Investigating Factors that affect Attitude, Consumer Satisfaction, and Intention to Use of Electric Vehicles: Implications on Promoting and Regulatory Policies

By

MUN, Hyeongdae

THESIS

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF PUBLIC POLICY

2022

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Approval as of December, 2022

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ABSTRACT

Demand for environmentally friendly vehicle has been rapidly increased due to paradigm transition of automobile industry and policies that foster the adoption of environmentally friendly vehicle to meet the goal of carbon neutrality. Among environmentally friendly vehicles, electric vehicle is the one that customers can easily access and experience based on demand across the countries. Therefore, how consumers perceive and understand characteristics of electric vehicles might be the key aspects to increase adoption rate. Based on the consideration, this study investigates factors that affect attitude, satisfaction, and intention to use of electric vehicle. By classifying actual and potential consumers, this study develops research questions i) how factors such as economic feasibility, sociality, environmental sustainability, inefficiency, inconvenience, convenience, and uncertainty affect attitude; ii) how attitude affects actual consumers satisfaction for actual consumers; and iii) how attitude affects intention to use for potential consumers. This study conducted online survey and applied factor and regression analyses, ANOVA, and *t*-test to test hypotheses. The results of this study found that economic feasibility and convenience factors significantly affect attitude based on both actual and potential consumers, while effects of inefficiency and uncertainty on attitude showed significant based on actual consumers. This study provides policy implications that foster promotional policies for the adoption of electric vehicles to meet carbon neutrality and regulate negative aspects. This study also provides managerial implications for manufacturers to develop better technology competences such as battery related to enhance reliability on electric vehicles.

Keywords: Electric Vehicle, Carbon Neutrality, Attitude, Satisfaction, Intention to Use, Policy

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I. Introduction

The world has experienced extreme climate disasters due to climate change over the past few years, therefore, there is the need to respond more actively to the climate crisis is being raised (Ramli, Kadir, Ismail, Othman, & Melo, 2021). The recent perception of climate change has changed because of the fact that the existing level of greenhouse gas reduction cannot overcome the climate crisis. To resolve this problem, major countries accelerated the declaration of carbon neutrality, which is the long-term policy plan for ultimate greenhouse gas reduction. Carbon neutrality is a concept that reduces greenhouse gas emissions due to anthropogenic activities as much as possible, and reduces actual emissions to zero by absorbing the remaining greenhouse gases naturally or by removing them through CCUS (Carbon Capture, Utilization and Storage) (Regufe, Pereira, Ferreira, Ribeiro, & Rodrigues, 2021). A similar but more comprehensive concept of net-zero was introduced as a concept of making the actual emissions of six greenhouse gases including carbon dioxide zero (Means, & Lallanilla, 2021). In order to achieve carbon neutrality, the need for regulation in industry and transport has emerged (Su, Yuan, Tao, & Umar, 2021). The world's major countries have prepared regulations regarding greenhouse gas reduction in every industrial sector including the transportation industry sector based on the perspective of environmental policy.

In the past, the transportation sector had applied relatively low regulatory policy priority due to the large amount of greenhouse gas emissions occupied by the power generation and industrial sectors (Lee, & Park, 2021). However, reducing greenhouse gas emissions in the transportation sector has also become an important policy issue for obligation (Gulzari, Wang, & Prybutok, 2022). Since there is strong need to reduce greenhouse gas in the transportation sectors, the rapidly increasing demand for hybrid vehicles, electric and hydrogen vehicles changes the paradigm shift in the automobile industry and increase the attention in environmentally friendly vehicles (Ju, Lee, & Kim, 2021). Electric vehicle can contribute to sustainable outcomes as an alternative if consumers choose

to adopt it as environmentally friendly innovations (Barbarossa, Pelsmacker, & Moons, 2017). Policymakers encourage the spread of all-electric mobility, regardless of vehicle-specific technologies (i.e., fully electric vehicles and hybrids) (Armenio, Bergantino, Intini, & Morone, 2021). These policies could help achieve a reduction of greenhouse effects in the transportation sector (Manjunath, & Gross, 2017). For these reasons, several incentives have been introduced, such as free parking, not paying a specific vehicle tax, and subsidy for purchase (Nanaki, & Koroneos, 2016), if consumers make purchase decision on electric vehicle.

In this situation, automobile manufacturers have recently stopped producing internal combustion engine vehicles and are accelerating the transition to electric vehicles. BYD Auto, electric vehicle manufacturer, has announced that it will stop producing internal combustion engine vehicles from March 2022 and supply only hybrid and electric vehicles (Lee, 2022). The transition from conventional vehicles to electric vehicles is also having a direct impact on the operations of automobile manufacturers and auto parts suppliers (Shillington, Zhang, Jacobson, & Miller 2021). Announcements and investment decisions by automobile manufacturers, battery manufacturers, energy companies, fleet operators and technology companies also represent changes in speed with the low- and zero-emission vehicle value chains (Cazzola, Craglia, Bunsen, & Sohu 2021). Companies transitioning to the electric vehicles ecosystem are adopting ESG (environmental, social, and governance) as a core strategy (Mirae Asset Global Investments, 2021). ESG management aims to use the environment, society, and governance as opportunities for change and challenge, not burdens and responsibilities. These changes reflect the reality that ESG is an important indicator for sustainability management in automobile manufacturers (Lamdouar, 2021). Electric vehicles also get paid attention by ESG investors and governments as the next generation of preferred vehicles, since those vehicles apply zero-emission technology that meets regulations limiting disposable or non-renewable products by automobile manufacturers (Mirae Asset Global Investments, 2021).

The shift in consumer behavior from conventional vehicles to electric vehicles, along with changes in automobile manufacturers, has accelerated the growth in demand for electric vehicles. According to Deloitte (2022) automobile consumption trends report, 58% of Korean consumers are considering an environmentally friendly vehicle as their next vehicle, and in most countries, consumers are considering purchasing an electric vehicle either because of expectations of fuel cost savings or concerns about climate change. Therefore, it is very important for companies that develop environmentally friendly vehicles to take the lead in technology development by accurately reflecting and supplementing consumer needs on changes in consumer perception (Bakar, & Hasan-Basri, 2017). However, there are also practical limits to expanding the supply of electric vehicles due to limited budgets and regulatory policies. In addition to positive factors, there are many negative factors related to the reluctant intention of use, such as reduced subsidies, lack of charging infrastructure, long charging times, and fire problems (Danielis, Rotaris, Giansoldati, & Scorrano, 2020).

In summary, the purpose of this study is to explore promoting and regulatory factors for electric vehicles among environmentally friendly vehicles, and to investigate how those factors affect consumer satisfaction and potential buyers' intention to use. In addition, this study will explore the relationship between ESG awareness and attitude toward electric vehicles and the policy implications of electric vehicles. By investigating the result, this study is expected to help encourage purchase and intention to use electric vehicles for the environmentally friendly perspectives.

1.1 Development of Research Questions

In this study, the electric vehicles were selected among various environmentally friendly vehicles because they are currently the most popular environmentally friendly vehicles. The number of consumers is growing rapidly due to the many advantages of using electric vehicles. In addition, government policies to encourage the use of electric vehicles and automobile manufacturers to

increase electric vehicle production can also be seen as accelerating this phenomenon. The ultimate goal of this study is to encourage consumers to adopt electric vehicles by preparing better policies and enhancing consumer reliability on electric vehicles. First, this paper derives positive and negative factors in the use of electric vehicles and find out how these affect consumers' attitudes. In addition, it is possible to reduce potential consumers' concerns about electric vehicles by analyzing the differences in perceptions of actual and potential consumers. Therefore, consumers who actually own electric vehicles need to understand how they are different from non-electric vehicle consumers and what factors they are satisfied with or dissatisfied with. Through this, it is possible to derive the policy implications of what should be promoted and what should be regulated in government policy. In addition, this study intends to investigate the consumers' perception of companies' ESG management. Therefore, the purpose of this study is to investigate how common factors such as eco-friendliness, sociality, and sustainability are related to the attitude of electric vehicles.

Based on the consideration, the proposed research questions include the following: 1) How do variables such as economic factors, social factors, environmental factors, inefficiency, convenience, and uncertainty affect overall attitudes toward electric vehicle? By classifying actual consumers and potential consumers of electric vehicles, this study also proposed the research questions. 2) How do proposed variables affect actual consumers' satisfaction on electric vehicle? 3) How do proposed variables affect potential consumers' intention to purchase electric vehicle? 4) How do overall attitudes affect satisfaction and intention to use electric vehicle? 5) What are the most positive and negative factor related to purchasing electric vehicles? 6) What are the opinions of actual consumers and potential consumers on the government's policies regarding electric vehicle? 7) What are the opinions of actual consumers and potential consumers about corporate activities related to the environment and society?

This study focuses on investigating the perceptions of electric vehicles and deriving policy

implications for electric vehicle actual consumers and potential consumers. Therefore, this study can be seen as a process evaluation in which consumers evaluate the policies currently being implemented. In addition, it can be seen as a preliminary evaluation in terms of setting the overall direction of development of the electric vehicle industry through evaluation and implementing policy proposals accordingly. In particular, in the case of actual consumers, based on their experiences and satisfaction, they will be able to give opinions on perceived factors focusing on the use of electric vehicles and naturally derive necessary policies. In addition, when potential consumers investigate how perceived positive and negative factors affect attitudes toward electric vehicles and reflect these appropriately in policies, they will be able to increase their intention to use electric vehicles and ultimately help the government achieve environmental policies.

II. Literature Review

2.1 Definition of Environmentally Friendly Vehicle

Environmentally friendly vehicle can be defined as a vehicle with improved technology to reduce greenhouse gas and harmful emissions compared to conventional vehicles (Ju, Lee, & Kim, 2021). These vehicles use eco-friendly energy sources in order to save on the use of conventional fossil fuels or to replace fossil fuels (Armenio, Bergantino, Intini, & Morone, 2021). Environmentally friendly vehicles that meet this definition include hybrid electric vehicles, plug-in hybrid electric vehicles, battery electric vehicles, and hydrogen fuel-cell vehicles. (U.S. Department of Energy, Retrieved from 2022)

The standards for these environmentally friendly vehicles are similarly defined in countries around the world, including the United States and Europe. An electric vehicle is a vehicle that uses an electric motor as traction, driven by an electric source, usually a rechargeable battery (Din, & Barbu, 2021). A hybrid electric vehicle (HEV) is powered by an internal combustion engine in

combination with electric motors that use energy stored in batteries (U.S. Department of Energy, Retrieved from 2022). The battery only has a self-charging function and external power charging is not possible. A plug-in hybrid electric vehicle (PHEV) can operate using power from a battery or power from an internal combustion engine (Cazzola, Craglia, Bunsen, & Sohu 2021). A fuel cell electric vehicle (FCEV) is powered by electricity, which is generated on board by a fuel cell stack that uses hydrogen, which has to be carried in a tank (European Environment Agency, 2021).

