Spending time with an EV helps people to become thoroughly acquainted with its capabilities and limitations, leading to more informed preferences and decisions. This supports the notion that firsthand experience can reshape preferences and promote a greater understanding of the realities involved with EVs, influencing purchase decisions.

Building on this premise, Wang et al. (2022) report on the complex dynamics of EV adoption, shedding light on a concept of importance: "lead users." These lead users possess firsthand experiences with EVs and boast extensive expertise in their operation and advantages. Wang et al. (2022) argue that lead users are more likely to be early adopters of EVs due to their substantial knowledge and practical experience with these vehicles. The rationale behind this phenomenon is that lead users are well-versed in the specifics and benefits of EVs. They know the advantages and potential drawbacks, have firsthand knowledge of charging infrastructure and maintenance, and can provide valuable insights to prospective EV adopters. They can act as advocates and educators within their social circles and communities, and their informed decision to adopt EVs serves as a potential catalyst for broader adoption.

2.7 Demographic and psychological factors influencing consumer intentions

Exploring how demographic and psychological factors affect consumer intentions to purchase electric vehicles (EVs) reveals a complex interplay of individual characteristics and psychological factors. To advance sustainable transportation, it is essential to understand factors like age, gender, income, education, attitudes, perceived benefits, and environmental consciousness. Understanding how these factors interact to influence consumer intentions in the dynamic environment of EV adoption is enlightening and crucial to developing successful strategies.

I. Demographic factors

Egbue and Long (2012) meticulously examined the socio-demographic factors influencing the interest in electric vehicles. They report significant correlations between interest in alternative fuel vehicles (AFVs) and specific demographic factors, notably gender and education. They found that males are interested in AFVs, cars without traditional gasoline or diesel engines. In addition, individuals holding graduate degrees demonstrated an increased inclination toward AFVs compared to their counterparts with undergraduate or lower levels of education. Egbue and Long (2012) argue that income, gender, education, and age influence interest in alternative fuel vehicles (AFVs). Environmental and sustainability concerns also drove electric vehicles (EVs) adoption.

Similarly, Plötz et al. (2014) identified various traits of early EV adopters in Germany. Considering the research conducted, employed males with higher socio-economic status, solid environmental values and a preference for technology were more inclined to adopt EVs. Due to lower rates of urban vehicle ownership, people living in smaller cities and towns were more likely to purchase EVs.

Sovacool et al. (2019) examined the impact of demographic factors like gender, age, and income on EV preferences in the Nordic Region. Their results showed that EV adoption intentions were positively related to perceived self-efficacy, reflecting people's confidence in using charging stations and alternative travel modes for longer distances. This suggests that demographic factors can affect EV adoption through their impact on perceived abilities.

Higueras-Castillo et al. (2020) conducted a study in Spain to identify early adopters of hybrid and electric vehicles (EVs). Their research revealed that demographic factors, including gender, age, and income, significantly impacted people's preferences for EVs. Specifically, the study found that males, certain age groups and higher-income individuals were more likely to adopt EVs, consistent with previous studies (Egbue & Long, 2012; Plötz et al., 2014).

Berneiser et al. (2021) focused on socio-economic, psychological, and mobility-related variables influencing EV adoption in Germany. Insights revealed that demographic characteristics, precisely age and gender, influence individuals' inclination toward EVs. Notably, specific age groups and males exhibited a heightened interest in electric vehicles, echoing the findings of Higueras-Castillo et al. (2020). This consistency in results across different geographic regions validates the significance of these demographic factors in shaping the preference and adoption of EVs.

Drawing from the studies discussed above, younger individuals, more adept at new technologies, tend to embrace EVs due to their digital proficiency, environmental consciousness, and interest in sustainable options. On the other hand, older people favour conventional modes of transportation. It is critical to recognize these age-related preferences for specific EV adoption strategies. Gender differences indicate that males are more interested in EVs than females; this warrants the need for gender-specific initiatives. Income levels also impact: people with higher incomes are more likely to consider EVs because they have the means to do so. Addressing financial barriers for lower-income groups is crucial for inclusive EV adoption efforts.

II. Psychological factors

Psychological factors are complex in their influence on consumer intentions towards EVs. White and Sintov (2017) explored these factors and divided them into two categories: instrumental and symbolic. The instrumental attributes encompass practical considerations related to the financial aspects of EV ownership. These include fuel and maintenance cost savings, infrastructure for charging and the overall cost-effectiveness of EVs compared to conventional gasoline or diesel vehicles. These characteristics address the practical and observable benefits of switching to electric mobility. Symbolic characteristics, on the other hand, go deeper into the imagery and identity associated with EV ownership. The qualities examine the perceived lifestyle, environmental awareness, and social identity associated with EV ownership and cost-efficiency. Adopting an electric vehicle can be seen as a declaration of commitment to innovation, sustainability, and a futuristic, eco-conscious way of life.

Furthermore, Mishra and Malhotra (2019) emphasize that psychological factors influence consumer purchase intentions in their study on EV adoption in India. They mention that individual beliefs, values, attitudes, and perceptions are important in the decision-making process toward adopting an EV. Consumer's motivations, values, and emotions all come into play when considering the purchase of an EV. It is imperative to understand these psychological drivers to create persuasive communication and marketing strategies that appeal to potential EV buyers. On the contrary, Lin et al. (2021) offer a counter perspective by examining the effect of knowledge management on EV adoption intentions. They argue that an individual's intention to adopt EVs is influenced by their understanding and awareness rather than emotional factors.

To complement the discussion, Morton et al. (2016) report on the impact of consumer innovativeness on EV preferences. Gathering insights from this research, they challenge the notion that rational and functional factors solely drive consumer preferences. These findings suggest that the appeal of EVs is intertwined with emotional, psychological, and even social dimensions. For instance, aspects like the perception of environmental responsibility, the feeling of being at the forefront of technology, and the desire to align one's identity with sustainability may sway the decision to opt for an EV.

Adding to the discourse of psychological factors, Herberz et al. (2021) mention that behavioural interventions can increase EV adoption by addressing psychological barriers in addition to current policies. Herberz et al. (2021) argue that interventions to influence consumer behaviour, attitudes and perceptions can complement existing policies by tackling barriers beyond financial considerations. In this context, this behavioural intervention might focus on elements like education and awareness campaigns that emphasize the long-term environmental benefits of EVs, the ease of charging, or the potential cost savings over time. These interventions can bridge the gap between policy incentives and consumer adoption by addressing psychological barriers, such as range anxiety or misconceptions about EV performance.

Chapter 3: The Conceptual Framework

3.1 Introduction

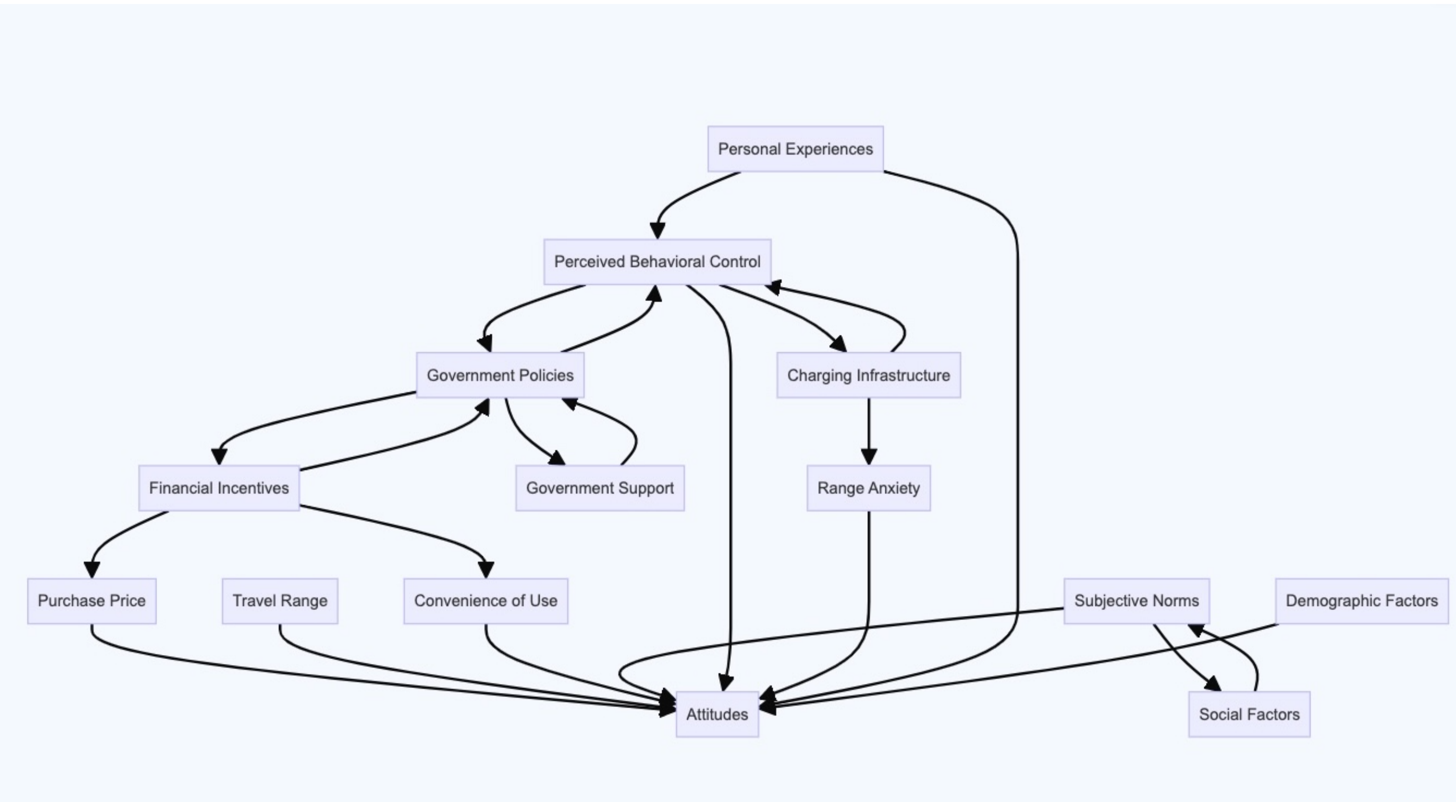
This section aims to construct a conceptual framework to explore the factors influencing students' adoption of Electric Vehicle (EV). Drawing on a comprehensive literature analysis on EV adoption and the theory of planned behaviour (TPB), this framework examines the cognitive, economic, environmental, and social influences that shape students' attitudes and perceptions toward EVs. EV adoption represents more than a technological innovation; it embodies the intersection of environmental concern, societal influence, economic considerations, and personal preferences. For students, this often translates into viewing EVs as symbols of sustainability and modernity due to their interest in innovative trends and eco-friendly choices.

Understanding the complex interplay of these diverse factors is critical, as students' perception and sentiments significantly shape their attitudes toward EVs, ultimately influencing their purchase decisions (McLure et al., 2022). Economic considerations, such as financial strength and stability, also play a substantial role in decision-making (Jena et al., 2023). Furthermore, the availability of financial incentives, like subsidies, discounts or bonuses associated with EV ownership, can be decisive in students' acceptance of EVs (Malik & Sharma, 2022). Beyond the individual factors, the influence of social networks and media representations cannot be overlooked. Recommendations from teachers, peers, and media representatives and a positive depiction of EVs in popular culture can positively shape students' perceptions and attitudes (Malik & Sharma, 2022).

This conceptual framework attempts to synthesize these cognitive, environmental, economic, and social influences to provide a structured understanding of the complex dynamics that shape students' attitudes and perceptions regarding the adoption of EVs. By addressing these complex factors, the framework offers a comprehensive lens to explore and understand the drivers and barriers to EV adoption within the student community.

Figure 1

Unravelling attitudinal influences: A Conceptual framework for understanding Electric Vehicle Adoption among students



3.2 Attitudes

Attitudes play a pivotal role in shaping an individual's behaviour and decision-making. Attitudes are an individual's overall evaluation or feeling towards an object, person, issue, or action. In the context of EV adoption, attitudes encompass an individual's positive or negative behaviour related to EV usage. The purchase price, travel range, personal experiences, range anxiety, and convenience influence these attitudes. Positioned on the far right of the diagram are demographic factors such as age, income, education, gender, and household size, which significantly shape attitudes and perceptions toward Electric Vehicle (EV) adoption. For instance, younger individuals often perceive EVs as modern and environmentally friendly due to their inclination toward technological innovations (Esteves et al., 2021; Mo et al., 2022). This demographic tends to be more open to embracing EVs due to their alignment with innovation and sustainability. Students represent a distinct group within this demographic range marked by a great tendency to embrace technological developments. Their perception of EVs as symbols of technological advancements and eco-friendliness resonates with their acquaintance and appreciation for pioneering trends.

Transitioning from these demographic influences, income levels also play a pivotal role in shaping attitudes toward EVs. Higher-income levels, for example, can alleviate concerns regarding the upfront cost, leading to more positive attitudes toward adopting EVs. Conversely, lower-income individuals might perceive EVs as financially unattainable, leading to a more negative attitude toward adopting this technology. These demographic variations influence people's attitudes and readiness to adopt EVs, making financial incentives or student-specific financing crucial in influencing their attitudes toward EV adoption.

Furthermore, education and household size impact the attitudes and practicalities of EV ownership. Higher education levels may increase awareness of EVs' environmental and technological benefits, influencing favourable attitudes towards them. Also, larger households may need more logistical issues regarding charging infrastructure and vehicle suitability, limiting their ability to transition to EVs. Similarly, Higher education among students heightens their awareness of EV benefits, potentially influencing favourable attitudes toward EV adoption.

