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A Study on the Factors Influencing the Purchase of Electric Vehicles

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Abstract

As of 2020, the cumulative number of electric vehicles worldwide increased 43% from 2019, exceeding 10 million. We surveyed and analyzed important factors when purchasing electric vehicles for consumers who own electric vehicles. Through this, we tried to find an effective way to supply electric vehicles in the future. The purpose of this study is to present customized marketing proposals for companies by empirically analyzing the factors affecting consumers' electric vehicle purchases and deriving market demands for electric vehicles. We identified the market status of electric vehicles through literature research and reviewed previous studies on the factors affecting the purchase intention of electric vehicles. Through empirical studies, differences in electric vehicle purchase factors according to gender, age, and the degree of importance of performance were analyzed. To this end, the SPSS statistics package was used. Factors influencing the purchase of electric vehicles were set to mileage, charging time, new technology, degree of driving autonomous development, design, price, infrastructure for charging, the phase of maintenance and repair, by the government and local governments. In addition, the most important factors were derived, and the average difference analysis was conducted according to gender, age, and performance importance.

Keywords: *Electric Vehicle, Purchases Intention, Charging Time, Autonomous Driving*

1. Introduction

Amid severe climate change due to environmental pollution, interest in environmental conservation around the world has become an absolute and essential era. In the present era, the importance of people's perception of eco-friendly has grown and eco-friendly policies are becoming a trend, and the market size and sales of eco-friendly vehicles such as electric vehicles are expected to continue to increase. In 2020, the cumulative number of electric vehicles worldwide increased 43% year-on-year, exceeding 10 million units. Due to the spread of COVID-19, the total number of new cars registered decreased by 16% from the

previous year, but the proportion of electric vehicles among all new vehicles increased by 70% compared to the previous year. This is analyzed to be due to the policy to expand the supply of electric vehicles, the introduction of additional electric vehicle-related incentives to overcome the COVID-19 economy, the expansion of electric vehicle models, and falling battery costs. By 2030, the number of electric vehicles worldwide will grow by 30%, and the total cumulative number of electric vehicles by 2030 will reach 145 million [1]. Several countries have strengthened their policies to mandate carbon emission standards or zero-carbon emission vehicles, especially in 2020, 20 countries have announced policies banning the sale of internal combustion engine vehicles and mandating the sale of carbon-free vehicles [1].

Electric-powered cars emit less greenhouse gas than traditional combustion engine cars driven by gasoline or diesel, and higher market share of eco-friendly cars is expected to significantly lower greenhouse gas emissions [2]. Despite the growing demand for electric vehicles, research on the factors affecting the purchase and satisfaction of electric vehicles is insufficient. The purpose of this study is to find implications for revitalizing the spread of electric vehicles by analyzing important factors in purchasing electric vehicles for consumers who actually operate electric vehicles.

2. Theoretical Backgrounds

2.1. Definition of Electric Vehicle

An electric vehicle refers to a vehicle that obtains a driving force through an electric motor based on the power produced from fossil fuels or alternative energy sources. An electric vehicle (EV) is driven by electric energy generated through a battery and a motor, and thus there is no use of petroleum by the vehicle itself. Electric vehicles no longer need to use internal combustion engines, so electric vehicles' electric vehicles correspond to the engines of conventional traditional vehicles, and storage batteries correspond to conventional fuel tanks.

Electric vehicles are divided into Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV), Battery Electric Vehicle (BEV), and Fuel Cell Electric Vehicle (FCEV). HEV is a vehicle type that allows users of internal combustion engine cars to easily experience eco-friendly vehicles. HEV stores electrical energy in a battery in a vehicle body by engine driving and regenerative braking, and then an electric motor intervenes to improve fuel efficiency and increase the mileage. PHEV is an electric vehicle in the intermediate stage between a HEV and a BEV. PHEV has a relatively large battery capacity and a charging terminal. The PHEV combines the advantages of an electric vehicle and a hybrid vehicle, so it is possible to realize pure electric power, zero-emission driving, etc. In addition, the driving distance of the vehicle may be increased through the mixed power method. The BEV is driven only by an electric motor without an internal combustion engine. Since the BEV is driven only by the power of a battery and an electric motor, it does not generate air pollution and has little noise. BEV may charge electricity to a battery in a vehicle body from an external charger to drive only by using an electric force. The biggest advantage of BEV is that it can be used as an eco-friendly car, and it can be operated at a much lower price than gasoline or diesel [3].