Table1. Definition of Environmentally Friendly Vehicle

Vehicle type	Description	Publication
Plug-in Hybrid Electric Vehicle (PHEV)	PHEV is a combination of gasoline and electric vehicles. They have a battery, an electric motor, a gasoline tank, and an internal combustion engine.	EPA*, 2022
	PHEV powered by an electric motor and an internal combustion engine designed to work either together or separately. The on-board battery can be charged from the grid, and the combustion engine supports the electric motor when more operating power is required or when the battery's charge is low.	EEA**, 2022
Electric Vehicles (EV/BEV)	EV has a battery instead of a gasoline tank, and an electric motor instead of an internal combustion engine.	EPA*, 2022
	BEV powered by an electric motor, using electricity stored in an on-board battery which has to be charged, typically by plugging the vehicle in to a recharging point connected to the local electricity grid.	EEA**, 2022
Fuel Cell Electric Vehicles (FCEV)	FCEV use an electric motor instead of an internal combustion engine to power the wheels. FCEV generates their electricity onboard. In a fuel cell, hydrogen (H2) gas from the vehicle's fuel tank combines with oxygen (O2) from the air to generate electricity with only water and heat as byproducts of the process.	EPA*, 2022
	FCEV entirely propelled by electricity, which is generated on board by a fuel cell stack that uses hydrogen, which has to be carried in a tank.	EEA**, 2022

*EPA: United States Environmental Protection Agency, **EEA: European Environment Agency

According to the EPA and EEA, they did not put hybrid electric vehicle (HEV) into the category of environmentally friendly vehicles. However, hybrid electric vehicle (HEV) is still classified as environmentally friendly vehicles in Korea. Table 2 shows the characteristics of each type of environmentally friendly vehicle announced by the Ministry of Environment of Korea. Solar vehicle is excluded because consumers are extremely rare and it is relatively difficult to purchase in Korea.

Table 2. Characteristics of Environmentally Friendly Vehicles

Vehicle type	Component	Fuel	Battery (kWh)	Characteristic
Hybrid Electric Vehicle (HEV)	Motor Engine Battery Fuel tank	Fossil fuel Electricity (self-charged during driving)	0.9 ~ 1.8	· Driving with motor power only at low speed · Fuel economy is better and less gas emissions
Plug-in Hybrid Electric Vehicle (PHEV)	Motor Engine Battery Fuel tank	Fossil fuel Electricity (external and self-charging)	4 ~ 16	· Possible to drive in electric and hybrid mode · 30-40 km can be driven only in electric mode · Complicated vehicle structure
Electric Vehicles (EV)	Motor Battery	Electricity	10 ~ 30	· Driving the vehicle only with batteries and motors · Low noise and vibration, no exhaust gas · Charging takes a long time
Fuel Cell Electric Vehicles (FCEV)	Motor Fuel cell Battery Hydrogen tank	Hydrogen	0.9 ~ 1.8	· Charging time is short · No emissions · Construction of fuel supply infrastructure is required

Sources: https://www.ev.or.kr [*Mugonghaecha Nulijib*]

In table 2, a hydrogen vehicle refers to hydrogen fuel cell vehicles (FCEVs), and hydrogen internal combustion engine vehicle that uses hydrogen as fuel for internal combustion engines is excluded. Meanwhile, the battery electric vehicle (BEV) is defined as the electric vehicle (EV) in this paper.

2.2 Development of Environmentally Friendly Vehicle

Major countries around the world, which declared carbon neutrality, are very active in disseminating environmentally friendly vehicles, which can be said to be an effective means of reducing greenhouse gas emissions in the transportation sector (Hawkins, Singh Majeau-Bettez, & Strømman, 2012). In particular, the supply of environmentally friendly vehicles is rapidly spreading due to strong regulations on internal combustion engine vehicles, as well as subsidies and tax support that supplement the economic feasibility of environmentally friendly vehicles (He, Zhan, & Hu, 2018). According to the International Energy Agency (2022), sales of electric vehicles including fully electric and plug-in hybrids doubled in 2021 to a new record of 6.6 million, with more now sold each week than in the whole of 2012. Therefore, environmentally friendly vehicle sector continues to grow due to the continuous launch of new vehicles and the influence of each country's supply policies.

However, some countries exclude hybrid vehicles in environmentally friendly vehicle category. According to Fit for 55: how the EU will turn climate goals into law by The European Council, EU is focusing on supporting non-polluting vehicles such as electric vehicles and fuel cell electric vehicles among environmentally friendly vehicles. France has decided to abolish the tax reduction regulations provided for hybrid vehicles, and Germany is also considering stop the subsidy for plug-in hybrid electric vehicles (Korea Automotive Technology Institute, 2022). Korean government is also pushing to exclude hybrid vehicles from environmentally friendly vehicles.

2.3 Electric Vehicle

2.3.1 The History and Present of Electric Vehicle

In between years 1832 and 1839, the first prototype electric-powered carriage, which powered by non-rechargeable primary cells was invented by Robert Anderson (Guarnieri, 2011). Since then, electric vehicles have greatly developed with the invention and development of storage batteries, and have rapidly spread in the city from the late 1890s to the early 1900s, and have less smell, vibration and noise compared to gasoline vehicles (Wilson, 2022). However, electric vehicle lost popularity after the introduction of Ford's Model T, and the availability of gasoline kept the era of internal combustion engine vehicles for a long time (Yong, Ramachandaramurthy, Tan, & Mithulananthan, 2015). In the 1990s, the environmental pollution problem became more serious, and then California ordered that automakers sell a small percentage of zero-emission vehicles (Bellis, 2019). As a result, General Motors developed the mass-produced electric vehicle EV1 and released the low-end electric vehicle Bolt EV in 2017 (Wilson, 2022). After that Tesla's electric vehicles have become the driving force for the growth of these electric vehicles, and many automobile manufacturers launched electric vehicles.

Governments of major countries have also set detailed targets for reducing carbon emissions

in recent years to achieve carbon neutrality because it is an essential part of responding to climate change (IEA, 2022). Accordingly, global automobile manufacturers are also rapidly pushing for large-scale electric vehicle production. Because electric vehicles have been identified as one of the major opportunities to reduce greenhouse gas emissions in the transportation sector and fossil fuel consumption (Abouee-Mehrizi, Baron, Berman, & Chen, 2021).

Table 3. Environmental Policy and Automotive Industry Regulation in Major Countries

Country	Environmental Policy for Carbon Neutrality	Automobile Industry Regulation
EU	Reduce greenhouse gas emissions by at least 55% by 2030 compared to 1990	・ 35% of new vehicles are made up of eco-friendly vehicles such as electric vehicles (until 2030) ・ Complete ban on the sale of new cars with internal combustion engines (until 2035) ・ Elimination of all internal combustion engine vehicles in Europe (after 2050)
United States	Reduce carbon emissions by less than half of 2005 by 2030	・ Increase the share of EV sales to 50% by 2030 ・ Promoting a bill to subsidize assembly electric vehicles in the United States up to $7,500 per unit ・ Abolition of the limit on subsidies for electric vehicles per brand, which is limited to 200,000 cumulative vehicles
China	Set the goal for achieving carbon neutrality by 2060	・ 20% of new vehicles are made up of eco-friendly vehicles such as electric vehicles (until 2025), since then, it has expanded to 40% by 2030 and 50% by 2035 ・ Gradually reduce the proportion of internal combustion engine vehicles
Japan	Set the goal for achieving carbon neutrality by 2050	・ Sales of new internal combustion engines have been phased out, completely banned in 2035 ・ Sales of new internal combustion engines have been phased out, completely banned in 2035 ・ Expansion of electric vehicle charging infrastructure and support for electric vehicle business transformation
Korea	In order to achieve carbon neutrality by 2050, greenhouse gas emissions will be reduced by 40% compared to 2018	・ Increase sales of eco-friendly vehicles to 910,000 units (51%) by 2025, and 1.5 million units (83%) by 2030 ・ Build more than 500,000 charging infrastructure by 2025

Sources: IEA (International Energy Agency, 2022), KOTRA (Korea Trade-Investment Promotion Agency)

Table 3 shows the environmental policies for carbon neutrality in major countries and the regulations of the automobile industry accordingly. Governments of each country have set deadlines to achieve carbon-neutral goals to actively respond to climate change and are seeking specific

measures. As a common policy, it regulates the production of existing internal combustion engine vehicles and encourages the expansion of electric vehicles. Global automobile manufacturers are also making efforts to expand the production of electric vehicles.

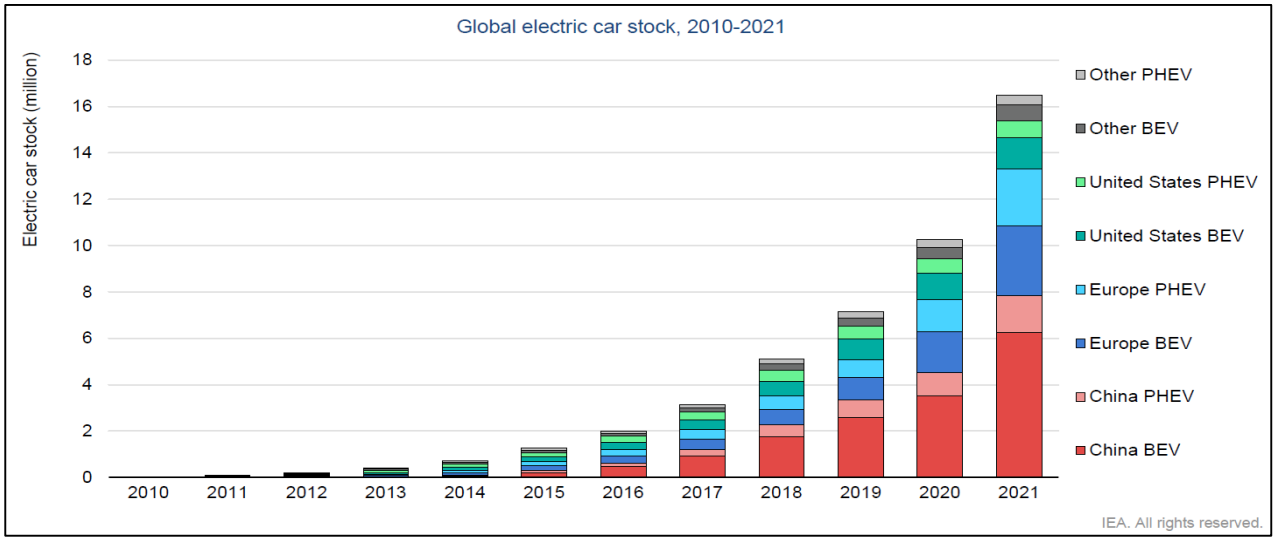

Figure 1. Global Electric Vehicle Stock, 2010-2021

Sources: Global Electric Vehicle Outlook 2022, IEA analysis based on country submissions, complemented by ACEA; CAAM; EAFO; EV Volumes; Marklines.