On the far-left side lies the pivotal role of the purchase price in shaping attitudes toward adoption of electric vehicles (EVs). The higher upfront cost of EVs poses a significant challenge within the student demographic, who often need more financial resources. Students may see this cost gap as a substantial barrier to EV adoption, as their budgetary constraints make the initial investment a crucial consideration. However, introducing financial incentives such as subsidies, tax credits, and rebates can increase EV ownership's economic attraction and feasibility, positively impacting student attitudes. Substantial governmental incentives targeted at reducing the upfront cost of EVs, like tax credits granted in countries like the United States and Norway, have significantly increased adoption rates by making these vehicles financially accessible and attractive (Javadnejad, 2023).

Recognizing the importance of affordability for students, tailored financial strategies, such as student-specific financing models or targeted subsidies, could be potent tools to influence their attitudes toward EV adoption positively. These approaches aim to alleviate the immediate financial burden while emphasizing the long-term economic benefits of EV ownership, such as reduced fuel and maintenance costs. Furthermore, the impact of these financial incentives extends beyond just the initial purchase decision. By making EVs more financially accessible, this measure can also contribute to students' perceptions of the long-term cost-effectiveness of EV ownership, further reinforcing their positive attitudes and willingness to embrace these sustainable transportation options.

The travel range, positioned to the right of the purchase price, is a crucial factor influencing attitudes toward adopting EVs. This key component directly addresses consumers' concerns about range anxiety. Longer travel ranges alleviate this anxiety, making EVs more appealing and reducing psychological barriers to adoption. This factor, in turn, is closely intertwined with charging infrastructure. Battery advancements that increase travel capabilities positively impact attitudes and perceptions of EV feasibility for daily commutes and longer journeys. Convenience, including easy charging access and user-friendly features, significantly influences attitudes, making it an essential consideration for potential EV users. For instance, innovations in battery technology, as seen in vehicles like the Tesla Model S (Dual Motor All-Wheel Drive) with extended range options reaching up to 647 kilometres on a single charge, have notably addressed range issues, positively impacting consumer attitudes toward EVs (Model S, 2023).

Additionally, a well-established charging infrastructure alleviates students' concerns regarding range anxiety, fostering a positive shift in attitudes toward EVs. For students, convenient charging options, especially around educational institutions, or urban areas, hold a substantial sway in instilling confidence and promoting a positive attitude toward EV adoption.

At the center of the diagram lie government policies, which are pivotal in driving EV adoption. These policies, which provide financial incentives and support, positively influence attitudes, removing barriers and creating a suitable atmosphere for mass EV adoption. Robust government initiatives, such as subsidies, tax incentives, grants for EV purchase and substantial infrastructure investments, create an environment conducive to EV adoption. This improves public perception and fosters more excellent adoption rates. For example, robust policies like California's Zero Emission Vehicle (ZEV) program have significantly increased EV adoption by providing incentives and fostering a supportive infrastructure for EVs (Czerwinski, 2022).

Prime Minister Justin Trudeau and Quebec Premier François Legault are a testament to this commitment with multi-billion-dollar investments and efforts to support EV production, infrastructure development, and a sustainable economy (Shingler, 2023). Similar ambitious projects, such as Northvolt's massive manufacturing plant planned on Montreal's South Shore, will produce battery cells for a million EVs per year, demonstrating the practical influence of government policy on the EV landscape. Student-targeted policies like discounted EV programs or accessible charging stations near campuses can significantly impact student attitudes, making EV adoption more feasible and appealing.

3.3 Subjective norms

Beyond the demographic factors, practical considerations of cost, travel range and government policies, the adoption of EVs is also shaped by the broader societal context and the normalization of these sustainable mobility solutions. As the Theory of Planned Behaviour (TPB) conceptualizes, subjective norms encompass an individual's perception of social pressures or social influences regarding a particular behaviour. In the context of EV adoption, these subjective norms include the societal attitudes, beliefs and expectations surrounding the use of EVs. Media coverage, peer influence, and social norms emerging within the student community significantly influence individual attitudes toward EVs. Media portrayals and influential endorsements, like celebrities and respected figures, shape societal views on EVs (Salari, 2022). Positive depictions of EVs in popular media and advocacy by influential peers, like celebrities endorsing EVs, can contribute to a more positive attitude, favourable perception and higher desirability of EV ownership among the public, including students.

The endorsements of EVs by influential figures, such as professors or campus personalities, can significantly impact attitudes and perceptions within the student community. When these respected individuals within the student's social circles express support and enthusiasm for EVs, it can help normalize EV ownership and make it a more appealing and desirable choice. The power of influence is further amplified by the tendency of individuals, including students, to observe and imitate the behaviours of their social circles. As more students witness their peers adopting and enjoying the benefits of EVs, it can create a ripple effect, driving the normalization and widespread acceptance of EVs.

The growing acceptance and promotion of EV ownership among students' social circles can impact their attitudes and perceptions. As peers endorse or adopt EVs, owning an EV extends beyond mere transportation; it becomes a symbolic gesture of accepting environmentally friendly choices within their social sphere. This societal narrative successfully generates a collective desire among students to align with prevalent norms of sustainability and technological advancement exemplified by EV ownership. As a result, the positive social change encourages students to view EV adoption as a good decision that aligns with their environmental consciousness and social aspirations.

Furthermore, aligning individual choices within broader societal norms stressing the use of renewable energy sources amplifies the impact on attitudes and perceptions toward EV adoption. Societal norms that emphasize the importance of environmental stewardship and support eco-friendly behaviours act as a reinforcing influence (Axsen et al., 2016). This alignment of personal choices with societal norms enhances positive attitudes and intentions toward EV adoption. It creates an atmosphere in which the option to use EVs is consistent with individual preferences and broader societal ambitions for environmental sustainability.

3.4 Perceived behavioural control

Regarding adopting electric vehicles (EVs), an individual's perceived behavioural control plays a crucial role. This concept refers to a person's belief in their capacity to perform a particular behaviour, such as purchasing and using an EV. Various factors influence this perception of control, including the presence and accessibility of charging infrastructure, government policies, and the overall charging network. The availability and accessibility of charging stations are critical in determining people's opinions about their capacity to adopt EVs. A lack of a solid charging infrastructure often triggers range anxiety, a notable concern among potential EV adopters about the vehicle's travel range and charging accessibility (Mao et al., 2021). However, an expanding and reliable charging station network can alleviate this anxiety, improving EVs' perceived utility and convenience and instilling a sense of control over their practicability, positively influencing attitudes and perceptions toward adopting these vehicles.

Furthermore, government policies and interventions, such as targeted subsidies, tax incentives or financial assistance programs, significantly impact individuals' perceived control over their adoption decisions. These policies play a crucial role in easing financial barriers hindering the purchase or ownership of EVs. They effectively reduce the initial purchase cost and create a supportive atmosphere, urging potential consumers to consider EVs feasible and attractive transportation options. These governmental actions strengthen consumers' control over their adoption decisions by increasing the perceived ease of obtaining and owning an EV, contributing to a more favourable attitude toward accepting EVs.

Attitudes and perceived behavioural control over EV adoption are greatly influenced by individual experiences and the level of satisfaction gained from interactions with EVs. Good experiences, especially those that center around the ease and cost benefits of having an EV, significantly impact the development of positive attitudes. Furthermore, these experiences are vital in strengthening people's confidence in successfully incorporating an EV into their everyday routine.

Students' positive experiences, characterized by the smooth integration of EVs into their daily routines and the evident cost benefits, play a vital role in fortifying their confidence in embracing EV technology. These experiences develop a positive mindset and inspire confidence in students, reaffirming the feasibility of incorporating EVs into their lifestyles. The positive encounters and successful integration of EVs into students' daily lives contribute to shaping a more positive attitude toward EV adoption. As students encounter firsthand the practical benefits and convenience of incorporating EVs into their daily routines, their confidence grows, solidifying the perception that EV ownership corresponds with their goals for sustainable living and technological advancement.

The conceptual framework comprehensively explains the complex factors influencing students' attitudes toward adopting electric vehicles (EVs). Several key elements emerge as crucial in shaping EV acceptance, each playing a vital role in the complex landscape of EV adoption. At the forefront lies the purchase price of EVs and the availability of financial incentives, which together determine the economic viability and accessibility of these vehicles for consumers. Addressing these economic considerations is essential in making electric vehicles a more attractive and feasible transportation option. Alongside the financial factors, practical considerations such as travel range and convenience also significantly influence attitudes towards electric vehicles. Consumers' perceptions of an EV's ability to meet their daily transportation needs either facilitate or hinder their willingness to adopt these vehicles.

Furthermore, demographic variables highlight the diverse range of influences and attitudes toward EVs, underscoring the need for targeted policy interventions and innovative strategies to promote inclusive adoption. By catering to different consumer segments' unique needs and preferences, we can foster a more equitable and widespread acceptance of electric vehicles.

It is important to note the interconnected nature of these variables, as they do not exist in isolation but have the potential to create synergies in driving EV uptake. For instance, the availability of financial incentives can alleviate the impact of high purchase prices, while a robust charging infrastructure can address concerns about travel range and range anxiety. In conclusion, this conceptual framework provides a valuable lens for understanding the complex landscape of

EV adoption. By addressing the economic, social, practical, and demographic factors and recognizing their interconnected nature, we can develop a more effective and inclusive approach to promote the widespread of electric vehicles.

From the conceptual framework provided, the variables that would require analysis in the study include purchase price, financial incentives, travel range, social factors, charging infrastructure, government policies, range anxiety, personal experiences and demographic factors. By examining these elements and their interplay, we can understand the drivers and barriers to EV adoption among students, ultimately informing the development of targeted strategies and policies that accelerate the transition to sustainable mobility.

Chapter 4: Research Design and Methodology

4.1 Introduction

This chapter details the methodology used to address the research questions and achieve the thesis objectives. It is structured into two key sections. The first section offers an overview of the target group and study area. The second section outlines the research design and data collection and analysis approach. A quantitative approach was used, and survey questionnaires were utilized to understand students' attitudes and perceptions of electric vehicle adoption. This section provides a detailed account of the methods used. It includes information on sampling strategies, data collection techniques and data analysis procedures.

4.2 Target population and study area

This study focuses on the attitudes and perceptions toward electric vehicle (EV) adoption among undergraduate and graduate students currently enrolled at Trent University, Peterborough, Ontario. The university's commitment to sustainability and the diverse backgrounds of its student body makes it an ideal location for this research. Trent University offers a diverse academic environment, attracting students from various disciplines. It is situated at an intersection of urban, suburban, and rural areas. This proximity ensures a diverse representation of students with distinct backgrounds, lifestyles, and transportation needs, which provides an excellent basis for analyzing attitudes toward EV adoption.

4.3 Research methods

Given the complex nature of understanding students' perceptions and attitudes regarding electric vehicle adoption, this research adopts a quantitative approach to explore this topic. The exclusive use of quantitative methods seeks to systematically analyze numerical data and unveil trends, preferences, and measurable patterns in students' willingness to embrace EV technology (Nardi, 2018).

The quantitative methodology offers distinct advantages for this study, allowing for systematic data collection from many participants. By employing statistical analysis and numerical assessments, this approach helps to derive measurable trends and patterns (Plonsky & Gass, 2011; Walker, 2005). The goal is to uncover statistically supported insights regarding factors influencing students' attitudes and perceptions toward the adoption of EVs. Using quantitative measurements, this research ensures consistency and reliability in data collection, facilitating a standardized evaluation of students' perspectives within the university environment (Nardi, 2018; Hancock et al., 2018).

4.4 Data collection sources

4.4.1 Secondary data sources

This study uses secondary data from the Statistics Canada database to examine the sales of zero-emission cars (ZEV) in Canada from the 4th quarter of 2017 to the 3rd quarter of 2023. The results were presented in tabular form, and the respective years, alongside the quantities of ZEV registration – were categorized by province. This data is crucial for understanding the dynamics of ZEV adoption across different provinces during this period. By delving into the Statistics Canada database, this research aims to gain comprehensive insights into the patterns of new ZEV registration over the specified years, thereby shedding light on the evolving landscape of sustainable transportation practices in Canada. Including this data is pivotal as it allows for a detailed examination of the geographical distribution of ZEV sales, offering valuable information on the regional variations in adoption rate. Moreover, by categorizing the ZEV registration data by province, this study can discern disparities or trends in the uptake of ZEVs across different regions of Canada.

4.4.2 The quantitative questionnaire

Data collection involved administering questionnaires to a sample of 154 Trent University students. To ensure clarity and consistency, the questionnaire utilized a variety of question formats, including Likert Scale questions with a five-point scale ranging from '1= Very important' to '5= Not Important at all,' open-response questions, closed-ended questions, and multiple-choice questions. The questionnaire was in paper format and comprised 54 questions covering diverse topics such as demographic information, knowledge of EVs, barriers to adoption, benefits of EV ownership, and views on governmental policies. Additionally, it delved into the social factors influencing EV adoption, evaluated the effectiveness of campus EV charging infrastructure and addressed economic considerations. These economic considerations include affordability, maintenance costs, and financial implications associated with embracing EVs embracing EVs. The complete questionnaire is provided in Appendix A.

Questionnaires were strategically placed in high-traffic places around campus, including residence colleges, the Trent library, the student center, student lounges and other shared spaces, to ensure accessibility and convenience. The researcher personally facilitated the distribution by engaging with students—in-person interactions involved explaining the student to interested students, highlighting its importance, and encouraging participation. Additionally, participants were informed about the opportunity to enter a $50 Amazon gift card draw by completing a separate form and providing their name, email, and phone number. This draw was designed to add an incentive for the participant and was conducted randomly, with winners contacted via the provided email or phone number, ensuring confidentiality and privacy.