2.2. Consumer's Reaction to Electric Vehicle

The younger and higher the educational background, the higher the interest in electric cars. In addition, the higher the understanding and sensitivity of the environment, the higher the perception of oil costs, greenhouse reduction emissions, and eco-friendliness when using electric vehicles. On the one hand, consumers expressed concern about short mileage and uncertainty about new technologies for electric vehicles [4]. It is said that providing consumers with sufficient information on the mileage of electric vehicles and improving the interface design of electric vehicles would improve consumers' negative perceptions of electric vehicles [5]. Moons & De Pelsmacker (2012) analyzed the factors influencing the

intention to use electric vehicles by applying the planned theory of behavior (TPB). As a result, it was found that emotions and perceptions of electric vehicles, followed by subjective norms, influence the intention to use them. In addition, respondents with high intention to use electric vehicles said they had a reflective emotion toward driving behavior in the use of electric vehicles [6]. Charging time appears to be the second most important factor for consumers, and research on ways to improve the efficiency of electric vehicle charging systems is important [7].

2.3. Factors Affecting the Purchase of Electric Vehicles

The high initial purchase cost of electric vehicles, limited mileage, insufficient charging infrastructure, and accurate information are not provided to consumers who have no experience in driving electric vehicles, thus slowing the penetration of electric vehicles. As a result of a survey of the general public on the most important factors when purchasing electric vehicles, economic factors such as low fuel costs and state subsidies were the main motives for choosing to purchase electric vehicles in Korea. And recently, interest in environmental protection has emerged as a major motivation. The most important factors when purchasing electric vehicles were maximum mileage (45%), performance (24%), vehicle price (17%), design (9%), and state subsidies (5%). It was analyzed that the previous year's ranking of state subsidies was pushed out of the second place (25%), which seems to have strengthened consumers' perspective on purchasing electric vehicles and their willingness to purchase them. On the other hand, most of the reasons for hesitation in purchasing electric vehicles are the lack of charging infrastructure (82%), which is interpreted that consumers are still anxious about facilities that can be charged even if the distance to drive increases. And 94% of the respondents said they were willing to purchase electric vehicles, up 3% from a year ago [8].

The biggest problem with the supply of electric vehicles in Korea is the insufficient construction of charging infrastructure. In the case of electric vehicles, the mileage available for one charge is lower than that of internal combustion engine vehicles, so it is necessary to increase the installation of fast chargers capable of fast charging. The disadvantage of electric vehicles is the short mileage, and the number of fast chargers needs to be increased to solve this problem. However, compared to the penetration rate of electric vehicles, the fast charging infrastructure considering the time required for charging is very insufficient [9].

Meanwhile, consumer preferences for electric vehicles have been studied for decades, and the factors influencing them are classified into socioeconomic, psychological, and mobility states and social influences [10]. Economic attributes include purchase price, operating cost, battery rental cost, and fuel cost. Technical attributes include mileage, charging time, and emissions, and infrastructure attributes include charging availability and charging station density [11]. As awareness of the environment gradually increases, studies have added environmental factors such as carbon dioxide emission reduction or pollution level to find out how environmental properties affect consumers' purchasing decisions [11]. In addition, various studies have recently been conducted, such as predicting "who will purchase electric vehicles" to spread electric vehicles to the public market or analyzing "characteristics of early adopters" to establish marketing strategies through market segmentation [12, 13].

3. Research Model and Hypotheses

This study set the following factors influencing the purchase of electric vehicles. A questionnaire was prepared on the Likert scale (1 point to 5 points) for the important factors influencing the purchase of electric vehicles.

- (1) I think mileage is an important factor in purchasing electric vehicles.
- (2) I think charging time is an important factor in purchasing electric cars.

- (3) I think new technologies are an important factor in purchasing electric vehicles.
- (4) I think the development of autonomous driving is an important factor in purchasing electric vehicles.
- (5) I think the design is an important factor in purchasing electric vehicles.
- (6) I think price is an important factor in purchasing electric cars.
- (7) I think infrastructure for charging is an important factor in purchasing electric vehicles.
- (8) I think the ease of maintenance and repair is an important factor in purchasing electric vehicles.
- (9) I think the incentives provided by the government and local governments are an important factor in purchasing electric vehicles.

And the following hypothesis was established.

H1: The importance values of electric vehicle purchase factors will vary by gender.

H2: The importance values of electric vehicle purchase factors will vary depending on age.

H3: The importance values of electric vehicle purchase factors will vary depending on the income level.

H4: The importance values of electric vehicle purchase factors will vary depending on the degree of importance of performance.