Figure 1 shows the global electric vehicle stocks from 2010 to 2021. According to the IEA (2022), BEV and PHEV sales nearly doubled year-on-year in 2021 to 6.6 million units, with the total number of electric vehicles exceeding 16.5 million. As shown in Figure 1, most of the global electric vehicle stocks in 2021 are from China, Europe and the United States, of which China accounts for half of the global electric vehicle stocks. In addition, it can be seen that the stock of PHEVs is larger than pure electric vehicles so far. Considering that PHEV is a vehicle with the characteristics of having two powers: an internal combustion engine vehicle and an electric vehicle, the stock of pure electric vehicles is expected to increase further in the future (Figure 1).

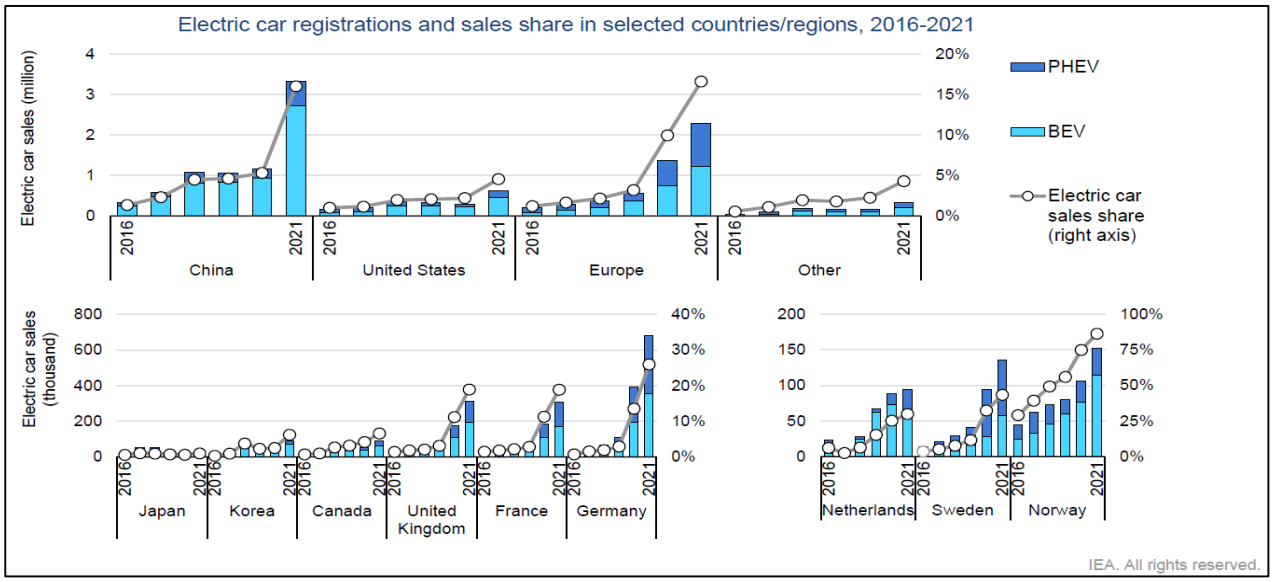

Figure 2. Electric Vehicle Registrations and Sales Share in Elected Countries/Regions, 2016-2021

Sources: Global Electric Vehicle Outlook 2022, IEA analysis based on country submissions, complemented by ACEA; CAAM; EAFO; EV Volumes; Marklines.

According to Figure 2, electric vehicle sales in major countries surged between 2020 and 2021, and BEV accounted for a larger proportion than PHEV. In particular, a large increase can be seen in China and Europe, which appears to be the result of active policy implementation and active production of electric vehicles by automobile manufacturers. Interestingly, China, Germany, France, UK, and Sweden have global automobile manufacturers of producing electric vehicles, and high electric vehicle sales can be seen in these countries as shown in the figure 2.

Table 4. The Registration Status of Electric Vehicle in Korea (2015-2021)

Year	2015	2016	2017	2018	2019	2020	2021
Registered Electric Vehicles	5,853	15,389	25,593	55,756	89,918	134,962	231,443

Sources: Korea Ministry of Land, Infrastructure and Transport (2022)

Table 4 shows that the registration of electric vehicles in Korea has been steadily increasing since 2015. Despite the supply problem of semiconductors for vehicles caused by COVID-19, electric vehicle sales are rapidly growing. Deloitte (2022) predicted that the share of electric vehicles in the global automobile market will increase to 32% by 2030. As such, the era of electric vehicles is

opening with the active efforts of governments and global automobile manufacturers to achieve carbon neutrality.

2.3.2 Positive and Negative Factors of Electric Vehicle

In the case of products with new technologies such as electric vehicles, not only the completeness of the technology but also the acceptance of consumers is very important (Vassileva, & Campillo, 2017). Even with good technology, it will be difficult to achieve the government's eco-friendly vehicle policy and automobile manufacturers' sales goals if consumers do not prefer electric vehicles. Previous studies have shown that perceived factors has a direct influence on the attitudes towards adoption of technology (Chen, & Chang, 2012; Davis, Bagozzi, & Warshaw, 1989). Therefore, it is very important to analyze the positive and negative factors of electric vehicles (Egbue, & Long, 2012; Williamson, Emadi, & Rajashekara, 2007). The challenge for the electric vehicle industry is to build market share and consumer demand beyond the domination of internal combustion engines for personal transportation for a century (Carley, Krause, Lane, & Graham, 2013). An effective way to get consumers to adopt electric vehicles is to gain knowledge of electric vehicles, which is an essential prerequisite for the transition (Noppers, Keizer, Bolderdijk, & Steg, 2014). Several scholars recognized that technology, safety, convenience, vehicle prices with other economic factors, and social factors including environmental issues were related to consumers' purchase of electric vehicles (Rezvani, Jansson, & Bodin, 2015; Biresselioglu, Kaplan, & Yilmaz, 2018). Typical positive factors for using electric vehicles re low maintenance costs and economic benefits such as government subsidies, which in particular can dilute the negatives of the relatively expensive electric vehicles (Ju, Lee, & Kim, 2021). Although these subsidies are a way to achieve environmental policies in the transportation sector, some consumers consider the environmental-friendly factors of electric vehicles to be a positive reason for their purchase (Ozaki, & Sevastyanova, 2010). Nevertheless, many studies have shown that the

higher purchasing cost of the electric vehicles, the more negatively it affects the preference for electric vehicles (Hidrue, Parsons, Kempton, & Gardner, 2011; Jensen, Cherchi, & Mabit, 2013). In addition, the short mileage due to the lack of battery capacity (Degirmenci, & Breitner, 2017), and insufficient charging infrastructure and long charging times (Liao, Molin, & Wee, 2017) are considered negative factors in the purchase of electric vehicles. Therefore, this paper will analyze the opinions of electric vehicle actual consumers and potential consumers by reflecting the perceived positive and negative factors of electric vehicles in the survey.

III. Hypotheses Development

This study is to investigate promoting and regulatory factors for electric vehicles among environmentally friendly vehicles, and to investigate how those factors affect consumers' attitude, satisfaction and intention to use. Suggested factors are economic feasibility, sociality, environmental sustainability, inefficiency, inconvenience, convenience, and uncertainty of electric vehicles. This study is conducted on actual consumers who have experience using electric vehicles and potential consumers who have no experience in using electric vehicles. Hypothesis testing examines which factors related to electric vehicles influence consumer attitudes, and determines how attitudes affect actual consumer's satisfaction and potential consumer's intention to use. In addition, it is expected that the opinions of the promoting and regulatory policies will help derive policy implications and increase the use and purchase intention of electric vehicles.

3.1 Effects of Factors on Consumer Attitude

3.1.1 Effects of Economic Factor on Overall Attitude

The economic factors of electric vehicles can be classified into two perspectives. In general, electric vehicles have to pay more than similar internal combustion engine models. Schmelzer, & Miess (2015) analyzed that the high price of electric vehicles increases the average vehicle price and

negatively affects consumption. Several scholars also argued that the purchase cost of expensive electric vehicles had a negative effect on electric vehicle preference (Hidrue, Parsons, Kempton, & Gardner, 2011; Jensen, Cherchi, & Mabit, 2013). However, the operating costs of electric vehicles, particularly fuel and maintenance costs, tend to be lower than those of internal combustion engine vehicles (Brase, 2019). In particular, when the high oil price continues, the effect of reducing fuel costs can be maximized. In addition, government subsidies and tax credits lower the relatively high price of electric vehicles, thereby increasing economic benefits. Liao, Molin and Wee (2017) found that reducing taxes on the purchase of electric vehicles is very effective in favoring electric vehicles. Nevertheless, the details of these patterns depend on the vehicle model, local fuel/electricity rates, driving patterns, and other factors (Lee, & Lovellette, 2011). Moreover the calculation of the costs and benefits associated with people making an electric vehicle purchase decision can vary widely from individual to individual. Therefore, this study hypothesized the effects of economic factor on overall attitudes toward electric vehicle for actual consumers and potential consumers.

H1 a: Perceived economic factor on electric vehicle affects overall attitude of actual consumers.

H1 b: Perceived economic factor on electric vehicle affects overall attitude of potential consumers.

3.1.2 Effects of Social Factor on Overall Attitude

The social factors related to electric vehicle are about how actual consumers or potential consumers are shown to others by using electric vehicles. This is because electric vehicles have many social meanings beyond general means of transportation. So, how electric vehicle use is viewed by others can influence electric vehicle acceptance (White, & Sintov, 2017). In several studies, social values were measured by classifying them as perceived values of consumers (Sheth, 1991; Sweeney, & Soutar, 2001; Brown, 2006). Electric vehicles can be said to be highly innovative products that are differentiated from conventional internal combustion engine vehicles. Therefore, the social value that

electric vehicles can provide to consumers can be distinguished from existing values. People strongly behave according to the social acceptance of a certain behavior when making decisions (Maya, López-López, & Munuera, 2011). Electric vehicles represent technological, social and cultural innovations, which may deviate significantly from previously accepted social values (Claudy, Garcia, & O'Driscoll, 2015; Noppers, Keizer, Boulderdijk, & Steg, 2014) argued that since electric vehicles signal innovation, it is necessary to study whether such innovativeness of electric vehicles influences consumer's electric vehicle adoption behavior. This influence can be interpreted in the form of social benefits that the consumer can perceive such as improving social status or reputation by choosing a green product such as electric vehicles (Din, & Barbu, 2021). Also, someone can be an influence that can participate in influencing the intention to use electric vehicles (Daziano, & Chiew, 2012). Thus, the following hypothesis is proposed:

H2 a: Perceived social factor on electric vehicle affects overall attitude of actual consumers.

H2 b: Perceived social factor on electric vehicle affects overall attitude of potential consumers.