4.4.3 Sampling, Sample size and Participant recruitment

The study employed a non-probability convenience sampling approach to select participants. This methodology was chosen due to its suitability for the specific population under investigation and the accessibility of participants. The study focused on understanding the viewpoints of Trent University undergraduate and graduate students, with the inclusion criteria centred on their enrollment at the university and willingness to participate. While convenience sampling offers practical advantages, such as ease of accessibility and participants' willingness, it is essential to acknowledge its limitations and potential biases. This non-probability sampling technique does not ensure the representativeness of the entire student population, as it relies on participant self-selection. Consequently, the sample may not accurately reflect the diverse characteristics and perspectives of the broader student body, leading to potential sampling bias.

Furthermore, convenience sampling may introduce self-section bias, where individuals who volunteer to participate in the study may possess distinct characteristics or motivations that differ from those who choose not to participate. This bias could skew the results and limit the generalizability of the findings to the broader student population. To mitigate these limitations, the study aimed to recruit a diverse range of participants by distributing the survey across various academic disciplines, levels of study, and demographic backgrounds. However, it is important to note that the non-random nature of the sampling technique may still introduce biases, and the results should be interpreted with caution, particularly when attempting to generalize findings beyond the sample.

The surveys were administered between November 13 and December 15, 2023. A pretest with a cohort of 10 students was undertaken to assess the clarity of the questionnaire. This approach aimed to improve the structure and wording of the questionnaire, ensuring optimal understanding before the main study commenced. The study exclusively enrolled voluntary participants, with 154 students actively engaging. The sample size was determined based on statistical considerations and specific requirements of the research objectives, using G*Power statistical software to ensure adequate power for detecting meaningful patterns and drawing conclusive insights into the attitudes and perceptions of Trent University students regarding electric vehicles.

4.4.4 Analyzing survey data

The survey data were analyzed using quantitative methods, including univariate and bivariate techniques. For the univariate data analysis, frequency distribution tables were used to describe the socio-demographic variables, including gender, age, marital status, academic program, and academic level. Crosstabulation was used for the bivariate data analysis to compare the socio-demographic variables against attitudes about electric vehicles. The comparison aimed to explore how demographic elements influence perceptions regarding environmental impact, cost considerations and the factors shaping the adoption of electric vehicles.

In addition to crosstabulation, a Likert scale analysis was used to gauge satisfaction levels and record opinions across various electric vehicle-related factors. This includes students' knowledge levels, environmental concerns, perceived benefits and barriers, views on government incentives, range anxiety, social perceptions, financial considerations, and awareness of charging infrastructure. Numeric coding of responses facilitated a descriptive statistical analysis to gauge satisfaction levels. The reliability of the Likert scale was evaluated using Cronbach's alpha coefficient, ensuring internal consistency. By comparing the Likert scale findings to the crosstab analysis, comprehensive insights were drawn concerning Trent University students' perceptions and attitudes toward embracing electric vehicles.

4.5 Reliability statistics

Reliability statistics are analytical tools to assess the consistency and stability of measurements or scales within a research study. In this research, reliability statistics were used to evaluate the internal consistency of various constructs related to the benefits and barriers of EV adoption and factors based on their importance in influencing the decision to purchase an EV. The reliability or internal consistency assessment was determined using Cronbach's Alpha coefficients.

Cronbach's Alpha measures a scale's internal consistency, indicating how closely related a set of items is as a group (Vaske et al., 2016). Higher Cronbach's alpha values signify greater consistency, while lower values imply more significant variability or potential measurement errors (Vaske et al., 2016). The Cronbach's alpha was **0.719 to 0.895.** These coefficients suggest a moderate to high level of reliability, confirming that the items on the scale concerning electric vehicles are interconnected and provide a reliable assessment of the examined constructs.

4.6 Cross tabulation

In this analysis, the cross-tabulation table examines the influence of diverse socio-demographic characters and other variables on students' adoption of electric vehicles. The significance probability of 0.05 is set, and a probability value below this indicates that the variable significantly influences EV adoption. The null hypothesis states that the variable does not influence EV adoption, while the alternative hypothesis suggests the opposite.

The Chi-square test was chosen as the statistical tool to examine the associations between the variables due to its ability to analyze categorical data. The variables in this study meet the assumptions essential for the Chi-square test, including independence of observation and fulfillment of expected cell counts.

Chapter 5: Data analysis and discussion

5.1 Introduction

This chapter analyzes and discusses the data obtained to understand students' perceptions and attitudes toward adopting electric vehicles. The analysis, aligned with the research questions of this thesis, includes secondary data analysis and quantitative analysis of survey data. The secondary data analysis explores Statistics Canada data on the total number of new zero-emission vehicle (ZEV) registrations across the provinces (2017 – 2023). The quantitative analysis focuses on the survey data that explores socio-demographic characteristics, knowledge about electric vehicles, benefits of EV ownership, main barriers to EV adoption and factors influencing students' decision to adopt EVs. These analyses shed more insights into students' attitudes and perceptions toward EV adoption, thereby informing policy implications for promoting student electric vehicle adoption.

5.2. Registration of new zero-emission vehicles in Canada

As discussed in Chapter One, adopting ZEVs in Canada has undergone notable changes over the years (He et al., 2023). Table 5.1 presents data on new ZEV registrations from the 4th quarter of 2017 to the 3rd quarter of 2023, providing insight into the changing landscape of ZEV adoption in Canada's major geographic areas. The data has been aggregated from the originally quarterly figures provided by Statistics Canada to present the information annually from 2017 to 2023.

EV registrations in Canada have shown a consistent upward trend since 2017, with notable increases in 2018 and 2023 (Table 5.1). The total registrations of ZEVs in Canada have experienced an approximately 200% increase from 2018 to 2023, aligning with the surge in EV production in the United States (Kim et al., 2022). This surge in EV sales reflects a broader shift towards embracing electric vehicles, driven by government incentives, consumer preferences for green technology, and expanding charging infrastructure.

Turning our focus to specific provinces, Quebec has been a leader in ZEV adoption, surpassing other provinces in new registrations. Data reveals an upward trajectory in Quebec, with a substantial increase of approximately 2,145.4% from 2017 to 2023. This trend reflects Quebec's active pursuit of sustainable transportation solutions and its rising preference for zero-emission vehicles. This surge reflects Quebec's proactive stance towards sustainable transportation solutions and its growing inclination toward ZEVs. The province's commitment to ZEV adoption is evident through its leading role in Canada and its continuous efforts to promote environmentally friendly transportation options.

Quebec's dedication to advancing EVs is underlined by significant financial incentives, including rebates and tax credits, to incentivize consumers to choose EVs (Rasbash et al., 2023). Also, the province's robust charging infrastructure addresses range anxiety and ensure convenient access to charging stations, which is pivotal in driving EV sales growth (Zhang et al., 2017). Furthermore, the province's proactive approach to emission trading and climate policy has created a conducive environment for EV adoption. Quebec has achieved cost savings through carbon trading partnerships with California, demonstrating a solid commitment to environmental sustainability and creating favourable conditions for EV adoption (Purdon et al., 2021).

Moving on to other provinces, Ontario is the second-highest province with ZEV registrations, with a substantial increase of approximately 1,225.4% from 2017 to 2023. Despite fluctuations in later years, Ontario maintained a strong preference for the ZEV market, demonstrating a continued interest in electric vehicles. Building on this momentum, British

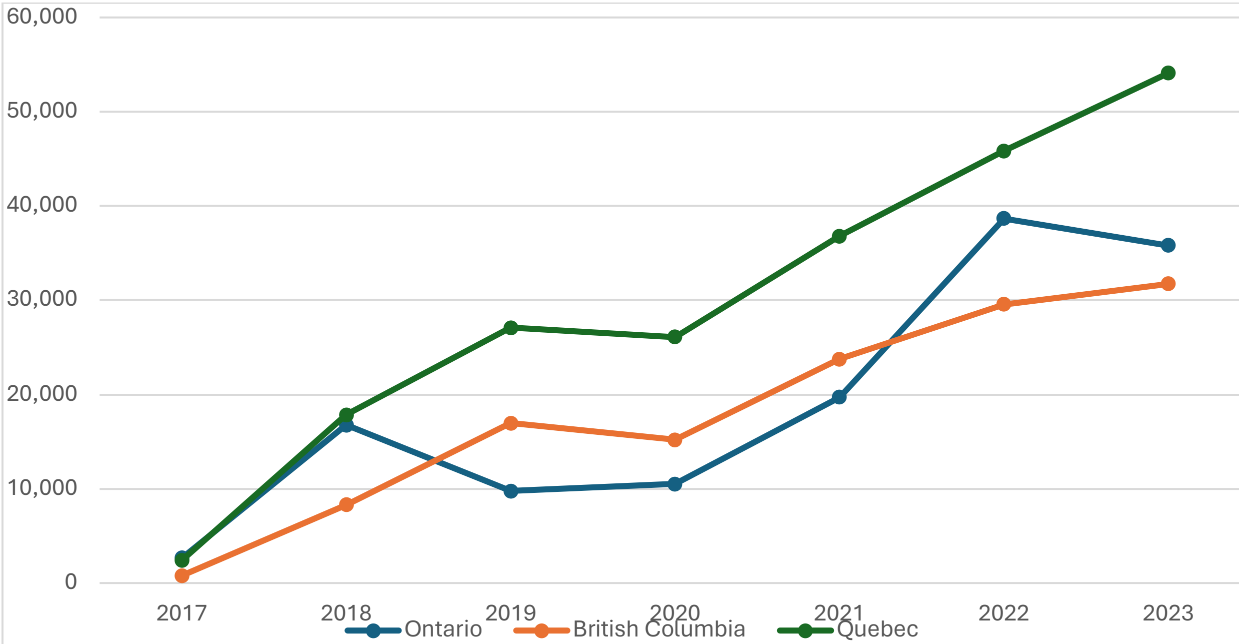
Columbia has also played a significant role in ZEV adoption, with a notable percentage increase of 3,926.4% in registrations from 2017 to 2023.

Connecting back to the broader context of ZEV adoption across Canada, the cases of the Yukon and Northern Territories highlight emerging trends despite the lower absolute numbers. The gradual rise in ZEV registrations in these regions suggests increasing interest despite challenges like extreme weather conditions and limited infrastructure (Wazneh et al., 2019). These factors stress the importance of addressing barriers to ZEV adoption to ensure a more widespread transition toward sustainable solutions nationwide.

In conclusion, the registration data for new ZEVs in Canada paints a promising picture of the country's progress toward a more sustainable transportation future. The significant growth in ZEV adoption, particularly in leading provinces like Quebec, Ontario, and British Columbia, demonstrates the effectiveness of government incentives, infrastructure investments, and consumer preferences. However, the challenges faced in remote regions underscore the need for a comprehensive and inclusive approach to ensure the benefits of ZEV technology are accessible to all Canadians. Continued efforts to address barriers and promote widespread ZEV adoption will be crucial in Canada's journey towards a low-carbon transportation system.

Figure 2

The trend of ZEV registrations in Canada's three largest provinces



Source: Statistics Canada, 2023

Table 5. 1

New zero emission vehicle registration from 2017 - 2023

Geography	No. of zero emission vehicles registered in the year						
	2017	2018	2019	2020	2021	2022	2023
Canada	5,999	44,283	56,165	54,353	86,032	123,562	132,783
Newfoundland and Labrador	-	-	-	-	-	-	-
Prince Edward Island	1	16	44	45	174	217	353
Nova Scotia	-	-	-	-	-	-	-
New Brunswick	8	56	166	180	472	861	1,207
Quebec	2,409	17,843	27,071	26,102	36,800	45,851	54,091
Ontario	2,642	16,758	9,762	10,515	19,726	38,655	35,810
Manitoba	12	159	289	311	631	1047	1,213
Saskatchewan	7	87	185	199	478	704	816

Alberta	-	-	-	-	-	-	-
British Columbia	788	8,313	16,970	15,179	23,767	29,580	31,728
Yukon	0	2	9	25	67	82	105
Northwest Territories	0	3	1	7	16	27	23
Nunavut	-	-	-	-	-	-	-

Source: Statistics Canada, 2023

Note. Symbol (-) demonstrates not available for a specific reference period

5.3 Primary data results

The secondary data analysis on ZEV registrations in Canada has provided valuable insights into the broader trends and adoption patterns nationwide. However, it is essential to complement this macro-level data with primary data to gain a deeper understanding of the factors influencing ZEV adoption among students. The transition from secondary to primary data allows us to bridge the gap between the broader market trends and the individual-level factors that shape consumer behaviour and attitudes. This section is structured as follows: demographics of participants, benefits of EV adoption among students, barriers to EV adoption, and factors influencing the adoption of EVs among students.

5.3.1 Demographics of Participants

The analysis of students' socio-demographic characteristics, as presented in Table 5.2, lays the framework for understanding the diverse sample surveyed in the study on electric vehicle adoption perception and attitudes. The exploration includes variables such as gender, age, marital status, academic discipline, and academic level, shedding light on the factors influencing students' perceptions and attitudes toward EV adoption.

Examining the gender distribution, the data reveals a diverse representation among surveyed students, with males accounting for 53.2%, females for 38.3%, non-binary individuals for 3.3%, and those who prefer not to disclose their gender for 5.2%. This diversity sets the stage for understanding how different gender identities may influence attitudes toward EV adoption.