4. Experiment and Results

4.1. Collecting Data & Analysis Method

As of January 2021, a survey was conducted after explaining the purpose of the study to 100 people operating cars. It was done by respondents filling out responses directly on the questionnaire. IBM SPSS for Win. 22.0 statistical program was used to analyze the data collected in this study.

4.2. Frequency Analysis

As for the demographic and sociological characteristics of the study subjects, gender, age, and average monthly household income were examined. In terms of monthly income, 9 people (9%) earned less than 2 million won, 17 people (17%) earned between 2 million won and 3 million won, 35 people (35%) earned between 3 million won and 39 people (39%) earned more than 5 million won. In terms of gender, 59 (59%) were male and 41 (41%) were female. By age, 3 (3%) were in their 20s, 21 (21%) were in their 30s, 42 (42%) were in their 40s, 23 (23%) were in their 50s, and 11 (11%).

4.3. Results

(1) Analysis of the Factors Influencing the Purchase of Electric Vehicles.

In the case of purchase motivation, the score for all factors was on the Likert 5-point scale, with an average of 3.56 points to a maximum of 4.39 points out of 5. Looking at each detailed sub-item of purchase motivation, the average value of the importance of mileage is 4.07 points (SD=0.795), charging time's is 4.35 points (SD=0.769), automobile new technology's is 3.88 points (SD=0.769), the degree of development of autonomous driving's is 3.75 points (SD=0.978). the design's is 3.56 points (SD=0.903), the charging infrastructure's is 4.31 points (SD=0.716), the ease of maintenance and repair's was 4.39 points (SD=0.764) and the incentive's was 4.18 points (SD=0.672).

(2) Analysis of the Difference in Importance Values of Electric Vehicle Purchase Factors according to Gender.

The motivation for purchasing electric vehicles was verified by an independent sample T test to analyze the variance difference according to gender. Among the factors influencing the purchase of electric vehicles, the importance of charging time and the phase of maintenance and repair differed significantly at the 5%

level according to gender. It was found that the importance of autonomous driving differs according to gender at the significance level of 10%. Charging time was found to be more important for women ($M=4.51$) than for men ($M=4.24$) ($t=2.004$, $p<0.05$). In the case of maintenance and repair, it was found that women ($M=4.59$) considered more important than men ($M=4.25$) ($t=-2.275$, $p<0.05$). It was found that women ($M=3.95$) consider autonomous driving more important than men ($M=3.61$) ($t=-1.758$, $p<0.10$)(see Table1).

Table 1. Analysis of the Difference in Importance Values of Electric Vehicle Purchase Factors according to Gender

Factors affecting the purchase of electric vehicles	Male(N=59)		Female(N=41)		t	p	difference of Mean	S.E. of difference
	M	SD	M	SD				
mileage	4.14	0.798	3.98	0.790	0.992	0.324	0.160	0.161
charging time	4.24	0.773	4.51	0.597	-2.004	0.048	-0.275	0.144
new technologies	3.80	0.783	4.00	0.742	-1.318	0.191	-0.203	0.156
autonomous driving	3.61	1.000	3.95	0.921	-1.758	0.082	-0.341	0.197
design	3.68	0.860	3.39	0.945	1.553	0.124	0.288	0.185
price	4.24	0.751	4.41	0.706	-1.203	0.232	-0.177	0.147
infrastructure	4.29	0.744	4.37	0.623	-.566	0.573	-0.078	0.137
the ease of maintenance and repair	4.25	0.822	4.59	0.631	-2.275	0.025	-0.331	0.153
the incentives	4.20	0.761	4.15	0.527	0.443	0.659	0.057	0.129

(3) Analysis of the Difference in Importance Values of Electric Vehicle Purchase Factors according to Age

Age was divided into two groups based on the average value ($M=45.54$) and an independent sample T test was performed to test the average difference in purchase motivation. Among the factors influencing the purchase of electric vehicles, the importance of mileage, charging time, price, infrastructure, the phase of maintenance and repair, and the incentives differed significantly according to age. It was found that the elderly put more importance on all significant factors than the low-aged. The average value of importance of the high-age group was higher than that of the low-age group. Specifically, mileage ($M=4.31$ vs. $M=3.84$), charging time ($M=4.61$ vs. $M=4.10$), and price ($M=4.51$ vs. $M=4.12$), Infrastructure for charging ($M=4.63$ vs. $M=4.16$), ease of maintenance and repair ($M=4.35$ vs. $M=4.02$), and the incentives ($M=4.35$ vs. $M=4.02$) showed high importance (see Table2).