3.1.3 Effects of Environmental Factor on Overall Attitude

The environmental factors are very important in the use of electric vehicles and are a strong motivation for consumers to purchase electric vehicles. It is also one of the main reasons why the government supports the electric vehicle business. This is because the use of electric vehicles can improve the environment by reducing emissions and achieve carbon neutrality. Wang, Tang and Pan (2018) investigated and analyzed the factors of electric vehicle purchase intention of potential consumers in Shanghai, China, and found that moral responsibility for environmental protection was the main influencing factor. Perceived environmental factors are defined as consumers' perceptions of the positive consequences of driving electric vehicles on the environment (López-Gamero, Molina-Azorín, & Claver-Cortés, 2000). Thus, the sustainability of environmental factors promote adoption

of green products (Chen, & Chang, 2013). In this regard, as a sustainable innovation, electric vehicles reduce CO_2 emissions and fuel consumption (Jiang, Hu, An, Wang, & Park, 2017). Rezvani, Jansson and Bodin (2015) report that consumers are more environmentally conscious and are more willing to purchase electric vehicles because of their environmental benefits. Several studies have argued that environmental awareness is a key factor that can influence perceptions of electric vehicles, which in turn influence intentions to use these types of vehicles (Sefora, Chuchu, Chiliya, & Ndoro, 2019; Moons, & Pelsmacker, 2012). Therefore, this study hypothesized the effects of environmental factor on overall attitudes toward electric vehicle for actual consumers and potential consumers.

H3 a: Perceived environmental factor on electric vehicle affects overall attitude of actual consumers.

H3 b: Perceived environmental factor on electric vehicle affects overall attitude of potential consumers.

3.1.4 Effects of Inefficiency on Overall Attitude

Inefficiency is related with the efficiency of a battery that has the power to drive an electric vehicle. According to a report by Deloitte (2022), consumers who are not considering purchasing an electric vehicle cited anxiety about the mileage as their biggest concern. In particular, potential consumers are less motivated to purchase due to concerns about short mileage, which is considered a major factor hindering the spread of electric vehicles (Ju, Lee, & Kim, 2021; Degirmenci & Breitner, 2017). Degirmenci and Breitner (2017) analyzed that the short mileage of electric vehicles is caused by a lack of battery technology and negatively affects preferences. On the other hand, other researchers revealed that electric vehicle consumers feel satisfaction through adaptation to the mileage, and that mileage anxiety is not actually a big problem in electric vehicles (Franke, Neumann, Bühler, Cocron, & Krems, 2012). According to the results of UK consumers, the initial mileage anxiety decreased over time because knowledge and confidence improved as the driving time

increased (Vassileva, & Campillo, 2017). As other inefficiency factors, fuel efficiency and charging/discharging efficiency according to season or weather are mentioned. In general, lithium battery performance deteriorates when it is below 10 degrees Celsius or above 45 degrees Celsius (Zhang, Qian, Sprei, & Li, 2016). Therefore, this study hypothesized the effects of inefficiency on overall attitudes toward electric vehicle for actual consumers and potential consumers.

H4 a: Perceived inefficiency on electric vehicle affects overall attitude of actual consumers.

H4 b: Perceived inefficiency on electric vehicle affects overall attitude of potential consumers.

3.1.5 Effects of Inconvenience and Convenience on Overall Attitude

The convenience of electric vehicles is related to where electric vehicle consumers feel comfortable and uncomfortable. It might include charging facilities, charging time, and performance of electric vehicles that can be experienced while using electric vehicles. The obvious disadvantage of electric vehicles is that the batteries need to be charged, which requires a separate charging infrastructure and long charging times (Zhang, Qian, Sprei, & Li, 2016). Thus, charging takes a long time and the lack of charging infrastructure is considered to be the main obstacle to the adoption of electric vehicles (Liao, Molin, & Wee, 2017). However, since electric vehicles operate only with electric power, they have the convenience of not generating the same noise as internal combustion engine vehicles (Degirmenci, & Breitner, 2017). In addition, if the performance of a vehicle is generally judged by engine performance, acceleration time and maximum speed, electric vehicles have excellent performance. Reports show that consumers generally prefer better performance (McKinsey, 2017; Deloitte, 2022). In this respect, if consumers expect better performance from electric vehicles than previous conventional vehicles, the excellent performance of electric vehicles can give positive attitude. In addition, inconvenience caused by electric vehicle charging facilities and long charging times can also affect consumer's attitudes. Therefore, this leads to the following

hypothesis:

H5 a: Perceived inconvenience on electric vehicle affects overall attitude of actual consumers.

H5 b: Perceived inconvenience on electric vehicle affects overall attitude of potential consumers.

H6 a: Perceived convenience on electric vehicle affects overall attitude of actual consumers.

H6 b: Perceived convenience on electric vehicle affects overall attitude of potential consumers.

3.1.6 Effects of Uncertainty on Overall Attitude

In general, there are many people who are concerned about the uncertainty about battery safety related to electric vehicles. Therefore, it can be said that the lack of stability for the battery is perceived as a big uncertainty in purchasing electric vehicles (Zubaryeva, Thiel, Barbone, & Mercier, 2012). As the use of electric vehicles enlarges, the number of electric vehicle fires is also increasing. According to the Korea National Fire Agency, there have been 45 electric vehicle fires in the past five years. The causes of battery-related fires include defective battery manufacturing, overcharging, and external shock. Electric vehicle fires amplify consumer anxiety in that they require special attention due to the fact that the fire spreads rapidly due to thermal runaway and is difficult to extinguish (National Transportation Safety Board). According to Nepomuceno, Laroche and Richard (2014), perceived risk is generally perceived as uncertainty in relation to the use of products or services, which negatively affects purchasing behavior. In China, the largest electric vehicle market in the world, the electric vehicle subsidy plan has been extended from the existing expiration date of 2020 to the end of 2022, and the basic subsidy has been reduced by 10%, 20%, and 30% annually (IEA, 2022). In addition, disruptions in the supply of raw materials for batteries and automotive semiconductors due to global supply chain problems are causing significant delays in the receipt of purchased electric vehicles. Therefore, this study hypothesized the effects of uncertainty on overall attitudes toward electric vehicle for actual consumers and potential consumers.

H7 a: Perceived uncertainty on electric vehicle affects overall attitude of actual consumers.

H7 b: Perceived uncertainty on electric vehicle affects overall attitude of potential consumers.

3.2 Effects of Attitude on Satisfaction and Intention

Although the term attitude is widely used, this study considers attitude as a consumer's overall and continuous evaluation of an object and factor (Arnould, Price, & Zinkhan, 2001). Many researchers have studied that a person's attitude affects their intentions and behavior (Ajzen, & Fishbein, 1980; Solomon, 2009; Blackwell, Miniard, & Engel, 2006). Behavior can also be thought of as consumer behavior toward attitude objects (Ajzen, 2008). Oliver (1980) hypothesized that consumer satisfaction influences attitudes and in turn affects purchase intentions, and this is supported by the results that consumer satisfaction positively influences attitudes. Positive attitudes have been shown to increase purchase intentions, which is consistent with the Fishbein model (Fishbein, & Ajzen 1975). Perceived positive attitudes influence behavioral intentions to use, and individuals may have conscious plans to perform specific behaviors (Brezavscek, Sparl, & Znidarsic, 2017). Therefore, this study hypothesized the effects of the positive attitude toward electric vehicles affects the satisfaction and purchase intention of actual consumers and potential consumers.

H8: Positive attitude toward electric vehicles affects higher level of actual consumers' satisfaction.

H9: Positive attitude toward electric vehicles affects higher level of intention to use for potential consumers.

IV. Methodology

4.1 Data Collection

This study investigates how affect actual consumers' satisfaction and intention to use for potential consumers by measuring attitude from perceived various factors on electric vehicle. Data

was collected via an online survey. The survey was distributed through an online community (web portal NAVER's electric vehicle club) and SNSs, such as KakaoTalk messenger. The questionnaire consists of three parts, warm-up questions, main questions, and demographic questions. This study developed several questions for major factors such as economic feasibility, sociality, environmental sustainability, inefficiency, inconvenience, convenience, and uncertainty. This study applied a 5-point Likert scale of 1 – strongly disagree and 5 – strongly agree for major variables. The total of 134 respondents completed the survey, consisting of 78 electric vehicle actual consumers and 55 non-electric vehicle consumers. The response rate was 32.9%. In order to check reliability, this study conducted Cronbach's alpha tests in Table 5.

Table 5. Cronbach's Alpha Test for the Factors in Electric Vehicle

Factors	Statements	Actual Consumers	Potential Consumers
Economic Feasibility	1. I think that the use of electric vehicles helps save fuel costs. 2. I think that the management and maintenance cost of electric vehicles tend to be lower than that of non-electric vehicles. 3. I think that subsidies and tax deductions for electric vehicles help reduce costs. 4. I think that the cost of electric vehicles is more expensive than internal combustion engine vehicles. 5. I think that cost is burdensome when replacing battery in electric vehicles. 6. I think that the usage of electric vehicles help reduce costs overall. Reliability (Cronbach's Alpha)	0.838	0.713
Sociality	1. Usage of electric vehicles is one of the social issues 2. I think that using electric vehicles give a responsibility to society. 3. I think that using electric vehicles is following a social trend. Reliability (Cronbach's Alpha)	0.776	0.649
Environmental Sustainability	1. I think that electric vehicles are eco-friendly. 2. I think that electric vehicles can improve the environment by reducing emissions. 3. I think that the use of electric vehicles helps obtain carbon neutrality. Reliability (Cronbach's Alpha)	0.691	0.884
Inefficiency	1. I think that electric vehicles tend to have shorter mileage. 2. I think that the charging/discharging efficiency of electric vehicles is relatively low. 3. I think that electric vehicles have poor fuel efficiency due to batteries reasons such as seasonal, weather, etc. Reliability (Cronbach's Alpha)	0.924	0.756

Inconvenience	1. I think that charging facilities are not enough. 2. I think that charging time is long. Reliability (Cronbach's Alpha)	0.673	0.444
Convenience	1. I think that electric vehicles provide comfortable driving feeling because of reduced noise. 2. I think that electric vehicles have good performance. Reliability (Cronbach's Alpha)	0.569	0.420
Uncertainty	1. There is concern about battery technology of electric vehicles. 2. Users might feel uncertainty regarding inconsistent promotional policies on electric vehicles such as subsidies, tax benefits, etc. 3. There are concerns about delays in receiving electric vehicles due to reason such as semiconductor and raw material of battery supply disruptions, etc. Reliability (Cronbach's Alpha)	0.776	0.668

Table 6 summarize demographic characteristic of respondents.