Moving on to age distribution, most students (53.3%) fall between the ages of 21 and 30, showcasing the importance of generational perspective in the study. Furthermore, marital status data indicates that most students are single (68.8%), while 24.7 % are married. Notably, a segment of the student population identifies as divorced or separated. This demographic information offers a lens to investigate how different marital statutes may influence student attitudes and perceptions toward EV adoption.

Exploring academic disciplines, students demonstrate a wide range of academic fields. Social Sciences (39.6%) include sociology, psychology, sustainability, economics, anthropology, criminology, political studies, and social work. Transitioning to Natural Sciences (27.3%) includes biology, chemistry, nursing, and environmental science. Within Applied Sciences (16.2%) engaged with applied modelling, data science, and computer science. Humanities (9.1%) centers around history, literature, and philosophy. Lastly, the Arts (7.8%) includes cultural studies, English, and Canadian studies.

Having explored the academic landscape, linking this diversity with the distribution of academic levels is essential. The academic level distribution ranges from first-year students (25.3%) to graduate students (21.4%), with various levels in between, including second-year (20.8%), third-year (14.3%) and fourth-year (18.2%). This academic diversity offers insights into how different stages of education may influence attitudes toward EV adoption among students.

Table 5.2

Socio-demographics of students

Variable	Characteristics	Frequency (n = 154)	Percentage (%)
Gender	Male	82	53.2
	Female	59	38.3
	Non-Binary	5	3.3
	Prefer Not to Say	8	5.2
Age	Less than 20 years	38	24.7
	21 - 30 years	82	53.3
	31 – 40 years	31	20.1
	41 – 50 years	2	1.3
	Over 51 years	1	0.6
Marital Status	Married	38	24.7
	Single	106	68.8
	Divorced/Separated	8	5.2
	Widowed	2	1.3
Academic Discipline	Applied Science	25	16.2
	Arts	12	7.8
	Humanities	14	9.1
	Natural Science	42	27.3
	Social Science	61	39.6
Academic Level	First year	39	25.3
	Second year	32	20.8
	Third year	22	14.3
	Fourth year	28	18.2
	Graduate Student	33	21.4

Source: Primary Survey Questionnaire, 2024

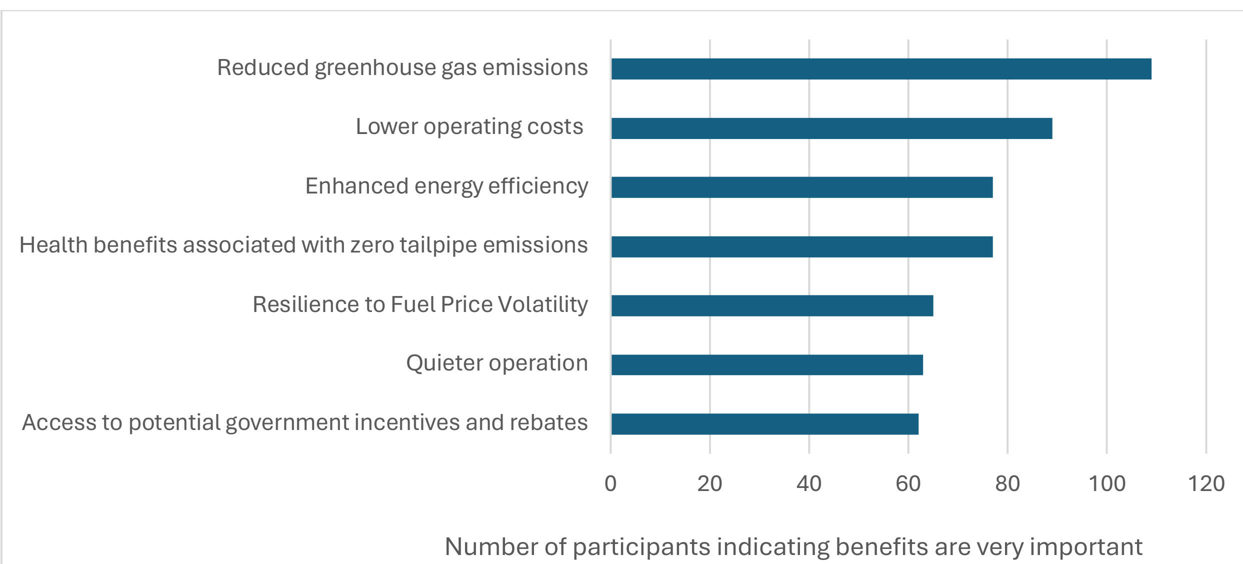
5.4 Benefits of electric vehicle adoption among students

Electric Vehicle (EV) adoption is gaining momentum worldwide, driven by its potential to mitigate environmental impact, reduce operational costs, and enhance sustainability. In this context, participants were asked to provide their perspective on the importance of various benefits associated with EV adoption. Specifically, they were asked to rate the importance of these benefits on a scale provided in the survey questionnaire. Figure 3 illustrates the survey responses regarding the benefits of EV adoption among students.

Among the array of benefits identified, several stand out as particularly impactful for students. These include reduced GHG emissions, which align with the environmentally conscious mindset prevalent among students and foster a sense of environmental responsibility. Additionally, lower operating costs present a tangible financial advantage, appealing to students managing tight budgets. Moreover, the enhanced energy efficiency of EVs contributes to improved fuel economy, while their resilience to fuel price volatility ensures more stable budgeting for vehicle operation. The health benefits of reduced air pollution and emission contribute to a healthier student living environment, promoting overall well-being, quality of life, and quieter operations, offering a more peaceful and serene driving experience. Lastly, governmental incentives further sweeten the deal, providing students with additional financial support or incentives for choosing EVs.

Figure 3

Benefits of Electric Vehicle Adoption



Source: Primary Survey Questionnaire, 2024

5.4.1 Reduced greenhouse gas emissions

The concern for reducing greenhouse gas (GHG) emissions is paramount among participants, with 70.8% considering this a significant benefit (Figure 3). This finding aligns with the research conducted by Din et al. (2023) and Hai-qing et al. (2021), which indicates that consumers choose EVs due to their reduced GHG emissions. The environmental impact of transportation, particularly in terms of GHG emissions, has received considerable attention in the context of climate change and sustainable living. As the transportation sector substantially contributes to GHG emissions, adopting EVs presents a promising solution to reduce these emissions and combat climate change (Adnan et al., 2016). The potential of EVs to lower GHG emissions is consistent with the growing awareness and concern among younger individuals, including students, regarding environmental sustainability and climate change (Li et al., 2020). Furthermore, reducing GHG emissions from transportation through the widespread adoption of EVs can improve air quality and public health, which are important considerations for students and the broader community (Li et al., 2020).

5.4.2 Lower operating cost

The economic benefits of adopting electric vehicles (EVs) were a key consideration for respondents in the survey. Most respondents, 57.8%, identified lower operating costs as an important benefit of EV adoption. This finding corroborates the conclusions drawn by Mersky et al. (2016) and Xue et al. (2021), who reported that EVs are generally more cost-effective than conventional vehicles due to lower fuel (electricity) costs and reduced maintenance requirements.

EVs have fewer moving parts than internal combustion engine vehicles (ICEVs), resulting in fewer components that may fail or require servicing. For example, EVs do not need oil changes, and their brake systems often last longer due to regenerative braking. The overall lower lifetime operating cost of EVs makes them an economically attractive choice for consumers. A recent study by Ma et al. (2023) found that the total cost of ownership for EVs, including fuel and maintenance expenses, is generally lower than that of comparable ICEVs. This benefits budget-conscious individuals, such as students, who may prioritize long-term cost savings.

5.4.3 Enhanced energy efficiency

Electric vehicles (EVs) stand out for their increased energy efficiency, which 50.0% of respondents consider very important. This current finding supports the conclusions of Vijayakumar et al. (2022), which indicate that consumers opt for EVs due to their enhanced energy efficiency. This efficiency stems mainly from how EVs convert electrical energy from the grid into power for the wheels. Unlike traditional gasoline cars, which only convert 12%-30% of the energy stored in fuel to power at the wheels, electric vehicles reach a conversion rate of more than 77% (Ritchie, 2023). This difference in energy conversion efficiency makes EVs more cost-effective for energy usage. It also contributes to their environmental benefits by reducing the electricity demand and, thus, the emissions associated with power generation. Advances in technology and more knowledge of energy management in EVs continue to push the limits of what is possible, making them an increasingly attractive option for consumers with both environmental sustainability and operational efficiency.

5.4.4 Health benefits linked to zero tailpipe emissions

The health benefits of zero tailpipe emissions are a significant benefit from EV adoption. Respondents recognize the importance of this advantage, with 50.0% of respondents considering the health benefits of zero tailpipe emissions technology an important benefit. This result reinforces the findings of Chang et al. (2023) and Ji et al. (2015), which revealed that consumers' willingness to adopt EVs is influenced by the health benefits associated with their zero-emission technology.

Electric vehicles (EVs) produce no tailpipe emission, significantly improving air quality by eliminating health-harming pollutants like nitrogen dioxide (NO_2) and particulate matter. This improvement in air quality, especially in urban areas with high traffic congestion and pollution levels, directly reduces health risks linked to air pollution, such as respiratory diseases and cardiovascular and premature deaths (Anosike et al., 2021; Hawkins et al., 2012).

Studies indicate that the health benefits of EVs extend to economic savings in healthcare costs. For instance, a study predicts that by 2050, EVs could save residents of Los Angeles an estimated $12.6 billion annually in health-related costs (NRDC, 2023). Furthermore, adopting EVs can help address environmental justice issues by reducing harmful emissions in low-income communities and communities of colour, leading to better health outcomes (Chang et al., 2023; Ji et al., 2015).

5.4.5 Resilience to fuel price volatility

The robustness of EVs to fuel price fluctuations is a noteworthy consideration, with 42.2% of students marking it as very important. Unlike gasoline or diesel prices, which are influenced by global market forces and geopolitical conflicts, electricity prices are more stable and predictable. This stability may be attributed to various energy sources that generate electricity, including renewables and pricing control. In line with Mishra and Malhotra's (2019) findings, this discovery affirms the substantial influence of increased fuel prices on shaping consumer attitudes towards EVs. As a result, adopting EVs can provide customers with a more stable and predictable cost structure reducing their vulnerability to abrupt increases in fuel prices.

5.4.6 Quieter operation

Electric vehicles are noted for their quieter operation, and 40.9% of the students identified this as a very important benefit of EV adoption. The lower noise levels of EVs are primarily due to the lack of an internal combustion engine, which usually accounts for most of the noise in conventional vehicles. Instead, EVs utilize electric motors to transform electricity power smoothly and quietly. This contributes to a more serene travelling experience for drivers and passengers and reduces noise pollution in urban environments, creating a more harmonic setting for communities. This finding is consistent with Bigerna and Micheli (2018), who revealed that the quiet operation of EVs influences the attitudes toward EVs among highly educated individuals, including students and faculty members, indicating its importance in shaping consumer preferences.

Moreover, it should be noted that the reduced noise levels of EVs have implications for pedestrian safety and awareness. Concerns have been raised about the potential risk of accidents and collisions due to the silent operation of EVs, which may go unnoticed by pedestrians. This has prompted research into the effectiveness of EV alarms based on pedestrians' perceptions and highlights the need to address the potential hazards associated with the quiet operation of electric motors (Belenguer et al., 2022).

5.4.7 Access to potential Government incentives and rebates

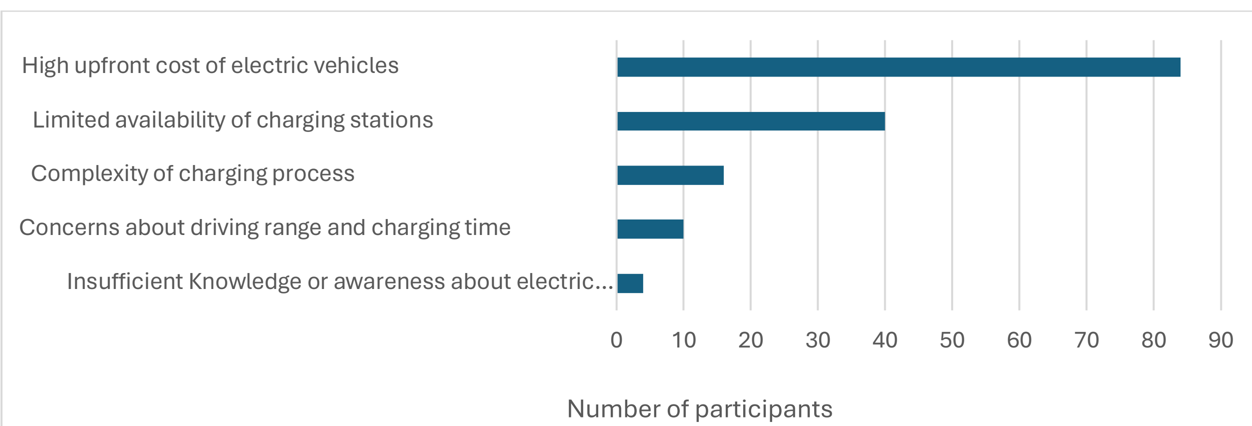
The desire to access potential government incentives and rebates is a significant benefit to students in evaluating EV adoption, with 40.3% regard it as very important. This result is consistent with the research conducted by Gomes et al. (2020), Javadnejad (2023) and Thananusak et al. (2020), which suggest that governmental incentives such as tax credits, rebates and subsidies are intended to make EVs more affordable and boost adoption by reducing the upfront costs. This, in turn, makes EVs a more viable option for a broader range of consumers, including students, and is a key reason why consumers choose to adopt EVs. Additionally, non-financial incentives, such as access to carpool lanes and free parking, further enhance the attractiveness of EVs. Consequently, government incentives are vital in accelerating the transition to electric mobility and supporting global and national efforts to reduce carbon emissions.