Table 2. Analysis of the Difference in Importance Values of Electric Vehicle Purchase Factors according to Age

Factors affecting the purchase of electric vehicles	Young(N=51)		Old(N=49)		t	p	difference of Mean	S.E. of difference
	M	SD	M	SD				
mileage	3.84	0.784	4.31	0.742	-3.034	0.003	-0.463	0.153
charging time	4.10	0.806	4.61	0.492	-3.866	0.000	-0.514	0.133
new technologies	3.80	0.800	3.96	0.735	-1.011	0.315	-0.155	0.154
autonomous driving	3.71	1.045	3.80	0.912	-.459	0.647	-0.090	0.196
design	3.59	0.829	3.53	0.981	.317	0.752	0.058	0.182

price	4.12	0.840	4.51	0.545	-2.783	0.007	-0.393	0.141
infrastructure	4.20	0.775	4.45	0.580	-1.853	0.067	-0.253	0.137
the ease of maintenance and repair	4.16	0.857	4.63	0.566	-3.287	0.001	-0.476	0.145
the incentives	4.02	0.735	4.35	0.561	-2.510	0.014	-0.327	0.130

(4) Analysis of the Difference Values in Importance of Electric Vehicle Purchase Factors according to the Importance of Performance

The group whose performance is important in choosing a car and the group that selected other factors (environment, brand, design, price) as important were divided into two groups. Then, the average difference in purchase motivation was tested by the independent sample T test. It was found that the group that values performance values charging time, autonomous driving, price, and the phase of maintenance and repair more than the group that does not. The group that prioritized performance showed higher mean values than the group that did not. Charge time (M=4.47 vs. M=4.20) and the degree of autonomous driving development (M=3.91 vs. M = 3.56), Price (M = 4.44 vs. M=4.16), ease of maintenance and repair (M=4.53 vs. M=4.22) showed high importance (see Table3).

Table 3. Analysis of the Difference in Importance Values of Electric Vehicle Purchase Factors according to the Importance of Performance

Factors affecting the purchase of electric vehicles	Performance-oriented group (N=55)		Other factor-oriented group (N=45)		t	p	diffrence of Mean	S.E. of diffrence
	M	SD	M	SD				
mileage	4.15	0.678	3.98	0.917	1.020	0.311	0.168	0.160
charging time	4.47	0.604	4.20	0.815	1.865	0.066	0.273	0.142
new technologies	3.91	0.752	3.84	0.796	0.414	0.680	0.065	0.156
autonomous driving	3.91	0.967	3.56	0.967	1.819	0.072	0.354	0.194
design	3.56	0.856	3.56	0.967	0.044	0.965	0.008	0.185
price	4.44	0.601	4.16	0.852	1.864	0.066	0.281	0.151
infrastructure	4.35	0.673	4.29	0.727	0.400	0.690	0.057	0.141
the ease of maintenance and repair	4.53	0.663	4.22	0.850	1.968	0.052	0.305	0.155
the incentives	4.18	0.611	4.18	0.747	.029	0.977	0.004	0.139

5. Conclusion

We examined the factors affecting the purchase of electric vehicles and confirmed the importance of each factor. In addition, it was verified through t-test which factors differ according to the degree to which age, gender, and performance are important.

First, looking at the importance of motivation for purchasing electric vehicles, the ease of maintenance and repair (M=4.39) was the highest. Next, charging time (M=4.35), charging infrastructure (Mean=4.32), price (M=4.31), incentive (M=4.18), mileage (M=4.07), automobile new technology (M=3.88), and degree of self-driving development (M=3.75) and design (M=3.56) were sequentially found to be important factors in purchasing electric vehicles.

Secondly, looking at the results of the difference in importance of purchase motivation according to

gender, the average difference according to gender was verified in the importance of charging time, degree of autonomous driving development, and ease of maintenance and repair.

Thirdly, according to the results of differences in importance of purchase motivation according to age, the average difference according to gender was verified in mileage, charging time, price, infrastructure for charging, ease of maintenance and repair, and importance of incentives. All significant factors were considered more important to the elderly than to the lower age. Therefore, it will be necessary to increase the benefits of mileage, charging time, price, infrastructure, ease of maintenance and repair, and incentives to induce older people (46 years or older) to purchase electric vehicles.

Lastly, according to the results of the difference in importance of purchasing motivation according to the group that prioritizes performance when selecting a car and the group that does not, the average difference was verified in charging time, degree of autonomous driving development, price, ease of maintenance and repair. Through this, it was confirmed that in order to induce performance-conscious groups to purchase electric vehicles, it is necessary to emphasize the excellence of charging time, autonomous driving, price, and ease of maintenance.

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