Table 6. Sample Demographics

	Actual Consumers (78)		**Potential Consumers (55)**	
	%	*N*	*%*	*N*
Gender				
Male	78.2%	(61)	50.9%	(28)
Female	21.7%	(17)	49.1%	(27)
Occupation				
Educational institution	14.1%	(11)	27.3%	(15)
Public corporate sector	16.7%	(13)	12.7%	(7)
Profit sector	24.4%	(19)	23.6%	(13)
Research institution	9.0%	(7)	7.3%	(4)
Government sector	10.3%	(8)	9.1%	(5)
Self-employed	10.3%	(8)	0%	(0)
Housewife	1.3%	(1)	1.8%	(1)
Student	1.3%	(1)	1.8%	(1)
Others	12.8%	(10)	16.4%	(9)
Age				
21-24 years old	1.3%	(1)	1.8%	(1)
25-29 years old	0%	(0)	5.5%	(3)
30-34 years old	26.9%	(21)	30.9%	(17)
35-39 years old	16.7%	(13)	25.5%	(14)
40-44 years old	33.3%	(26)	21.8%	(12)
45-49 years old	10.3%	(8)	12.7%	(7)
50-54 years old	7.7%	(6)	1.8%	(1)
55-59 years old	1.3%	(1)	0%	(0)
More than 60 years old	2.6%	(2)	0%	(0)
Education				
Middle school graduate	0%	(0)	0%	(0)
High school graduate	2.6%	(2)	1.8%	(1)
2-year associated degree	11.5%	(9)	7.3%	(4)
Bachelor degree	59%	(46)	56.4%	(31)
Master degree	20.5%	(16)	32.7%	(18)
Ph.D	6.4%	(5)	1.8%	(1)
Marriage				
Married	74.4%	(58)	0.73%	(40)
Unmarried	25.6%	(20)	0.27%	(15)

Average Annual Salary				
Below KRW 10,000,000	0%	(0)	5.5%	(3)
More or equal to KRW 10,000,000 ~ below KRW 20,000,000	1.3%	(1)	0%	(0)
More or equal to KRW 20,000,000 ~ below KRW 30,000,000	3.8%	(3)	3.6%	(2)
More or equal to KRW 30,000,000 ~ below KRW 40,000,000	16.7%	(13)	14.5%	(8)
More or equal to KRW 40,000,000 ~ below KRW 50,000,000	12.8%	(10)	12.7%	(7)
More or equal to KRW 50,000,000 ~ below KRW 60,000,000	17.9%	(14)	25.5%	(14)
More or equal to KRW 60,000,000 ~ below KRW 70,000,000	17.9%	(14)	12.7%	(7)
More or equal to KRW 70,000,000	29.5%	(23)	25.5%	(14)

4.2 Data Analysis

In this study, the validity was checked by using factor analysis for the factors of electric vehicles applying extraction method with a varimax rotation of Kaiser. This study applied factors that Eigen values are greater than 1.00 for major variables including economic feasibility, sociality, environmental sustainability, inefficiency, inconvenience, convenience and uncertainty.

Table 7 and 8 summarizes the results of factor analysis for each factor of electric vehicles that affect the attitudes of actual consumers and potential consumers.

Table 7. Component Matrix: Factors of Electric Vehicle (Actual Consumer)

Factors	Scale Items	Components (Actual Consumer)						
		1	2	3	4	5	6	7
Econ 1	I think that the use of electric vehicles helps save fuel costs.	.862						
Econ 2	I think that the management and maintenance cost of electric vehicles tend to be lower than that of non-electric vehicles.	.802						
Econ 3	I think that subsidies and tax deductions for electric vehicles help reduce costs.	.771						
Econ 4	I think that the cost of electric vehicles is more expensive than internal combustion engine vehicles.	.761						
Social 1	Usage of electric vehicles is one of the social issues.		.807					
Social 2	I think that using electric vehicles give a responsibility to society.		.784					
Social 3	I think that using electric vehicles is following a social trend.		.774					
Enviro 2	I think that electric vehicles can improve the environment by reducing emissions.			.950				
Enviro 3	I think that the use of electric vehicles helps obtain carbon neutrality.			.948				
Enviro 1	I think that electric vehicles are eco-friendly.			.903				
Ineffic 2	I think that the charging/discharging efficiency of electric vehicles is relatively low.				.810			
Ineffic 1	I think that electric vehicles tend to have shorter				.786			

	mileage.							
Ineffic 3	I think that electric vehicles have poor fuel efficiency due to batteries reasons such as seasonal, weather, etc.				.747			
Incon 1	I think that charging facilities are not enough.					.828		
Incon 2	I think that charging time is long.					.822		
Con 1	I think that electric vehicles provide comfortable driving feeling because of reduced noise.						.912	
Con 2	I think that electric vehicles have good performance.						.894	
Uncert 3	There are concerns about delays in receiving electric vehicles due to reason such as semiconductor and raw material of battery supply disruptions, etc.							.792
Uncert 1	There is concern about battery technology of electric vehicles.							.777
Uncert 2	Users might feel uncertainty regarding inconsistent promotional policies on electric vehicles such as subsidies, tax benefits, etc.							.774

Table 8. Component Matrix: Factors of Electric Vehicle (Potential Consumer)

Factors	Scale Items	Components (Potential Consumer)						
		1	2	3	4	5	6	7
Econ 6	I think that the usage of electric vehicles helps reduce costs overall.	.867						
Econ 2	I think that the management and maintenance cost of electric vehicles tend to be lower than that of non-electric vehicles.	.697						
Econ 1	I think that the use of electric vehicles helps save fuel costs.	.679						
Econ 3	I think that subsidies and tax deductions for electric vehicles help reduce costs.	.409						
Social 3	I think that using electric vehicles is following a social trend.		.854					
Social 1	Usage of electric vehicles is one of the social issues.		.766					
Social 2	I think that using electric vehicles give a responsibility to society.		.715					
Enviro 1	I think that electric vehicles are eco-friendly.			.913				
Enviro 2	I think that electric vehicles can improve the environment by reducing emissions.			.910				
Enviro 3	I think that the use of electric vehicles helps obtain carbon neutrality.			.891				
Ineffic 1	I think that electric vehicles tend to have shorter mileage.				.883			
Ineffic 2	I think that the charging/discharging efficiency of electric vehicles is relatively low.				.854			
Ineffic 3	I think that electric vehicles have poor fuel efficiency due to batteries reasons such as seasonal, weather, etc.				.721			

Incon 2	I think that charging time is long.					.796		
Incon 1	I think that charging facilities are not enough.					.791		
Con 1	I think that electric vehicles provide comfortable driving feeling because of reduced noise.						.815	
Con 2	I think that electric vehicles have good performance.						.765	
Uncert 2	Users might feel uncertainty regarding inconsistent promotional policies on electric vehicles such as subsidies, tax benefits, etc.							.828
Uncert 3	There are concerns about delays in receiving electric vehicles due to reason such as semiconductor and raw material of battery supply disruptions, etc.							.816
Uncert 1	There is concern about battery technology of electric vehicles.							.682

This study applied factor scores for regression analysis to find out the significant of each factor. Table 9 and 10 indicate how much each factor of electric vehicle affect the attitude of actual consumers and potential consumers. According to ANOVA, the model in table 9 denotes *R-square* = .591 and $F = 12.592$ at 0.01 level of significant.

Table 9. Effects of Factors on Attitudes of Actual Consumer

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Economic Feasibility → Attitude (H1 a)	.262 (2.631**)
Sociality → Attitude (H2 a)	.150 (1.377)
Environmental Sustainability → Attitude (H3 a)	.020 (.192)
Inefficiency → Attitude (H4 a)	.353 (3.471**)
Inconvenience → Attitude (H5 a)	.053 (.541)
Convenience → Attitude (H6 a)	.468 (4.565***)
Uncertainty → Attitude (H7 a)	.413(4.256***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

The ANOVA model results in table 10 showed *R*-square = .335 and $F = 3.165$ at the significant level of 0.01.

Table 10. Effects of Factors on Attitudes of Potential Consumers

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Economic Feasibility → Attitude (H1 b)	.259 (1.758*)
Sociality → Attitude (H2 b)	.016 (0.113)
Environmental Sustainability → Attitude (H3 b)	.015 (0.100)
Inefficiency → Attitude (H4 b)	.158 (0.986)
Inconvenience → Attitude (H5 b)	.015 (0.99)
Convenience → Attitude (H6 b)	.395 (2.710**)
Uncertainty → Attitude (H7 b)	.56(0.443)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

Table 11 and 12 represent the result of regression analysis based on the effect of attitude on actual consumer's satisfaction and potential consumer's intention to use electric vehicle. The ANOVA model results in table 11 showed *R-square* = .550 and *F* = 72.163 at the significant level of 0.01.

Table 11. Effects of Attitudes on Actual Consumers' Satisfaction

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Attitude → Satisfaction (H8)	0.742 (8.495***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

The ANOVA model results in table 12 showed *R-square* = .525 and *F* = 45.358 at the significant level of 0.01.

Table 12. Effects of Attitudes on Intention to Purchase of Electric Vehicle

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Attitude → Intention (H9)	0.725 (6.735***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

In conclusion, the result of hypotheses testing of factors related to electric vehicle is summarized in Table 13.

Table 13. Summary of Effects of Factors on Attitude

Determinant	Hypothesis Testing	Result	
		Actual Consumers	Potential Consumer
Economic Feasibility	Economic Feasibility → Attitude (H1 a~b*)	Accepted	Accepted
Sociality	Sociality → Attitude (H2 a~b*)	Rejected	Rejected
Environmental Sustainability	Environmental Sustainability → Attitude (H3 a~b*)	Rejected	Rejected
Inefficiency	Inefficiency → Attitude (H4 a~b*)	Accepted	Rejected
Inconvenience	Inconvenience → Attitude (H5 a~b*)	Rejected	Rejected
Convenience	Convenience → Attitude (H6 a~b*)	Accepted	Accepted
Uncertainty	Uncertainty → Attitude (H7 a~b*)	Accepted	Rejected

* a: Actual Consumer, b: Potential Consumer

Table 14 shows the test results of hypotheses 8 and 9 of the effect of attitude on electric vehicle actual consumers' satisfaction and the effect of attitude on potential consumer's purchase intention.

Table 14. Summary of Effects of Attitude on Satisfaction and Intention

Determinant	Hypothesis Testing	Result
Attitude	Attitude → Satisfaction (H8)	Accepted
Attitude	Attitude → Intention (H9)	Accepted

V. Conclusion

5.1 The Summary of Findings

The purpose of this study is to explore factors that affect attitude, satisfaction, and intention to use electric vehicles by classifying actual and potential consumers. The results of this study found that economic feasibility and convenience factors showed significant on attitude based on both groups of consumers of electric vehicles. The results also found that effects of the level of inefficiency and the level of certainty showed significant on attitude based on actual consumers. Therefore, H1a, 4a, 6a, and 7a were accepted based on actual consumers, while H1b and 6b were accepted based on potential consumers. Among factors, convenience showed strong effect size followed by economic feasibility both actual and potential consumers. Effects of factors including sociability, environmental sustainability, and inconvenience on attitudes were not significant based on both groups of actual and potential consumers. Therefore, H2, 3, 5 were rejected. Effects of inefficiency and level of certainty on attitude do not show significant based on potential consumers. Therefore, H4b and H7b were rejected.