5.5 Main barriers to electric vehicle adoption among students

Understanding the barriers to electric vehicle (EV) adoption among students is critical for guiding targeted interventions and promoting a sustainable transportation transition. Participants were asked to identify their main barriers to EV adoption. Identifying these barriers sheds light on students' specific challenges, enabling policymakers, educators, and industry stakeholders to develop tailored strategies for this population segment. Among the key barriers highlighted by respondents was the lack of charging infrastructure, which poses practical challenges in accessing charging stations conveniently. The high upfront cost of EVs presents a financial barrier for students, impacting their decision-making process. Concerns regarding driving range and charging time add to the apprehension around EV adoption. Additionally, insufficient knowledge and awareness about EVs emerge as significant barriers, indicating a need for enhanced education and outreach efforts to bridge this gap.

Figure 4

Main Barriers to Electric Vehicle Adoption



Source: Primary Survey Questionnaire, 2024

5.5.1 High upfront cost

The high upfront cost is a significant barrier hindering student adoption of EVs. This financial concern impacts students' attitudes toward EV adoption, with 54.5% of respondents identifying it as a prominent barrier, as illustrated in Figure 4. The results presented here align with the conclusions drawn by Sovacool et al. (2019), who found that the high upfront cost of EVs is the main barrier impeding consumer adoption. The high upfront cost of EVs presents a formidable challenge rooted in students' financial constraints and the cost difference between EVs and conventional vehicles. This cost disparity can discourage students from considering EVs as a viable option. This finding was also reported by Rezvani et al. (2015), highlighting financial issues as a critical influencer in EV adoption intentions.

A multifaceted strategy is required to address this primary impediment. This involves exploring new business models and financial incentives to make EVs more affordable to students so they can overcome economic barriers to adoption (Bohnsack et al., 2014; Shalender, 2018). As Sovacool et al. (2019) suggested, government incentives or subsidies can make EVs more financially accessible to students, fostering a positive shift in attitudes and promoting increased adoption. Existing literature supports the findings of this research since others have established the importance of economic stability and incentives in overcoming barriers to EV adoption (Gopinathan & Shanmugam, 2022; Javadnejad, 2023).

5.5.2 Limited availability of charging stations

The limited availability of charging stations is a barrier to the widespread adoption of EVs among students, as cited by 26% of the respondents. These findings corroborate the research conducted by Qi et al. (2018), which identified the limited availability of charging stations as a significant barrier to widespread EV adoption. This limitation influences the viability and practicality of EV ownership for students, especially regarding daily commuting. The scarcity of charging points around educational institutions and student residential areas is challenging, as students often need more travel range and charging options. This constraint can cause range anxiety and raise concerns about the viability of using EVs as a mode of transportation.

Additionally, the absence of a well-distributed network of charging stations might hamper the smooth integration of EVs into students' daily routines, reducing their trust in EVs' dependability and practicality for their mobility needs. These findings align with the research conducted by Ullah et al. (2022), which reveals that the convenience and accessibility of charging stations are critical factors for EV consumers, including students. Students often have tight schedules and may be unable to accommodate the extended detours to locate available charging stations (Ullah et al., 2022).

5.5.3 Complexity of the charging process

The complexities in the charging process of EVs pose a barrier to adoption, as 10.4% of the respondents indicated. This result is consistent with research conducted by Globisch et al. (2019) and Hardinghaus et al. (2022), which found that complexities in the EV charging process pose a barrier to adoption, discouraging potential EV adopters. The complex nature of charging procedures, including locating stations, navigating payment systems, and understanding usage protocols, introduces perceived difficulty that discourages consumers from adopting EVs. Students who frequently balance demanding schedules prioritize simplicity and efficiency in everyday activities. The complex charging process creates a barrier and adds another degree of burden to an already demanding lifestyle (Brady & O'Mahony, 2016; Wang et al., 2013).

Furthermore, the complex charging procedures may cause students to lose confidence and feel inconvenienced. Due to their unfamiliarity with complicated systems, students may be hindered from adopting EVs as they seek a straightforward and user-friendly way to incorporate electric vehicles into their daily lives (Ou et al., 2020). In essence, addressing this barrier entails not only improving the physical charging infrastructure but also ensuring that the associated processes are intuitively designed and easily navigable, in line with the preferences and demands of the student population (Wang et al., 2019; Yamamoto & Morikawa, 2016).

5.5.4 Concerns about driving range and charging time

Concerns regarding driving range and charging time were identified as barriers to EV adoption by 6.5% of the surveyed students. The results presented here align with the research conducted by Kim et al. (2017), which emphasized the concerns about driving range as a barrier to EV adoption. The study by Kim et al. (2017) found that when EVs have a limited driving range, it frequently leads to range anxiety - the worry about the EV's ability to cover sufficient distance on a single charge. This range anxiety can be a psychological barrier that dissuades consumers from viewing EVs as a feasible option for their transportation needs (Steinstraeter et al., 2021).

Furthermore, the time required for charging emerges as one of the primary concerns cited by consumers who hesitate to buy an EV (Markit, 2023). This finding is consistent with the present research, highlighting concerns about charging time among the surveyed students. The perceived difficulty and inconvenience associated with the lengthy charging process can discourage consumers from choosing EVs, as they may prefer the faster fueling times of conventional gasoline-powered vehicles.

5.5.5 Insufficient knowledge or awareness about electric vehicles

Insufficient knowledge and awareness about EVs have been identified as barriers to adoption, as indicated by 2.6% of the respondents. This finding is consistent with that of Long et al. (2019) and Wang et. (2018), which revealed that misconception due to lack of information is a barrier to EV adoption among consumers. This lack of awareness extends to various topics, including the benefits, technology, operational elements, cost savings, government incentives, and overall ownership experience of EVs. This knowledge gap may undermine students' confidence and motivation to adopt EVs as an alternative mode of transportation, potentially leading to misconceptions and limited understanding of EVs' capabilities and benefits.

Moreover, the limited awareness about EV-related factors such as range capabilities and charging infrastructure contributes to uncertainty and hesitance among students. This misunderstanding about the convenience and practicality of EVs becomes a critical factor in students' transportation decision-making process. Addressing these knowledge gaps is crucial to fostering a positive perception and encouraging the adoption of EVs among students, as it not only enhances their understanding of this sustainable transportation option but also dispels misconceptions that may deter them from considering EVs as a viable option.

5.6 Key contributing factors to electric vehicle adoption among students

The transition towards sustainable mobility is increasingly reliant on understanding the factors that drive consumer adoption of EVs. In this section, participants were asked to provide insights into the key contributing factors influencing their decision-making process regarding EV adoption. Specifically, they were asked to rate the importance of these factors on a scale provided within the survey questionnaire.

Amidst the global momentum surrounding EV adoption, understanding these factors becomes paramount for shaping targeted strategies that resonate with students' preferences and needs. Table 5.3 presents an overview of the key contributing factors, shedding light on the diverse factors influencing students' attitudes and perceptions toward EV adoption.

Table 5.3

Key contributing factors to electric vehicle adoption among students

Reasons	Very Important		Somewhat Important		Not at all Important	
	n	%	n	%	n	%
Cost savings (e.g., lower fuel and maintenance costs)	97	63.0	63	33.8	5	3.2
Environmental considerations (e.g., reduced emissions)	81	52.6	56	36.4	17	11.0
Availability of charging infrastructure	70	45.5	67	43.5	17	11.0
Social pressure	68	44.2	65	42.2	21	13.6
Government incentives and rebates	47	30.5	79	51.3	28	18.2
Vehicle performance and features	75	48.7	55	35.7	24	15.6
Reliability and durability of electric vehicles	59	38.3	71	46.1	24	15.6
The resale value of electric vehicles	56	36.4	62	40.2	36	23.4
Concerns about battery life and replacement costs	64	41.6	68	44.1	22	14.3

5.6.1 Cost savings

The economic benefits of EVs emerge as a primary driver of adoption among students, with 63% rating them as an important factor. Palmer et al. (2018) confirmed this finding, identifying cost savings as a key influence on consumer preferences for alternative fuel vehicles. Comparing the findings with previous studies, it is evident that EVs generally have lower fuel and maintenance costs, which aligns with students' budget constraints. This makes EVs an attractive option for long-term savings and reducing operational expenditures. This observation is consistent with the research conducted by Dumortier et al. (2015), which supports the notion that EVs' lower operational costs impact consumer preferences for alternative fuel vehicles. This evidence highlights the compelling incentive for students to seek affordable transportation options within their budget limits. EVs' economic appeal and reduced fuel and maintenance costs are critical in encouraging adoption.

Existing literature, such as the study by Palmer et al. (2018), has shown that EVs often have lower operating expenses due to reduced yearly fuel costs, taxes, and maintenance requirements. This benefit aligns with the current findings, which suggest that students' budget constraints present an opportunity for long-term savings and reduced operational expenses through the adoption of EVs. This underlines the necessity of explaining the economic benefits of EV adoption to students so they know the financial advantages of adopting electric vehicles.

5.6.2 Environmental considerations

Environmental considerations, such as reduced emissions, are a key factor driving EV adoption among students, with 52.6% of respondents indicating that they are very important in their decision-making. This finding highlights the profound environmental awareness among students regarding the impact of transportation on the planet and underscores the environmental considerations as a key contributing factor to EV adoption. The current findings align with research conducted by Din et al. (2023), Hai-qing et al. (2021), Hawkins et al. (2012) and Rezvani et al. (2015), who reported that environmental considerations such as reduced emissions are a key contributing factor to EV adoption among consumers. The existing literature supports this observation, as the impact of transportation on the environment, especially GHG emissions and air pollution, has gained substantial attention in the pursuit of climate change mitigation. Electric vehicles (EVs) emerge as a promising solution to mitigate these emissions and combat climate change, aligning with students' growing environmental awareness and concerns.

Additionally, the life cycle assessment of EVs, including consideration of environmental impact during production, use and end-of-life treatment processes, emphasizes the environmental advantages of EVs compared to conventional vehicles (Singh et al., 2014). This evidence can influence students' perceptions and attitudes regarding EV adoption as they recognize the potential for EVs to contribute to a more sustainable future.

However, it is important to note that the overall environmental impacts of EVs are partly determined by the electricity sources used to charge them and the emissions associated with vehicle and battery production. Despite these considerations, the transition to EVs, especially when combined with a shift toward cleaner energy sources for power generation, represents a crucial step toward reducing the carbon footprint of personal transportation.

5.6.3 Vehicle performance and features

The performance and features of EVs play a pivotal role in driving student adoption, with 48.7% of respondents indicating it as very important. This suggests that students are drawn to electric vehicles due to economic and environmental considerations and vehicle performance, features, and the overall driving experience. This result echoes the conclusion drawn by White and Sintov (2017), who found that technical capabilities and unique features, such as acceleration, range, and advanced driver assistance systems, increase the attractiveness of EVs among consumers. These features improve the driving experience and align with students' preferences in seeking efficient and technologically advanced transportation options.

Additionally, the availability of advanced features such as connectivity, infotainment systems, and autonomous driving capabilities is consistent with students' technological expectations, further contributing to the appeal of EVs as modern and innovative transportation solutions (Liu et al., 2018). Integrating these advanced features and performance capabilities enhances the attractiveness of EVs to students, aligning with their preferences for modern and technologically advanced vehicles.

5.6.4 Availability of charging stations

The availability of charging infrastructure is also crucial, with 45.5% of students considering it very important. This factor influences the practicality, ease, and viability of electric vehicles among students. These findings reflect those of Wolbertus & Hoed (2019) and Wu (2022), who also found that a well-distributed charging infrastructure network is crucial to consumer decisions to adopt EVs. This factor directly addresses issues about range anxiety and charging accessibility, which are essential for students with tight schedules and limited flexibility.

Furthermore, a well-established charging station network assures students that they can quickly charge their EVs, effectively addressing concerns about their reliability and practicality for daily transportation (Fotouhi et al., 2019; Ullah et al., 2023). This accessibility alleviates concerns and contributes to a positive ownership experience for students. Additionally, the availability of charging infrastructure substantially impacts students' confidence in owning electric vehicles. Access to charging facilities increases the appeal of electric vehicles as a sustainable and feasible mode of transportation (Ma et al., 2021; Ullah et al., 2022). The consistent availability of charging stations not only answers practical problems but also helps to give a more significant impression of EVs as a dependable and convenient means of transportation.

5.6.5 Social pressure

The importance of social pressure is evident, with 44.2% of students noting it as a very important factor in their consideration of EVs. This finding aligns with the evidence presented by previous studies, such as those conducted by White & Sintov (2017) and Liao et al. (2016). These studies suggest that people tend to observe and imitate the behaviours of their peers and social circles, particularly when adopting new technologies like EVs. The presence of EVs within an individual's social network and the positive encouragement from their peers can help students perceive EV ownership as a normal and desirable choice.

Furthermore, the impact of social pressure can extend beyond the initial adoption decision. Sharing positive experiences and recommendations within social networks can increase the overall appeal of EVs among students (Rezvani et al., 2015). As individuals witness their peers enjoying the benefits of EV ownership and sharing their enthusiasm, it can create a ripple effect, further driving the normalization and desirability of sustainable mobility options within the student population.

Additionally, the impact of social pressure manifests in the context of environmental awareness and sustainability. When EV adoption aligns with social and environmental values within peer groups, it can foster a sense of social responsibility and desirability regarding sustainable transportation choices. Consequently, students view EV adoption as a conscientious decision reflecting an individual and collective commitment to environmental well-being (White & Sintov, 2017; Liao et al., 2016).