The results implied that both potential and actual consumers perceive the use of electric vehicle helps reduce fuel costs, management and maintenance costs, helps gain subsidies and deduct tax related costs. Actual consumers perceive the cost of electric vehicle is more experience than internal combustion engine vehicles, while potential consumers perceive the use of electric vehicle helps reduce overall costs related to electric vehicles. The results also implied that both potential and actual consumers perceive the use of electric vehicle helps provide comfortable driving feeling because of reduced noise and good performance. Actual consumers perceive the use of vehicle with

shorter mileage, relatively lower charging/discharging efficiency, and poor fuel efficiency due to batteries reasons such as seasonal, weather, etc. Actual consumers perceive the use of vehicle with uncertainties, including batter technology, delays in receiving electric vehicles due to reasons such as semiconductor and raw material of battery supply disruptions, and inconsistent promotional policies such as subsidies, tax benefits, etc.

The results implied that both potential and actual consumers do not perceive the use of electric vehicles as social issue, and do not follow social trend. Both potential and actual consumers do not perceive the use of electric vehicle helps improve environmental issue and accomplishment of carbon neutrality. Both potential and actual consumers' attitudes on electric vehicle were not affected by the perceived lack of infrastructure for charging facilities and longer charging time. The results of this study also showed that effects of attitude on satisfaction for actual consumers and effects of attitude on intention to use for potential consumers were significant. Therefore, H8 and H9 were accepted.

5.2 Policy and Managerial Implications

By exploring how proposed factors affect consumer satisfaction and potential consumer's intention to use electric vehicles, this study ultimately propose promotional and regulatory policy implications. This study suggests the importance and expected implications of policies for the government, local governments, and automobile manufacturers by examining perceived effects by actual and potential consumers.

First, economic feasibility was found to have a positive effect on the attitudes of electric vehicle actual consumers and potential consumers. In addition, both actual consumers and potential consumers chose economic benefit as the positive factor in purchasing an electric vehicle. Therefore, it is necessary for the government to continue promoting policies that help increase consumers'

purchase intentions by providing financial benefits. Managerially, automobile manufacturers should target consumers by applying better strategies such as providing more information and promotional activities that highlight convenience, economic factor, etc.

On the other hand, it should be noted that various factors of electric vehicles in the survey do not affect potential consumer's attitudes despite the growing proportion of electric vehicles in total vehicle sales. In particular, sociality, environmental sustainability, and inconvenience showed insignificant for both actual consumers and potential consumers, while those factors might increase consumer satisfaction and intention to use through policy improvement. Even though the effects of sociability factor on attitude were not significant for both groups of actual and potential consumers, the usage of electric vehicle might be enhanced by promoting other aspects highlighting social issues, particularly targeting Generation Y, called Millennials who tends to interests on sustainability and have economic capability to own a vehicle. The results of this study (Table 6) also showed that approximately 78% of actual consumers were in that cohorts of Generation Y. Therefore, it is expected that automobile manufacturers should consider to develop integrated marketing communication targeting to Generation Y as people born from 1981 to 1996 (Thigpen, & Tyson, 2021). Among promotional tools, automobile manufacturers might consider to encourage social factors such as social responsibilities and trend if consumers adopt electric vehicles.

Although environmental sustainability was not significant for attitudes in this study, 34.5% of respondents from a group of potential consumers answered the survey questions asking that realization of carbon neutrality and conformity to eco-friendliness is the positive factor in purchasing an electric vehicle. Moreover, according to Deloitte (2022), consumers in most countries and regions are considering purchasing electric vehicles due to climate change concerns and reduced carbon emissions. Nevertheless, there are claims that doubt eco-friendliness of electric vehicles (Hawkins, Singh, Majeau-Bettez, & Stromman, 2012). At the center of the controversy, the problem cause by

the battery, a key component of electric vehicles. Because lithium mining requires a large amount of water and then releases harmful substances. In addition, electric vehicles do not emit carbon dioxide while driving, but they are inevitably generated in the process of producing vehicles and electricity. Therefore, in order to resolve these doubts, it is necessary to transparently disclose data to prove the eco-friendliness of electric vehicles, such as eco-friendly electricity production, carbon footprint of battery production, and the emission of pollutants during the manufacturing process of electric vehicles, and several studies have analyzed them in detail. (Ellingsen, Singh, & Strømman, 2016; Verma, Dwivedi, & Verma, 2021; Dillman, Arnadottir, Heinonen, Czepkiewicz, & Daviosdottir, 2020)

The inefficiency and uncertainty factors of electric vehicles are important in terms of managerial implication because they can positively influence consumers' attitudes through marketing by automobile manufacturers. Since electric vehicles are generally perceived as next-generation vehicles with new technologies, enhanced reliability will help target to potential consumers. Additionally, the results of this study found that 64 out of 134 respondents mentioned insufficient charging infrastructure and long charging times as the biggest concerns. This can become a bigger problem as the number of electric vehicle consumers increases, and many studies argue for the need for sufficient charging facilities (Kowalska-Pyzalska, Kott, & Kott, 2020; Zhang, Qian, Sprei, & Li, 2016; Liao, Molin, & Wee, 2017). Therefore, it is necessary for automobile companies to develop technologies that can reduce charging time along with the implementation of policies to install more charging facilities in the government and local governments.

It is also interesting to note that electric vehicle consumers also consider potential benefits. It can be seen that consumers expect additional factors that can be obtained by using electric vehicles apart from the fundamental purpose of transportation. This can be considered a natural phenomenon of accepting the rapid change from the existing internal combustion engine vehicle to the electric vehicle. By considering rapid growth of market share of electric vehicles, related policies should be

better prepared, therefore, consumers might show interests in policies such as subsidies and charging station installations. Therefore, further studies investigating and analyzing factors influencing the attitudes of electric vehicle actual consumers and potential consumers can be very important in providing the right direction for policy.

5.3 Additional Findings

This study conducted an additional analysis for future electric vehicle policy development. First, this study found that more than 83% of actual consumers and potential consumers agreed that the government needs to prepare better policies related to electric vehicles by considering the situation in Korea. Based on the results from independent-samples *t*-test, the mean value for actual consumers was 4.32 (SD=0.777) and potential consumers was 4.22 (SD=0.738). In addition, 88.6% of actual consumers and 83.6% of potential consumers agreed that it was necessary to prepare better electric vehicle's policies suitable for the local situation in Korea. An additional regression analysis using groups of actual consumers found that the installation policy for charging facilities and economic benefits to consumers influenced the need for proper promotional policies on electric vehicles by the government. In addition, as for potential consumers, only economic benefits were found to affect the need for the government's electric vehicle promotion policy. Therefore the results indicate that there is necessity of preparing a promotion policy such as economic benefits to both of actual consumers and potential consumers.

Second, after conducting a factor analysis of the company's ESG activities, a regression analysis was performed on the effect of electric vehicle attitudes for both actual consumers and potential consumers. As a result, it was found that environmental and social factors have a significant effect on the attitude of electric vehicle for both of groups.

Finally, question about the prospects of electric vehicles, both actual and potential consumers

perceived. Based on the results from independent-samples t-test, the mean value of the question for growth of the electric vehicle industry was 4.38 (SD=0.704) for actual consumers. Moreover, potential consumers was 4.43 (SD=0.602). In particular, it was found that more than 90% of respondents agreed with continuous development of electric vehicle industry and companies that produce electric vehicles.

5.4 Limitation and Future Study

This paper has limitations. The sample size could be improved in the future study. Additional research is needed to explore other factors besides factors that applied in this study to measure the satisfaction of actual consumers or intention to use of potential consumers. Third, the results may be limited to Korea, as the data was collected from Koreans. Given the differences between countries, applying the research model to different countries may result in further studies. Lastly, this paper was limited to the characteristics of electric vehicles among eco-friendly vehicles, and the satisfaction and intention to use were explored regardless of different types of products and brands. Therefore, future research should analyze consumer satisfaction and intention to use based on different types of products and brands.

References

Abouee-Mehrizi, H., Baron, O., Berman, O., & Chen D. (2021). Adoption of Electric Vehicles in Car Sharing Market. *Production and Operations Management*, *30*(1), 190–209.

Ajzen, I. (2008). *Consumer attitudes and behavior*. Handbook of Consumer Psychology (525-548). New York: Lawrence Erlbaum Associates.

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. New Jersey: Prentice-Hall.

Armenio, S., Bergantino, A. S., Intini, M., & Morone, A. (2021). Cheaper or eco-friendly cars: What do consumers prefer? An experimental study on individual and social preferences. *Ecological Economics*, *193*. https://doi.org/10.1016/j.ecolecon.2021.107323

Arnould, E. J., Price, L., & Zinkhan, G. (2001). *Consumers (McGraw-Hill Series in Marketing)*. McGraw-Hill Education - Europe; I.S.ed edition.

Bakar, N., & Hasan-Basri, B. (2017). Strategic innovation and consumer preferences: an analysis of Malaysian car policy, *Millennial Asia*, *8*(1), 64-77.

Barbarossa, C., Pelsmacker, P. D., & Moons, I. (2017). Personal Values, Green Self-identity and Electric Car Adoption. *Ecological Economics*, *140*, 190–200.

Biresselioglu, M. E., Kaplan, M. D., & Yilmaz, B. K. (2018). Electric mobility in Europe: A comprehensive review of motivators and barriers in decision making processes. *Transportation Research Part A: Policy and Practice*, *109*, 1-13.

Blackwell, R. D., Miniard, P. W., & Engel, J. F. (2006). *Consumer Behavior* (10th edition). Australia: Thomson South-Western.

Brase, G. L. (2019). What Would It Take to Get You into an Electric Car? Consumer Perceptions and Decision Making about Electric Vehicles. *The Journal of Psychology*, *153*(2), 214–236.

Brezavscek, A., Sparl P., & Znidarsic, A. (2017). Factors Influencing the Behavioural Intention to Use Statistical Software: The Perspective of the Slovenian Students of Social Sciences. *EURASIA Journal of Mathematics Science and Technology Education*, *13*(3), 953-986.

Brown, R. M. (2006). *Drivers of student satisfaction and student loyalty in an Australian University Setting*. Doctor of Philosophy thesis at The University of Western Australia.

Carley, S., Krause, R. M., Lane, B. W., & Graham, J. D. (2013). Intent to purchase a plug-in electric vehicle: A survey of early impressions in large US cites. *Transportation Research Part D*, *18*, 39–45.

Cazzola, P., Craglia, M., Bunsen, T., & Sohu, V. (2021), Cleaner Vehicles: Achieving a Resilient Technology Transition, *International Transport Forum Policy Papers*, *90*, OECD Publishing, Paris.

Chen, Y. S., & Chang, C. H. (2012). Enhance green purchase intentions: The roles of green perceived value, green perceived risk, and green trust. *Management Decision*, *50*(3), 502-520.

Chen, Y. S., & Chang, C. H. (2013). The determinants of green product development performance:

Green dynamic capabilities, green transformational leadership, and green creativity. *Journal of business ethics*, *116*(1), 107-119.

Claudy, M. C., Garcia, R., & O'Driscoll, A. (2015). Consumer resistance to innovation—a behavioral reasoning perspective. *Journal of the Academy of Marketing Science*, *43*(4), 528-544.

Danielis, R., Rotaris, L., Giansoldati, M., & Scorrano, M. (2020). Drivers' preferences for electric cars in Italy. Evidence from a country with limited but growing electric car uptake. *Transportation Research Part A: Policy and Practice*, *137*, 79-94.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical model. *Management Science*, *35*(8), 982-1003.

Daziano, R. A., & Chiew, E. (2012). Electric vehicles rising from the dead: Data needs for forecasting consumer response toward sustainable energy sources in personal transportation. *Energy Policy*, *51*, 876-894.

Degirmenci, K., & Breitner, M. H. (2017). Consumer purchase intentions for electric vehicles: Is green more important than price and range? *Transportation Research Part D: Transport and Environment*, *51*, 250-260.

Deloitte. (2022). *2022 Global Automotive Consumer Study*. United Kingdom. Retrieved from https://www2.deloitte.com/global/en/pages/consumer-business/articles/global-automotive-consumer-study.html

Dillman, K, J., Arnadottir, A., Heinonen, J., Czepkiewicz, M., & Daviosdottir, B. (2020). Review and Meta-Analysis of EVs: Embodied Emissions and Environmental Breakeven. *SUSTAINABILITY*, *12*(22).

Din, M. I., & Barbu, A. (2021). The Factors That Influence the Acceptance Level of Electric Cars. *FAIMA Business & Management Journal*, *9*(4), 5-19.

EEA. (2022). *Transport and environment report 2021 Decarbonising road transport — the role of vehicles, fuels and transport demand*, European Environment Agency. https://www.eea.europa.eu/publications/transport-and-environment-report-2021

Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. *Energy policy*, *48*, 717-729.

Ellingsen, L. A. W., Singh, B., & Strømman, A. H. (2016). The size and range effect: Lifecycle greenhouse gas emissions of electric vehicles. *Environmental Research Letters*, *11*(5), 1-1.

Fishbein, M., & Ajzen, I. (1975). Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research, Reading, MA: Addison-Wesdly

Franke, T., Neumann, I., Bühler, F., Cocron P., & Krems, J. F. (2012). Experiencing Range in an Electric Vehicle-Understanding Psychological Barriers. *Applied Psychology: An International Review*, *61*(3), 368-391.

Guarnieri, M. (2011). When Cars Went Electric, Part One [Historical]. *IEEE Industrial Electronics Magazine*, *5*(1), 61-62.

Gulzari, A., Wang, Y., & Prybutok, V. (2022). A green experience with eco-friendly cars: A young consumer electric vehicle rental behavioral model. *Journal of Retailing and Consumer Services*, *65*.

Hawkins, T. R., Singh, B., Majeau-Bettez, G., & Stromman, A. H. (2012). Comparative environmental life cycle assessment of conventional and electric vehicles. *Industrial Ecology*, *17*(1), 54-64.

He, X., Zhan, W., & Hu, Y. (2018). Consumer purchase intention of electric vehicles in China: The roles of perception and personality. *Journal of Cleaner Production*, 204, 1060-1069.

Hidrue, M. K., Parsons, G. R., Kempton, W., & Gardner, M. P. (2011). Willingness to pay for electric vehicles and their attributes. *Resource and Energy Economics*, *33*(3), 686-705.

IEA. (2022). *Global electric vehicle outlook 2022*. International Energy Agency. https://www.iea.org/reports/global-ev-outlook-2022

Jensen, A. F., Cherchi E., & Mabit, S. L. (2013). On the stability of preferences and attitudes before and after experiencing an electric vehicle. *Transportation Research Part D: Transport and Environment*, *25*, 24-32.

Jiang, H., Hu, J., An, S., Wang, M., & Park, B. B. (2017). Eco approaching at an isolated signalized intersection under partially connected and automated vehicles environment. *Transportation Research Part C: Emerging Technologies*, *79*, 290-307.

Ju, N., Lee, K. H. & Kim, S.H. (2021). Factors Affecting Consumer Awareness and the Purchase of Eco-Friendly Vehicles: Textual Analysis of Korean Market. *Sustainability 2021*, *13*(10). https://doi.org/10.3390/su13105566

Kowalska-Pyzalska, A., Kott, J., & Kott, M. (2020). Why Polish Market of Alternative Fuel Vehicles (AFVs) is the Smallest in Europe? SWOT Analysis of Opportunities and Threats. *Renewable and Sustainable Energy Reviews*, *133*.

Lee, H., & Lovellette, G. (2011). *Will Electric Cars Transform the U.S. Vehicle Market? An Analysis of the Key Determinants*. Discussion Paper 2011-08, Cambridge, Mass.: Belfer Center for Science and International Affairs.

Lee, Y., & Park, M. (2022). The Challenges and Direction of Green Car Industry Policies in the Era of Carbon Neutrality. *J. Korean Soc. Transp*, *40*(1), 11-26.

Liao, F., Molin, E., & Wee, B. E. (2017). Consumer preferences for electric vehicles: a literature review. *Transport Reviews*, *37*(3), 252-275.

López-Gamero, M. D., Molina-Azorín, J. F., & Claver-Cortés, E. (2010). The potential of environmental regulation to change managerial perception, environmental management, competitiveness and financial performance. *Journal of Cleaner Production*, *18*(10-11), 963-974.

Manjunath, A., & Gross, G. (2017). Towards a meaningful metric for the quantification of GHG emissions of electric vehicles (EVs). *Energy Policy*, *102*, 423–429.

Maya, S. R., López-López, I., & Munuera, J. L. (2011). Organic food consumption in Europe: international segmentation based on value system differences. *Ecological Economics*, *70*(10), 1767–1775.

Moons, I., & Pelsmacker, P. D. (2012). Emotions as determinants of electric car usage intention. *Journal of Marketing Management*, *28*(3–4), 195–237.

Nanaki, E. A., & Koroneos, C. J. (2016). Climate change mitigation and deployment of electric vehicles in urban areas. *Renewable Energy*, *99*, 1153–1160.

Nepomuceno, M. V., Laroche, M., & Richard, M. O. (2014). How to reduce perceived risk when buying online: The interactions between intangibility, product knowledge, brand familiarity, privacy and security concerns. *Journal of Retailing and Consumer Services*, *21*(4), 619-629.

Noppers, E. H., Keizer, K., Bolderdijk, J. W., & Steg, L. (2014). The Adoption of Sustainable Innovations: Driven by Symbolic and Environmental Motives. *Global Environmental Change*, *25*, 52-62.

Oliver, R. L. (1976). A Cognitive Model of the Antecedents and Consequences of Satisfaction Decisions. *Journal of Markrting Research*, *17*, 460-469.

Ozaki, R., & Sevastyanova, K. (2010). Going hybrid: An analysis of consumer purchase motivations. *Energy Policy*, *39*(5), 2217-2227.

Ramli, A. R., Kadir, J. M. A., Ismail, N., Othman, A. A., & Melo, P. C. (2021). Fuel Subsidies, Fuel Consumption, and Road Transport Emissions: A Systematic Review. *Environment-Behaviour Proceedings Journal*, *6*(16), 275-281.

Regufe, M. J., Pereira, A., Ferreira, A. F. P., Ribeiro, A. M., & Rodrigues, A. E. (2021). Current Developments of Carbon Capture Storage and/or Utilization–Looking for Net-Zero Emissions Defined in the Paris Agreement. *Energies 2021*, *14*, 2406.

Rezvani, Z., Jansson, J., & Bodin, J. (2015). Advances in consumer electric vehicle adoption research: A review and research agenda. *Transportation Research Part D: transport and environment*, *34*, 122-136.

Schmelzer, S., & Miess, M. (2015). *The Economic Costs of Electric Vehicles*. Institute for Advanced Studies, Vienna. https://irihs.ihs.ac.at/id/eprint/3511/

Sefora, I., Chuchu, T., Chiliya, N., & Ndoro, T. (2019). An Investigation of Young Consumers' Perceptions towards the Adoption of Electric Cars. *African Journal of Business and Economic Research*, *14*(2), 107–126.

Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why we buy what we but a theory of consumption values. *Journal of Business Research*, *22*(2), 159-170.

Shillington, A., Zhang, V., Jacobson, D., & Miller, O. (2021) *The Electric Vehicle Revolution and ESG Charge Ahead*. VanEck, New York. Retrieved from https://www.vaneck.com/eme-gha-whitepaper-2021.pdf

Su, C. W., Yuan, X., Tao, R., & Umar, M. (2021). Can New Energy Vehicles Help to Achieve Carbon Neutrality Targets? *Journal of Environmental Management*, *297*, 113348.

Sweeney, J. C., & Soutar, G. N. (2001). Consumer perceived value: The development of a multiple item scale. *Journal of Retailing*, *77*(2), 203-220.

Vassileva, I., & Campillo, J. (2017). Adoption barriers for electric vehicles: Experiences from early adopters in Sweden. *Energy*, *120*(1), 632-641.

Verma, S., Dwivedi, G., & Verma, P. (2021). Life cycle assessment of electric vehicles in comparison to combustion engine vehicles: A review. *Materials Today: Proceedings*, *49*(2), 217-222.

Wang, N., Tang, L., & Pan, H. (2018). Analysis of public acceptance of electric vehicles: An empirical study in Shanghai. *Technological Forecasting & Social Change*, *126*, 284-291.

White, L. V., & Sintov, N. D. (2017). You are what you drive: Environmentalist and social innovator symbolism drives electric vehicle adoption intentions. *Transportation Research Part A: Policy and Practice*, *99*, 94-113.

Williamson, S. S., Emadi, A., & Rajashekara, K. (2007). Comprehensive efficiency modelling of electric traction motor drives for hybrid electric vehicle propulsion applications. *IEEE Transactions on Vehicular Technology*, *56*(4), 1561-1572.

Yong, J. Y., Ramachandaramurthy, V. K., Tan, K. M., & Mithulananthan, N. (2015). A review on the state-of-the-art technologies of electric vehicle, its impacts and prospects. *Renewable and Sustainable Energy Reviews*, *49*, 365–385.

Zhang, Y., Qian, Z. S., Sprei, F., & Li, B. (2016). The impact of car specifications, prices and incentives for battery electric vehicles in Norway: Choices of heterogeneous consumers. *Transportation Research Part C: Emerging Technologies*, *69*, 386–401.

Zubaryeva, A., Thiel, C., Barbone, E., & Mercia, A. (2012), Assessing factors for the identification of potential lead markets for electrified vehicles in Europe: expert opinion elicitation. *Technological Forecasting and Social Change*, *79*(9), 1622-1637.