5.6.6 Concerns about battery life and replacement cost

Regarding the adoption of EVs among students, the practical considerations of battery life and replacement costs play a significant role in shaping students' attitudes and perceptions. The findings indicate that these factors are highlighted as major concerns, with 41.6% rating them as important in influencing their decision to adopt EVs. This aligns with the existing evidence resented by studies conducted by Axsen et al. (2016) and Pamidimukkala et al. (2024), which have also identified concerns about battery life and replacement cost as key factors influencing consumer decisions to purchase EVs.

The uncertainty surrounding battery life and replacement cost can impact students' perceptions and EVs' overall reliability and durability. The potential need for battery replacement may also raise questions about EVs' long-term performance and functionality, influencing students' confidence in their investments. Moreover, battery life concerns and replacement could lead to students questioning the environmental sustainability of EVs, as replacing batteries may raise concerns about the disposal of old batteries.

5.6.7 Reliability and durability of electric vehicles

The reliability and durability of EVs emerge as a critical consideration for students when adopting EVs. The research findings indicate that 38.3% of respondents consider these factors important in their decision-making process. This finding corroborates the conclusions drawn by Rezvani et al. (2015), who indicate that the reliability and durability of EVs influence consumers' intention to adopt EVs. Like many consumers, students value durable, long-lasting, and low-maintenance vehicles. The reliability and durability of electric vehicles can give students confidence in their long-term performance and functionality. Students are inclined to choose vehicles that provide constant and reliable performance and long-term durability to fulfill their transportation needs without frequent disruptions or unexpected maintenance.

Furthermore, the reliability and durability of EVs can shape students' perceptions of the long-term cost-effectiveness of EV ownership. Vehicles that are reliable and durable are often linked to lower maintenance costs and a reduced likelihood of unexpected repairs, which aligns with students' budgets (White & Sintov, 2017).

5.6.8 The resale value of electric vehicles

The potential resale value of the vehicle is a pivotal consideration for students when it comes to the adoption of EVs. The findings indicate that 36.4% of respondents view this as an important factor in their decision-making process. This result is consistent with the research conducted by Egbue and Long (2012), who also reported that the resale value of an EV is an important factor for consumers, including students, as it influences long-term cost ownership and potential return on investment.

Given that students often have budget constraints and financial concerns, the potential resale value of an EV might influence their decision to adopt this technology. A greater resale value can make EV ownership more appealing, providing students with a sense of security and confidence in their investment, particularly if they plan to sell their vehicles in future. The ability to recoup a substantial portion of the initial investment through a favourable resale value can be a significant factor in students' evaluation of the overall cost-effectiveness of EV ownership. This, in turn, can contribute to their willingness to embrace EVs as a viable and financially prudent transportation option.

5.6.9 Government incentives and rebates

Regarding student adoption of electric vehicles (EVs), the importance placed on government incentives and rebates cannot be overstated. The research findings indicate that 30.5% of the surveyed students consider these financial measures a crucial factor in their decision-making process. This emphasis on government incentives and rebates aligns with existing research in this field. Studies conducted by Gomes et al. (2020), Javadnejad (2023), and Thananusak et al. (2020) suggest that these financial measures, including tax credits, rebates, and subsidies, in shaping consumer adoption of EVs, particularly among students who often face budget constraints and limited resources.

These government-backed financial incentives can act as catalysts, helping to overcome the higher upfront costs associated with EVs and making them a more accessible and viable transportation option for students. By offsetting the initial investment required, these incentives and rebates can contribute to students' perceptions of the long-term cost-effectiveness of EV ownership.

To illustrate, Canada has implemented the Incentives for Zero Emission Vehicles (ZEV) program, providing various incentives to promote EV adoption. Eligible consumers can benefit from up to $5,000 in purchase and lease incentives (Transport Canada, 2024). Furthermore, specific provinces offer additional rebates to enhance their financial attractiveness. In British Columbia, EV drivers can qualify for up to $5,750, Quebec provides up to $7,000 to purchase a fully electric or plug-in hybrid vehicle, and Prince Edward Island offers up to $5,000 for such purchases (Electric Vehicle Incentives, n.d.).

5.7 Factors influencing adoption of electric vehicles among students

In pursuing sustainable mobility, understanding the factors influencing the adoption of electric vehicles (EVs) among students is paramount. This section addresses the research question, "What factors influence the adoption of electric vehicles among students?". It explores the relationship between various factors and the student population's adoption of electric vehicles (EVs). Utilizing cross-tabulation tables, this study examines the influence of demographic characteristics and other relevant factors on the adoption of electric vehicles. The analysis seeks to unveil associations and patterns within these variables, offering insights into the factors that significantly contribute to the adoption of electric vehicles among students.

Table 5. 4

Chi-Square test for categorical variables

Variables	Willing to adopt an EV				p-value	Chi-square value	Degree of freedom
	Yes		No				
	n	%	n	%			
Gender					0.728	1.306	3
Male	63	76.8	19	23.2			
Female	45	76.3	14	23.7			
Non-Binary	3	60.0	2	40.0			
Prefer not to say	7	87.5	1	12.5			
Age					0.145	6.841	4
Less than 20 years	33	86.8	5	13.2			
21 – 30 years	60	73.2	22	26.8			
31 – 40 years	24	77.4	7	22.6			
41 – 50 years	1	50.0	1	50.0			
Over 51 years	0	0	1	100.0			
Marital Status					0.180	4.893	3
Married	28	73.7	10	26.3			
Single	85	80.2	21	19.8			

Divorced/ Separated	4	50.0	4	50.0			
Widowed	1	50.0	1	50.0			
Academic Discipline					0.110	7.548	4
Applied Science	21	84.0	4	16.0			
Social Science	48	78.7	13	21.3			
Natural Science	34	81.0	8	19.0			
Humanities	7	50.0	7	50.0			
Arts	8	66.7	4	33.3			
Academic Level					0.476	3.509	4
First Year	32	82.1	7	17.9			
Second Year	25	78.1	7	21.9			
Third Year	14	63.6	8	36.4			
Fourth Year	23	82.1	5	17.9			
Graduate Student	24	72.7	9	27.3			
Knowledge about Electric Vehicles*					.038*	4.296	1
Very Knowledgeable	51	86.4	8	13.6			
Somewhat Knowledgeable	36	75.0	12	25.0			
Neutral	19	65.5	10	34.5			
Not very Knowledgeable	8	72.7	3	27.3			
Not Knowledgeable at all	4	57.1	3	42.9			
Ridden or driven an EV*					.002*	3.841	1
Yes	62	76.5	19	23.5			
No	56	76.7	17	23.3			
Awareness of Government Incentives*					.008*	2.925	2
Yes	81	83.5	16	16.5			
No	37	64.9	20	35.1			
Availability of charging infrastructure*					.008*	9.586	2

Very Important	64	86.5	10	13.5			
Somewhat Important	44	71.0	18	29.0			
Not at all important	10	55.6	8	44.4			
High Upfront Cost*					.004*	5.726	2
Very Important	80	87.0	12	13.0			
Somewhat Important	29	63.0	17	40.0			
Not at all important	9	56.3	7	43.7			
Environmental impact of Electric Vehicles compared to gasoline vehicles*					.000*	15.478	1
Better	75	90.4	8	9.3			
Somewhat better	34	68.0	16	32.0			
About the same	6	46.2	7	53.8			
Somewhat worse	3	50.0	3	50.0			
Much worse	0	0	2	100.0			
Positive influence on social image*					.000*	21.539	1
Yes	78	90.7	8	9.3			
No	40	66.7	28	33.3			
Social pressure/Peer influence*					.028*	10.847	4
Very influential	47	94.0	3	6.0			
Somewhat influential	25	73.5	9	26.5			
Not very influential	25	61.0	16	39.0			
Not influential at all	21	77.8	6	22.2			
Not sure	0	0	2	100.00			

Note: * p <0.05

When comparing the percentages of respondents expressing a positive attitude towards adopting EVs, we find that gender does not emerge as a statistically significant factor impacting

EV adoption among students. Positive attitudes towards EV adoption are evenly distributed across genders, with a similar trend observed among gender identities. While age differences exist, they are not statistically significant.

Marital status does not significantly impact EV adoption; however, singles exhibit slightly greater willingness than married individuals. Academic levels and disciplines do not show statistically significant variations; nevertheless, distinct attitudes are noted among first-year and graduate students. Knowledge about EVs emerged as a significant influencer, with students classified as very knowledgeable about EVs" showing a higher willingness to adopt.

First-hand experience with EVs significantly influences willingness to adopt. The availability of charging infrastructure is associated with positive attitudes towards EV adoption, significantly influencing adoption. Factors such as high upfront cost, awareness of governmental incentives, social pressure and environmental considerations significantly influence students' willingness to adopt EVs.

In conclusion, these findings provide valuable insights into factors influencing students' attitudes toward adopting EVs. Factors such as firsthand experience, social influence, costs, charging infrastructure, government incentives and environmental considerations are key determinants affecting EV adoption among students.

Chapter 6 Conclusions and Directions for Future Research

6.1 Introduction

In today's world, it is essential to prioritize sustainable practices to help mitigate climate change, particularly regarding transportation. To address this need, the study examines Trent University students' perceptions and attitudes toward using electric vehicles (EVs). While previous research has predominantly concentrated on the general public's attitudes toward EV adoption (Abotalebi et al., 2019; Kitt, 2019; Mohamed et al., 2016; Singh et al., 2021) there is a notable lack of understanding about specific consumer groups, particularly students. By addressing these gaps, this study aims to uncover the factors that influence the adoption of EVs among students in Canada. By delving into the perspectives of this specific demographic, we can gain valuable insights that may contribute to a more sustainable future in transportation.

This study explored four primary research questions using quantitative and secondary data sources. This chapter provides a summary and conclusion of the primary findings presented in Chapter Five. The findings are organized into the following major sections: registration of new zero-emission vehicles in Canada, socio-demographics of students, benefits of EV adoption among students, main barriers to EV adoption among students, key contributing factors to electric vehicle adoption among students, and factors that influence the adoption of electric vehicles among students. Finally, the chapter concludes by outlining limitations and proposing directions for future research.

6.2 Registration of new zero-emission vehicles in Canada

The analysis of new zero-emission vehicle (ZEV) registrations in Canada from 2017 – 2023 reveals a significant upward trend in EV adoption, reflecting a shift towards embracing electric vehicles driven by various factors. The surge in ZEV registrations, particularly in Quebec, Ontario, and British Columbia, emphasizes the growing preference for sustainable transportation solutions nationwide. Proactive initiatives undertaken by provinces like Quebec are strong examples for other regions to follow in promoting ZEV adoption and fostering a more environmentally friendly transportation landscape nationwide.

Even in regions like the Yukon and Northern Territories, there has been a gradual rise in ZEV registrations despite the challenges these areas face due to extreme weather conditions and limited infrastructure. Addressing these challenges and disparities requires nationwide targeted interventions and awareness campaigns to create a more uniform and sustainable transportation landscape. By promoting ZEV adoption across all provinces and addressing regional variations, Canada can strengthen its commitment to environmentally conscious transportation practices.

6.3 Socio-demographic characteristics of students

The detailed analysis of students' socio-demographic characteristics, as presented in Table 5.2, enhanced the understanding of these factors influencing students' attitudes toward EV adoption. The diversity observed in gender, age, marital status, academic discipline, and academic level within the survey sample provides a comprehensive view of the student population under consideration.

First, the gender distribution shows varied representation. Second, most students who responded were between the ages of 21 and 30. Additionally, the diversity in marital status and academic fields offers a unique perspective on EV adoption. Furthermore, the distribution across academic levels sheds light on evolving attitudes toward EV adoption across the educational ladder. These socio-demographic factors weave a complex narrative underlying the significance of tailored interventions and awareness campaigns for the diverse student population to promote sustainable transportation practices effectively.

6.4 Benefits of electric vehicle adoption among students

This study's findings on electric vehicle (EV) adoption among students provide valuable insights into factors influencing their preferences. One key benefit identified is students' strong concern for reducing GHG emissions, emphasizing the pivotal role of EVs in addressing environmental concerns and reflecting a growing awareness among younger individuals regarding climate change and sustainable living. Transitioning to economic benefits, lower operating costs were highlighted, resonating with previous research, and supporting that EVs are generally more cost-effective than traditional vehicles due to lower fuel costs and reduced maintenance requirements. Specifically, enhanced energy efficiency was identified as a key benefit, coupled with reduced electric demand and emissions associated with power generation, making EVs an attractive, sustainable option. Health benefits linked to zero tailpipe emissions were deemed crucial, emphasizing the positive impact on local air quality and mental well-being.

Additionally, EVs' resilience to fuel price volatility adds stability to their cost structure compared to traditional vehicles. Also, students noted a preference for EVs' quieter operation, which enhances travel experiences and reduces noise pollution. Lastly, government incentives were crucial to making EVs more accessible and appealing.

The broader context of electrification of transportation highlights the significant benefit of EV adoption beyond individual preferences. EVs improve air quality, reduce noise pollution, enhance energy independence, and position cities as leaders in sustainable mobility. By addressing challenges and seizing opportunities presented by EVs, cities can pave the way for a cleaner, more efficient, and sustainable future while attracting investments and fostering innovation in the EV sector.

6.5 Main barriers to electric vehicle adoption among students

Examining barriers to EV adoption among students has revealed critical challenges hindering the widespread adoption of environmentally friendly transportation. One major barrier identified is the high upfront cost, as highlighted by respondents and supported by previous studies (Rezvani et al., 2015; Sovacool et al., 2019). This financial concern emphasizes the need for targeted financial incentives, subsidies, or alternative financing options to mitigate the initial cost burden associated with EV adoption. Implementing such policies could reshape perceptions and encourage a more favourable attitude toward EV adoption.

Moreover, the limited availability of charging stations emerges as a significant barrier, emphasizing the need for infrastructure development and strategic planning to expand charging networks and make EVs a more viable option for students. Additionally, concerns about the complexity of the charging process stress the need for a simplified and intuitive infrastructure for EV charging to enhance the overall EV experience and address operational complexities.

Furthermore, respondents expressed concerns about driving range and charging time, highlighting the necessity of battery technology, and charging infrastructure improvements to enhance the practicality of EVs for daily use. Lastly, some respondents cited needing more knowledge or awareness about EVs as a barrier to adoption, indicating a critical need for educational initiatives and awareness campaigns targeted at students to dispel misconceptions and foster a deeper understanding of EV benefits.

Transitioning from financial barriers to infrastructure challenges and operational concerns, addressing these issues through targeted policies, infrastructure development, technological advancements, and educational initiatives is crucial in overcoming barriers to EV adoption among students. By tackling these obstacles comprehensively, the path towards wider acceptance and integration of EVs in society can be smoother.

6.6 Key contributing factors to electric vehicle adoption among students

Several key factors emerge as pivotal drivers in students' adoption of electric vehicles (EVs). Cost savings are highlighted as a significant motivator, aligning with the economic benefits of EV ownership, and appealing to students' budget-conscious mentality. This financial factor emphasizes long-term savings and lower operational costs, fitting within students' financial limits. Moreover, environmental concerns play a crucial role, with students increasingly valuing sustainability and showing a strong commitment to addressing environmental issues through reduced emissions.

The availability of charging infrastructure is a critical element influencing students' decisions, addressing range anxiety, and enhancing confidence in EV ownership for daily transportation needs. Additionally, vehicle performance and features are deemed pivotal, meeting students' technical expectations by offering advanced capabilities like acceleration and driver assistance systems.

Another essential factor shaping the EV adoption trend among students is social pressure. Peer behaviour significantly influences adopting sustainable mobility options, creating a social norm that supports environmentally friendly choices and fosters a sense of social responsibility among peers. Furthermore, considerations such as reliability, durability, battery life, replacement cost, and resale value are crucial in students' decision-making, emphasizing cost-effectiveness, functionality, and long-term sustainability.

Government incentives and rebates are also highlighted as significant drivers of EV adoption among students. These incentives make EVs more financially accessible and attractive to student populations, enhancing the financial appeal of EV ownership and instilling confidence in investment decisions related to EVs.

6.7 Factors influencing the adoption of electric vehicles among students

Gender, age, marital status, and academic levels do not significantly influence student adoption of EVs. Positive attitudes toward adopting EVs are balanced across genders, with similar patterns observed among various gender identities. While age differences exist, they are not statistically significant. Marital status does not significantly impact EV adoption; however, singles show a slightly higher willingness than married individuals. Academic levels and disciplines do not exhibit statistically significant variations; however, distinct attitudes are observed among first year and graduate students.

Knowledge about EVs emerged as a significant influencer on EV adoption among students. First-hand experience with EVs significantly impacts willingness to adopt. The availability of charging infrastructure is linked to positive attitudes towards EV adoption, significantly influencing adoption. High upfront costs, government incentives, social pressure, and environmental considerations significantly influence students' willingness to adopt EVs.

By recognizing the impact of factors like gender, age, marital status, and knowledge levels on student adoption of EVs, stakeholders can develop targeted strategies to enhance EV uptake among diverse groups. This comprehensive approach fosters an environment where people feel confident adopting EV technology and contributing to a more sustainable future.

Promoting the adoption of electric vehicles (EVs) among students necessitates a collaborative and multifaceted approach that involves stakeholders, policymakers, and educators. Government initiatives play a crucial role in driving EV education and adoption by raising awareness about the benefits of EVs and dispelling myths that hinder acceptance. Policymakers can mandate EV education in school curriculums and offer incentives to make EVs more financially accessible to student populations.

Industry stakeholders can promote EV adoption by organizing test drive events in collaboration with schools and universities to provide students with firsthand experience driving an EV. Collaboration with local utilities and government agencies can lead to student-focused programs like discounted prices and electricity rates for EV charging, making ownership more affordable.

Educators can be instrumental in shaping students' attitudes toward EV adoption through tailored initiatives like incorporating EV education into the curriculum. Engaging students through innovative approaches that highlight the benefits of EVs fosters a commitment to electric vehicles at an early age. Moreover, promoting environmental responsibility by installing EV charging stations in schools helps instill a sense of sustainability and innovation among students and EV adoption. The media can also play a crucial role in shaping public perceptions about EVs through responsible reporting and informative advertisements that educate students about the benefits of EV adoption. By highlighting the advantages of EV technology, the media can raise awareness and foster a positive attitude toward sustainable transportation options among students.

6.8 Directions for Future Research

This thesis provides valuable insights into the factors influencing students' attitudes and perceptions toward adopting electric vehicles. The findings contribute to the larger scientific and social science fields and inform EV adoption research. However, more research is needed to delve deeper into the complexities and barriers identified in this study, opening new avenues for future research.

In exploring future research directions, longitudinal studies could offer valuable insights into students' evolving attitudes and perceptions of electric vehicles. By tracking changes in the opinions through surveys or focus groups, researchers can capture the dynamic nature of these attitudes as individuals gain more exposure to electric vehicles and societal norms shift.

Additionally, the rapid pace of technological advancements in electric vehicles warrants further investigation into how innovations such as improved battery efficiency, charging infrastructure, and autonomous driving features shape student perceptions. Understanding the impact of technological developments on attitudes towards EVs can guide policymakers and industry stakeholders in fostering widespread adoption.

Furthermore, exploring the influence of government policies, incentives, and regulations on student attitudes toward electric vehicles is essential for designing effective strategies to accelerate adoption. Investigating the role of policy interventions in shaping perceptions of sustainability, cost-effectiveness, and convenience associated with electric vehicle ownership among students can provide valuable insights for promoting sustainable transportation choices.

Lastly, assessing the effectiveness of educational initiatives to raise awareness about the benefits of electric vehicles among students can offer valuable insights for future research. Understanding how information dissemination impacts attitudes and intentions toward sustainable transportation choices can inform targeted educational interventions to foster positive perceptions of electric vehicles among students.

6.9 Limitations of the study

While this study aimed to understand students' attitudes and perceptions toward adopting electric vehicles, it is important to acknowledge the limitations inherent in the research design and methodology. While efficient for data collection, the study’s sample size of 154 respondents may be considered relatively small for drawing definitive conclusions about students' attitudes and perceptions. Furthermore, focusing solely on students from Trent University may restrict the generalizability of the findings to a broader population or different educational settings.

Additionally, using convenient sampling for participant recruitment could introduce selection bias, potentially skewing the representation of the broader student demographic. This limitation may impact the generalizability of the study's results. Moreover, relying exclusively on survey questionnaires for data collection may restrict the depth of understanding regarding the motivations and barriers influencing student attitudes toward electric vehicles. The reliance on self-reported responses through questionnaires could also introduce repones bias or social desirability bias, affecting the accuracy of the data collected. By recognizing these limitations, future research can address these constraints to enhance the validity and applicability of findings related to students' attitudes and perceptions toward electric vehicle adoption.

6.10 Conclusions

This thesis delved into understanding students' perceptions and attitudes toward adopting electric vehicles using a quantitative data collection method with 154 student participants. The study explored the registration of new ZEVs in Canada and various sociodemographic variables and delved into the benefits, barriers, and key factors influencing EV adoption among students.

Interestingly, the findings revealed that gender, age, marital status, academic level, and discipline did not significantly influence students' attitudes and perceptions toward electric vehicle adoption. The study identified key determinants influencing electric vehicle adoption among students, including knowledge about EVs, cost considerations, firsthand experiences, social pressure, charging infrastructure availability, and government incentives. Noteworthy barriers highlighted in the research encompassed high upfront costs, limited charging stations, and insufficient knowledge or awareness regarding electric vehicles.

This research has made significant conceptual and empirical contributions to electric vehicle adoption by introducing a new study population – university students – to the traditional social science approach of generalizing consumer behaviour. Moreover, the study has enriched the EV adoption literature by identifying an emerging consumer segment: university students. This thesis highlights the factors influencing student attitudes and perceptions toward electric vehicle adoption. The findings advance our understanding of EV adoption dynamics and lay a solid foundation for future research in this evolving field.

In conclusion, this research advances our understanding of EV adoption among students and provides a comprehensive framework for achieving sustainable development across all pillars. By addressing the social, economic, environmental, and cultural dimensions, these findings pave the way for a holistic and inclusive transition towards sustainable transportation, ensuring a healthier, more prosperous, and environmentally responsible future for future generations.

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"APPENDIX A" SURVEY QUESTIONNAIRE APPROVED BY THE RESEARCH ETHICS BOARD AT TRENT UNIVERSITY PER THE TRI-COUNCIL GUIDELINES (ARTICLE D.1.6)

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TRENT UNIVERSITY
SCHOOL OF THE ENVIRONMENT

Understanding the perceptions and attitudes of students on the adoption of electric vehicles

Department of Sustainability Studies
Trent University

Confidential Questionnaire

Participant's Unique Identifier code ______________ Date ___________________

Introduction to the Survey Questionnaire:

Welcome to the survey on students' perceptions and attitudes toward adopting electric vehicles (EVs). By completing and submitting this questionnaire, you indicate your understanding of the study's objectives and procedures and provide informed consent to participate. It's important to note that your involvement is voluntary, and you can skip any questions you do not wish to answer. You can withdraw from the study at any time, up to the point when you submit your complete questionnaire. However, please be aware that once you submit your responses, you cannot withdraw your participation or remove your survey answers from the dataset. This is because of the survey's anonymity and the use of unidentifiable unique codes for participants. The researcher will be unable to associate specific survey responses with individual participants, making it impossible to remove data after submission selectively. Participants who choose to withdraw can do so by simply not completing or not submitting the questionnaire.

Rest assured, your responses will be kept confidential and anonymous. Thank you for contributing to our research on sustainable transportation.

SECTION: DEMOGRAPHIC INFORMATION

1. What is your gender?
   a. Male [ ] b. Female [ ] c. Non-binary [ ] d. Prefer not to say [ ]

2. How old are you?

a. Less than 20 years [ ] b. 21 – 30 years [ ] c. 31 – 40 years [ ] d. 41 – 49 years [ ] e. over 50 years [ ]

3. What is your marital status?

a. Married [ ] b. Single [ ] c. Divorced/ Separated [ ] d. Widowed [ ]

4. What academic program are you enrolled in?

   ____

5. What is your academic level?
   a. First year [ ] b. Second-year [ ] c. Third-year [ ] d. Fourth-year [ ] e. Graduate student [ ]

6. Do you currently have a valid driver's license? a. Yes [ ] b. No [ ]

7. Do you currently own or have you ever owned a vehicle?
   a. Yes, I own a vehicle [ ]
   b. Yes, I have owned a vehicle in the past, but I no longer do [ ]
   c. No, I have never owned a vehicle [ ]

8. Answer if you selected 7b or 7c.
   Do you regularly drive a vehicle belonging to someone else (select all that apply)?
   a. Friend's vehicle [ ]
   b. Family member's vehicle [ ]
   c. Colleague's vehicle [ ]
   d. Rental vehicle [ ]

9. What is your current mode of transportation for daily commuting to the university?
   a. Personal car [ ]
   b. Public transportation (bus, train, etc.) [ ]
   c. Bicycle [ ]

d. Walking [ ]
e. Other (please specify) [ ]

10. How far is your typical daily commute to the university?
a. Less than 5 KM [ ]
b. 5 - 10 KM [ ]
c. 11 - 20 KM [ ]
d. 21 - 30 KM [ ]
e. More than 30 KM [ ]

SECTION B: AWARENESS AND KNOWLEDGE

11. How knowledgeable are you about electric vehicles?
a. Very Knowledgeable [ ] b. Somewhat Knowledgeable [ ] c. Neutral [ ] d. Not very Knowledgeable [ ] e. Not Knowledgeable at all [ ]

12. Have you ever ridden in or driven an electric vehicle?

a. Yes [ ] b. No [ ]

13. What is your primary source of information about electric vehicles? (Select all that apply)

a. Friend or family [ ]
b. Online Sources (websites, social media) [ ]
c. Traditional media (TV, radio, newspapers) [ ]
d. Dealerships [ ]
e. Other ______________

SECTION C: PERCEPTION AND ATTITUDES

14. How concerned are you about the environmental impact of traditional gasoline-powered vehicles?
a. Very concerned [ ]
b. Somewhat concerned [ ]
c. Neutral [ ]
d. Not very concerned [ ]
e. Not concerned at all [ ]

15. How important do you perceive these factors as benefits of owning an electric vehicle?
Rank them in order of importance: 1 = Very Important; 2. Somewhat important; 3 = Not important

Reason	1. Very important	2. Somewhat important	Not at all important
Reduced greenhouse gas emissions			
Lower operating costs (e.g., fuel and maintenance)			
Access to potential government incentives and rebates			
Quieter operation			
Enhanced energy efficiency			
Resilience to Fuel Price Volatility			
Health benefits associated with zero tailpipe emissions			

16. Please rank the following challenges/drawbacks of owning an electric vehicle. *Rank them in order of importance: 1 = Very Important; 2. Somewhat important; 3 = Not important*