Internet Sources

Bellis M. (2019). History of Electric Vehicles. *ThoughtCo*: New York. Retrieved from http://inventors.about.com/od/cstartinventions/a/History-Of-Electric-Vehicles.htm

Korea Automotive Technology Institute. (2022). *Eco-friendly vehicle policy to avoid hybrids in EU*. *Industry Trend*, 95

Korea National Fire Agency. (2022). *Status of electric vehicle fires (2017-2021)*. Retrieved from https://www.nfa.go.kr

Lamdouar, S. (2021). Sustainable Investing Through the Supply Chain: Electric Vehicles. *BERNSTEIN*: United States. Retrieved from https://www.bernstein.com/our-insights/insights/2021/articles/sustainable-investing-through-the-supply-chain-electric-vehicles.html

Lee, D. (2022). China's BYD to Stop Producing Fossil-Fueled Vehicles on EV Shift. *Bloomberg*: New York. Retrieved from https://www.bloomberg.com/news/articles/2022-04-03/china-s-byd-stops-producing-oil-fueled-vehicle-on-ev-shift?leadSource=uverify%20wall

Means, T., Lallanilla, M. (2021). *Greenhouse Gas Emissions: Causes & Sources*. Retrieved from https://www.livescience.com/37821-greenhouse-gases.html

Mirae Asset Global Investments. (2021). *ESG & the Rise of Electric Vehicles*. Retrieved from https://www.am.miraeasset.com.hk/esg/esg-the-rise-of-electric-vehicles/

The European Council. (2022). *Fit for 55: how the EU will turn climate goals into law*. Retrieved from https://www.consilium.europa.eu/en/infographics/fit-for-55-how-the-eu-will-turn-climate-goals-into-law/

Thigpen, C. L., & Tyson, A. (2021). On social media, Gen Z and Millennial adults interact more with climate change content than older generations. *Pew Research Center*: Washington. Retrieved from https://www.pewresearch.org/fact-tank/2021/06/21/on-social-media-gen-z-and-

millennial-adults-interact-more-with-climate-change-content-than-older-generations/

U.S. Department of Energy. (2022). *Alternative Fuels and Advanced Vehicles*. Retrieved from https://afdc.energy.gov/fuels

Wilson, K. A. (2022). Worth the Watt: A Brief History of the Electric Car, 1830 to Present. *Car And Driver*: Michigan. Retrieved from https://www.caranddriver.com/features/g15378765/worth-the-watt-a-brief-history-of-the-electric-car-1830-to-present

Appendix

Survey Questionnaire

Thank you for participating in the survey. This survey is proposed to investigate your opinion on electric vehicles. Your responses will be treated strictly confidentially and applied for the academic purpose only. Also, this survey will be conducted with your voluntary participation. If you have experienced electric vehicle usage, please respond the questions based on your experience. If you have not experienced electric vehicle usage, please respond the questions based on what you think of using the electric vehicle.

1. Have you ever used an electric vehicle?

   (1) Yes. (2) No.

2. Are you currently using an electric vehicle?

   (1) Yes. (then please go to # 4 question) (2) No. (then please go to # 3 question)

3. Are you interested in purchasing an electric vehicle?

   (1) Yes. (then please go to # 3.1 question) (2) No. (then please go to # 4 question)

   3.1 (No. 3, for prospective purchasers) If you are willing to purchase, when do you plan to purchase?
   (1) Within 1 year
   (2) After 1 year ~ Within 2 years
   (3) After 2 year ~ Within 3 years
   (4) After 3 year ~ Within 4 years
   (5) After 4 year ~ Within 5 years
   (6) After 5 year

4. Please answer the economic factors related to electric vehicles.

	-	Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	I think that the use of electric vehicles helps save fuel costs.					
2	I think that the management and maintenance cost of electric vehicles tend to be lower than that of non-electric vehicles.					

3	I think that subsidies and tax deductions for electric vehicles help reduce costs.					
4	I think that the cost of electric vehicles is more expensive than internal combustion engine vehicles.					
5	I think that cost is burdensome when replacing battery in electric vehicles.					
6	I think that the usage of electric vehicles help reduce costs overall.					

5. Please answer the social factors related to electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	Usage of electric vehicles is one of the social issues.					
2	I think that using electric vehicles give a responsibility to society.					
3	I think that using electric vehicles is following a social trend.					

6. Please answer the environmental factors related to electric vehicles.

	-	Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	I think that electric vehicles are eco-friendly.					
2	I think that electric vehicles can improve the environment by reducing emissions.					
3	I think that the use of electric vehicles helps obtain carbon neutrality.					

7. Please answer about the inefficiency of electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	I think that electric vehicles tend to have shorter mileage.					
2	I think that the charging/discharging efficiency of electric vehicles is relatively low.					
3	I think that electric vehicles have poor fuel efficiency due to batteries reasons such as seasonal, weather, etc.					

8. Please answer about the convenience of electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	I think that charging facilities are not enough.					
2	I think that charging time is long.					

3	I think that electric vehicles provide comfortable driving feeling because of reduced noise.					
4	I think that electric vehicles have good performance.					

9. Please answer the uncertainty of electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	There is concern about battery technology of electric vehicles.					
2	Users might feel uncertainty regarding inconsistent promotional policies on electric vehicles such as subsidies, tax benefits, etc.					
3	There are concerns about delays in receiving electric vehicles due to reason such as semiconductor and raw material of battery supply disruptions, etc.					

10. Please answer the government's management plan of electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	I think that the government's support on installation of electric vehicles' charging stations is not enough.					
2	I think that subsidies on electronic vehicles are reduced due to increased usage of electric vehicles. (Reduction of state subsidies per electric vehicle: KRW 8 million → KRW 6 million, Ministry of Environment)					
3	Electric vehicles' charging rate policy prepared by the government is not appropriate. (Increased from KRW 292.9 to KRW 313.1 per kWh from July 2022, Ministry of Environment)					
4	The government, local governments, and companies need to make active efforts to increase electric vehicle users.					

11. Please select the most positive factor related to the purchase decision of an electronic vehicle.

(1) Economic benefits from fuel costs and subsidies

(2) Accompanying the high-tech experience and trends

(3) Realization of carbon neutrality and conformity to eco-friendliness

(4) Efficiency of vehicle management

(5) Comfortable driving and excellent performance

(6) Automobile manufacturers stop developing internal combustion engine vehicles

12. Please select the most important concern related to the purchase decision of an electronic vehicle.

(1) Short mileage

(2) Insufficient charging infrastructure and long charging times

(3) High purchase price

(4) High repair cost (battery replacement)

(5) Battery instability (fire accident)

(6) Reduce subsidies and tax benefits

13. Please answer the following government policy regarding electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	It is necessary for the government to prepare better policies related to electric vehicles by considering the situation in Korea.					
2	The government's promotion (activation) policy is necessary in relation to the positive factors of electric vehicles.					
3	The government's regulatory policy is necessary in relation to the negative factors of electric vehicles.					
4	The government should interact with local governments to prepare better electric vehicles' policies that meet local conditions.					

14. Please answer the following government's promotion policy regarding electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	Installation policy for charging facilities of electric vehicles is necessary.					
2	Preparation of subsidy support policy is needed when charging facilities for electric vehicles are installed.					
3	The government might consider to prepare better policies to support vehicle industries that manufacture environmentally friendly vehicles.					
4	The government might consider to provide economic benefits to consumers who make a purchase decision of electric vehicles.					
5	Overall, proper promotional policies on electric vehicles can be facilitated by the government.					

15. Please answer the following government's regulatory policy regarding electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	A policy can be prepared to persuade companies to purchase at least some electric vehicles.					
2	A policy is needed to impose fines for non-electric vehicles parked in electric vehicle charging areas.					
3	A policy is needed to impose fines for parking of electric vehicles even after finished charging.					
4	A policy needs to be prepared to protect industries that manufacture non-environmentally friendly vehicles (i.e. internal combustion engine vehicles), if they have business loss due to the regulation.					
5	Overall, proper regulatory policies on electric vehicles need to be prepared by the government.					

16. What is your overall attitude towards electric vehicles?

← Strongly Disagree		Neutral		Strongly Agree →
1	2	3	4	5

17. What is your overall satisfaction on electric vehicles? (in the case of those who have experience)

← Strongly Disagree		Neutral		Strongly Agree →
1	2	3	4	5

18. What is level of intention to purchase of an electric vehicle? (in the case of those who do not have experience)

← Strongly Disagree		Neutral		Strongly Agree →
1	2	3	4	5

19. Please answer the prospect of electric vehicles.

		Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	I think that the electric vehicle industry will continue to grow.					
2	I think that electric vehicles will contribute to the development of the automobile industry.					
3	I think that companies that produce electric vehicles will continuously grow in the future.					

20. Please answer the following corporate activities related to the environment and society.

	-	Strongly Disagree		Neutral		Strongly Agree
		1	2	3	4	5
1	Corporate activities in response to climate change are required.					

2	Corporate activities for resource circulation are required.					
3	Corporate activities for the preservation of the natural environment are required.					
4	Corporate activities to grow together with the local community are required.					
5	Corporate activities related to sustainable growth are required.					
6	Corporate activities that create consumer value are required.					
7	Corporate ethical management activities that comply with laws and regulations are required.					
8	Corporate activities that protect interests of shareholders are important.					
9	A company's activities for stakeholders are important.					

21. Please select your gender.
    (1) Male
    (2) Female

22. Please select your occupation.
    (1) Employee in the educational institution
    (2) Employee in the public corporate sector
    (3) Employee in the profit sector
    (4) Employee in the research institution
    (5) Employee in the government sector
    (6) Self-employed
    (7) Housewife
    (8) Student
    (9) Others ( )

23. Please select your age group.
    (1) 21 years old ~ 24 years old
    (2) 25 years old ~ 29 years old
    (3) 30 years old ~ 34 years old
    (4) 35 years old ~ 39 years old
    (5) 40 years old ~ 44 years old
    (6) 45 years old ~ 49 years old
    (7) 50 years old ~ 54 years old
    (8) 55 years old ~ 59 years old
    (9) more than 60 years old

24. Please select your educational background.
    (1) Middle school graduate
    (2) High school graduate
    (3) 2-year associated degree
    (4) Bachelor's degree
    (5) Master's degree
    (6) Ph.D.

25. Please select your marital status.
    (1) Married
    (2) Unmarried

26. Please select the range of your household's annual salary.
    (1) Below KRW 10,000,000
    (2) More or equal to KRW 10,000,000 ~ below KRW 20,000,000
    (3) More or equal to KRW 20,000,000 ~ below KRW 30,000,000
    (4) More or equal to KRW 30,000,000 ~ below KRW 40,000,000
    (5) More or equal to KRW 40,000,000 ~ below KRW 50,000,000
    (6) More or equal to KRW 50,000,000 ~ below KRW 60,000,000
    (7) More or equal to KRW 60,000,000 ~ below KRW 70,000,000
    (8) More or equal to KRW 70,000,000

Thank you for participating this survey.