Reason	1. Very important	2. Somewhat important	Not at all important
Limited driving range compared to traditional vehicles			
Longer charging times compared to refuelling with gasoline.			
Availability and accessibility of charging infrastructure			
The higher upfront cost of purchasing an electric vehicle			
Potential concerns about battery life and replacement costs			
Range anxiety			

17. What is your perception of the environmental impact of electric vehicles compared to traditional vehicles?

a. Electric vehicles are much better for the environment [ ]
b. Electric vehicles are somewhat better for the environment [ ]

c. Electric vehicles are about the same as traditional vehicles in terms of environmental impact [ ]
d. Electric vehicles are somewhat worse for the environment [ ]
e. Electric vehicles are much worse for the environment [ ]

18. What is your perception of the cost of electric vehicles compared to traditional vehicles?
a. Electric vehicles are much cheaper [ ]
b. Electric vehicles are somewhat cheaper [ ]
c. Electric vehicles are about the same price as traditional vehicles [ ]
d. Electric vehicles are somewhat more expensive [ ]
e. Electric vehicles are much more expensive [ ]

19. Rank the following factors based on their importance in influencing your decision to purchase an electric vehicle.

Rank them in order of importance: 1 = Very Important; 2. Somewhat important; 3 = Not important

Reason	**1. Very important**	**2. Somewhat important**	**Not at all important**
Cost savings (e.g., lower fuel and maintenance costs)			
Environmental considerations (e.g., reduced emissions)			
Availability of charging infrastructure			
Peer Influence			
Government incentives and rebates			
Vehicle performance and features			
Reliability and durability of electric vehicles			
The resale value of electric vehicles			
Concerns about battery life and replacement costs			
Other (please specify)			

20. Rate your willingness to switch to an electric vehicle after five years of completing your current degree or diploma?
a. Very willing [ ]
b. Somewhat willing [ ]
c. Neutral [ ]
d. Somewhat unwilling [ ]
e. Very unwilling [ ]

SECTION D: BARRIERS TO ADOPTION

21. What do you perceive to be your single main barrier to electric vehicle adoption?

a. Complexity of charging process [ ]
b. Limited availability of charging stations [ ]
c. High upfront cost of electric vehicles [ ]
d. Concerns about driving range and charging time [ ]
e. Insufficient knowledge or awareness about electric vehicles [ ]
f. Other (please specify) ______________________

SECTION E: PERCEIVED SOCIAL NORMS

22. Do you believe most of your peers would support owning an electric vehicle?

a. Yes [ ] b. No [ ]

23. Do you think owning an electric vehicle would positively influence your social image among your peers?

a. Yes [ ] b. No [ ]

24. How common are people owning electric vehicles in your social circle?

a. Very common [ ]
b. Somewhat common [ ]
c. Not very common [ ]
d. Not common at all [ ]
e. Not sure [ ]

25. How often do you see electric vehicles being used by others in your community?
a. Very frequently [ ]

b. Occasionally [ ]
c. Rarely [ ]
d. Almost never [ ]
e. Not sure [ ]

26. Are there any perceived stigmas or negative judgments associated with owning an electric vehicle among your peers?

a. Yes [ ] b. No [ ]

27. Would you feel socially pressured to own an electric vehicle based on the opinions or actions of your peers?

a. Yes, strongly [ ]
b. Yes, somewhat [ ]
c. No, not really [ ]
d. No, not at all [ ]
e. Not sure [ ]

28. Do you believe that owning an electric vehicle is considered a responsible choice for environmental impact by your peers?

a. Yes, definitely [ ]
b. Yes, to some extent [ ]
c. No, not really [ ]
d. No, not at all [ ]
e. Not sure [ ]

29. How much influence do you think your peers' opinions about electric vehicles would have on your decision to own one?

a. Very influential [ ]
b. Somewhat influential [ ]
c. Not very influential [ ]
d. Not influential at all [ ]
e. Not sure [ ]

SECTION F: PUBLIC PERCEPTION AND EDUCATION

30. How would you rate the overall public perception of electric vehicles?

a. Very positive [ ]
b. Somewhat positive [ ]

c. Neutral [ ]
d. Somewhat negative [ ]
e. Very negative [ ]

31. Do you think there is a need for more education and awareness campaigns about electric vehicles?

a. Yes [ ]	b. No [ ]

SECTION G: FINANCIAL CONSIDERATIONS

32. Are you aware of the potential long-term cost savings associated with owning an electric vehicle (e.g., lower maintenance, fuel costs)?

a. Yes [ ]	b. No [ ]

33. How would you rate the affordability of electric vehicles compared to traditional vehicles in terms of long-term ownership costs?

a. Much more affordable [ ]
b. Somewhat more affordable [ ]
c. About the same [ ]
d. Somewhat more expensive [ ]
e. Much more expensive [ ]

SECTION H: RANGE ANXIETY AND CHARGING CONCERNS

34. How concerned are you about running out of battery power while driving an electric vehicle?

a. Very concerned [ ]
b. Somewhat concerned [ ]
c. Neutral [ ]
d. Not very concerned [ ]
e. Not concerned at all [ ]

35. Would you be more likely to consider purchasing an electric vehicle with an extended driving range (e.g., 300+ KM?

a. Yes [ ]	b. No [ ]

SECTION I: VEHICLE OPTIONS AND AVAILABILITY

36. Rank the following factors based on their importance in influencing your decision to adopt an electric vehicle?

Rank them in order of importance: 1 = Very Important; 2. Somewhat important; 3 = Not important

Reason	**1. Very important**	**2. Somewhat important**	**Not at all important**
Availability of different vehicle types (e.g., sedans, SUVs, trucks) in electric models			
Ability to test drive an electric vehicle before making a purchase decision			

SECTION J: GOVERNMENT POLICIES AND INCENTIVES

39 Do you know of government incentives or rebates to promote electric vehicle adoption?

a. Yes [ ] b. No [ ]

40. If you are aware of government incentives, please specify which ones you know about (select all that apply):

a. Purchase rebates or tax credits [ ]
b. Reduced registration fees for electric vehicles [ ]
c. Access to high-occupancy vehicle (HOV) lanes [ ]
d. Subsidized charging station installation [ ]
e. Other (please specify) _________________

41. How do you perceive the effectiveness of current government policies in encouraging the adoption of electric vehicles?

a. Very effective [ ]
b. Somewhat effective [ ]
c. Neutral [ ]
d. Somewhat ineffective [ ]
e. Very ineffective [ ]

42. How do you think government policies could further support the adoption of electric vehicles? (Please provide your thoughts and ideas in the space provided below)

____
____
____
____
____

43. Would you be more likely to consider adopting an electric vehicle if additional government incentives or policies were in place? a. Yes [ ] b. No [ ]
44. What are some potential drawbacks or limitations of current government policies promoting electric vehicle adoption? (Please provide your thoughts and ideas in the space provided below)

____
____
____
____
____
____

SECTION K: ELECTRIC VEHICLE CHARGING STATIONS ON CAMPUS

45. Are you aware of an Electric Vehicle (EV) charging station on campus?

a. Yes [ ]	b. No [ ]

46. If you answered yes in Question 45, how satisfied are you with the availability and functionality of the EV charging stations on campus?

a. Very satisfied [ ]
b. Somewhat satisfied [ ]
c. Neutral [ ]
d. Somewhat dissatisfied [ ]
e. Very dissatisfied [ ]

47. What factors or sources could improve awareness about the EV charging station on campus? (Please select all that apply)

a. Campus-wide emails or announcements [ ]
b. Signage at strategic locations [ ]
c. Social media posts or campaigns [ ]
d. Collaboration with student organizations or clubs [ ]
e. Other (please specify) _______________

SECTION L: EV BATTERY LIFE CYCLE CONCERNS

48. Are you familiar with the primary materials used in manufacturing electric vehicle batteries?

a. Yes [ ]	b. No [ ]

49. Which materials do you know are commonly used in electric vehicle batteries? (Select all that apply)
    a. Lithium [ ]
    b. Nickel [ ]
    c. Cobalt [ ]
    d. Graphite [ ]
    e. Manganese [ ]
    f. Aluminum [ ]
    g. Other (please specify) _______________
    h. I am not sure/I have no idea. [ ]
50. How concerned are you about the availability of the resources used in electric vehicle batteries in the future?
    a. Very concerned [ ]
    b. Somewhat concerned [ ]
    c. Neutral [ ]
    d. Not very concerned [ ]
    e. Not concerned at all [ ]
51. Do you think advancements in battery technology will address concerns about the availability of battery resources in the future?

a. Yes [ ]	b. No [ ]

52. Are you aware of recycling programs or initiatives for electric vehicle batteries?

a. Yes [ ]	b. No [ ]

53. How concerned are you about the environmental impact of electric vehicle battery disposal and recycling?
    a. Very concerned [ ]
    b. Somewhat concerned [ ]
    c. Neutral [ ]
    d. Not very concerned [ ]
    e. Not concerned at all [ ]
54. In your opinion, what measures should be taken to improve the sustainability of electric vehicle batteries throughout their life cycle? (Please provide your thoughts and ideas in the space provided below)

55. Based on the information provided and your overall understanding of electric vehicles,are you willing to consider adopting electric vehicle in the future?
    a. Yes, I am willing to consider adopting an electric vehicle [ ]
    b. No, I am not willing to consider adopting electric vehicle [ ]

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Understanding the perceptions and attitudes of students on the adoption of electric vehicles

Department of Sustainability Studies
Trent University

Introduction Letter

Introduction:

You are invited to participate in a research study to understand students' perceptions and attitudes toward adopting electric vehicles (EVs). This study is being conducted to gain insights into the factors influencing students' opinions about EVs and to explore potential barriers and motivations for their adoption. Your participation in this study will help contribute to a better understanding of sustainable transportation options.

Study Details:

In this research, you will be asked to complete a survey questionnaire about your perceptions, attitudes, and experiences related to electric vehicles. The estimated time to complete the survey questionnaire is 30 to 45 minutes. Questionnaires will be available at various campus locations, including residence colleges, Trent Library, the student center, student lounges, and other common areas on campus. The researcher will explain the study, distribute questionnaires, and allow on-site or off-site completion. Participants taking questionnaires away will provide their names and phone numbers. This facilitates follow-up for collecting completed questionnaires.

Data Collection and Confidentiality:

Your survey responses will be collected anonymously, and no personal identifying information will be recorded. Instead, your answers will be associated with a unique identifier to ensure confidentiality. It is important to note that only aggregated and statistical results will be included in the current research project's publications, presentations, and reports. There are no plans to use this data for future research projects.

Voluntary Participation and Participant Withdrawal:

Participating in this research is entirely voluntary. You can withdraw from the study at any time, up to the point when you submit your complete questionnaire. However, please be aware that once you submit your responses, you cannot withdraw your participation or remove your survey answers from the dataset. This is because of the survey's anonymity and the use of unidentifiable unique codes for participants. The researcher cannot associate specific survey responses with individual participants, making it impossible to selectively remove data after submission. Participants who choose to withdraw can do so by simply not completing or not submitting the questionnaire. Also, choosing to withdraw from the study carries no negative repercussions. It will not impact your relationship with the research team or Trent University. Participants can choose not to answer any questions they prefer not to answer while completing the questionnaire.

Data Storage:

All data collected will be stored securely. Physical copies such as questionnaires, introduction letters and tear-off sheets will be stored in a locked cabinet in a secure, access-restricted area. Only the research supervisor will have access to this locked cabinet, ensuring the physical security of the documents. Electronic files will be stored using an encrypted password-protected drive accessible only to the research team. The research data collected during this study will be stored for one (1) year before destruction with applicable institutional and ethical guidelines.

Benefits and Risks:

Participating in this study presents minimal known risk, including potential moderate psychological discomfort. You will be asked to offer your thoughts about electric vehicles, a non-invasive and non-sensitive topic. By participating in this study, you can share your views on electric vehicles, contributing to valuable research on sustainable transportation.

Gift Card Draw:

As a token of appreciation for your participation, we are offering a $50 Amazon gift card drawing. To protect your privacy, we have included a separate tear-off paper at the back of the survey questionnaire to gather your contact information for the draw. Your provided details will be securely isolated and will have no association with the information you provide in the questionnaire. It is important to clarify that this gift card drawing is a random process, and your participation in the study does not guarantee eligibility for the incentive.

Contact Information:

If you have any questions or concerns about the study or your participation, contact the researcher, Godwin Yakubu (godwinyakubu@trentu.ca) and Research Supervisor, David Firang (davidfirnag@trentu.ca).

The Trent University Research Ethics Board has reviewed and approved this study; the study number is (ROMEO #28710). If you have questions or concerns that you don't wish to share with the researcher, please contact:

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Confirmation Of Agreement: By completing and returning the survey questionnaire, you consent to participate in this study and are not required to sign a separate consent form. We will provide you with a physical copy of this agreement on the spot, ensuring you have a record of your consent. Your participation does not involve giving up any legal rights.

Research Matrix

Research Question	Methods	Data Analysis Method
What are the trends in the registration of ZEVs in Canada and its provinces?	Secondary from Statistics Canada	Quantitative Analysis: Univariate and descriptive analysis
What are the benefits and barriers to electric vehicle adoption among students?	Survey Questionnaire	Quantitative Analysis: Likert scale and descriptive analysis
What key factors contribute to electric vehicle adoption among students, explicitly examining economic, environmental, and social factors?	Survey Questionnaire	Quantitative Analysis; Likert scale and descriptive analysis
What factors influence the adoption of electric vehicles among students?	Survey Questionnaire	Bivariate Analysis: Chi-square test for categorical variables