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친환경 자동차의 수용에 영향을 미치는 요인에 관한 탐색
Exploring the Factors Affecting the Adoption of Environmentally Friendly Vehicles

노민정*, 이한석**
경희대학교 경영대학 빅데이터 연구센터*, 상명대학교 글로벌경영학과**

Minjung Roh(pagani@khu.ac.kr)*, Han-Suk Lee(hansuk@smu.ac.kr)**

요약

본 연구는 친환경 자동차의 조기 수용을 유도하는 요인들에 대해 조사하고 있다. 미국, 독일, 그리고 일본의 3개국 자동차 소유자들을 대상으로 설문조사를 실시하였으며, 친환경 자동차의 조기 수용에 영향을 미치는 요인들을 정서적, 인지적, 행동적 요인들로 구분하여 살펴보았다. 실증 결과, 정서적 및 인지적 요소들은 조기 수용에 상당히 유의한 영향을 미치고 있었으며, 행동적 요인 또한 자동차 사용 맥락과 관련해 유의한 영향을 미치고 있음을 확인할 수 있었다. 즉, 환경 중심적 가치관과 녹색기술에 대한 지식 정도가 증대될수록 친환경자동차의 조기 수용의사는 증진되는 것으로 밝혀졌으며, 행동적 요인 차원에서는 자동차를 통근(vs. 여행) 등의 정규적, 실용적 (vs. 쾌락적) 목적으로 사용하는 비중이 커질수록 친환경자동차에 대한 조기수용의사가 고양되는 것으로 밝혀졌다. 이러한 일련의 결과는 친환경자동차의 조기수용을 독려하려면 소비자 개인의 자동차 사용 맥락 및 국가별 차이를 충분히 고려하여야 함을 보여주는 것이라고 할 수 있다.

■ 중심어 : | 친환경 자동차 | 전기 자동차 | 동료 효과 | 주행거리 불안증 | 운전 습관 |

Abstract

This study investigates the factors that induce the early adoption of environmentally friendly vehicles. We measure the affective, cognitive, and behavioral factors influencing the early adoption intentions of car owners in three countries (the US, Germany, and Japan). We find that affective and cognitive factors are significant, but behavioral factors are only partially significant. Specifically, eco-centric values and knowledge about green technology are significant in explaining early adoption intent. However, of the behavioral factors, usage context is significant, whereas commute distance is not significant in explaining early adoption intent. Finally, between-country differences indicate that any policy to increase the adoption of environmentally friendly vehicles should be fine-tuned for each country.

■ keyword : | Green Vehicle | Environmentally Friendly Vehicle | Peer Effect | Range Anxiety | Driving Habits |

I. Introduction

Vehicles are often cited as a major source of carbon dioxide (CO_2) emissions and hence global warming. Transportation contributes to almost half of all US carbon dioxide emissions, and half of all petroleum consumed in the US is used in the form of motor gasoline[1]. In Japan, 88% of the transportation

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sector's (i.e., planes, trains, and automobiles) CO_2 emissions have been ascribed to motor vehicles, 56% of which is attributed to passenger cars[2]. Therefore, to prevent global warming, curbing CO_2 emissions from vehicles is an urgent challenge for countries and international organizations.

Increasingly, researchers and manufacturers have become interested in developing sustainable energy sources in the auto sector[3]. As one solution, manufacturers have developed environmentally friendly vehicles (EFV), i.e., vehicles that use much less energy and emit less CO_2. The Toyota Prius, running on both gasoline and battery power, was the world's first commercially viable EFV. It was introduced in 1997, and its sales surpassed the one million mark in May of 2008[1]. Since the launch of the Prius, we have witnessed considerable growth in the number of hybrid models. In 2010, there were as many as 27 hybrid models available for sale in the US market. Overall, hybrid cars are capturing an increasing share of the US domestic automobile market, rising from 0.4% of all retail sales in May of 2004 to 3.6% in July of 2009[1].

More recently, we have witnessed the advent of the purely electric car, which runs solely or primarily on electric power from battery packs. Two such models were the Nissan Leaf and GM's Chevy Volt. Electric vehicles are powered mostly by batteries, which can be charged by plugging the car into an electrical outlet, either at home or at a charging station. Charging stations, like gas stations, make charging convenient, but they are costly to build and the progress in expanding them is slow[4]. Perhaps a greater problem with electric cars is that they may be limited in terms of the distance they can travel due to the limits of the battery. One way to extend the range is to equip the car with a small gasoline engine that is used only after the battery power becomes depleted (i.e., a plug-in hybrid electric vehicle). The difference between a purely electric car (e.g., the Nissan Leaf) and a plug-in hybrid electric car (e.g., the Chevy Volt) is the presence or absence of this spare gasoline engine[5]. Although GM and Nissan are the leaders in electric vehicles, other manufacturers, such as Mitsubishi, VW, Renault, and Peugeot, have also introduced electric vehicles into the market.

Similarly, the attempts to prompt the diffusion of EFVs have also intensively been made by several governments. Japanese government who has already recognized the environmental and economic potential of EFVs provides the subsidy for purchasing EFVs since it passed the low of "Green Vehicle Purchasing Promotion measures" in 2009[6]. U.S. government also allowed a maximum of $3400 tax credit for the purchase of hybrid electronic vehicles from 2006 and to 2010, and offered $2500-$7500 tax credit for the purchase of plug-in hybrid electric vehicles(PHEV) and battery electric vehicle(BEV). Chinese government has also kept close pace with these environmentally friendly movement by launching the "Electric Vehicle Subsidy Scheme since 2009"[6].

The dispute revolving around the effect of subsidy has arisen between proponents and opponents for a government subsidy policy. The evidences supporting the optimistic views on subsidy are abundant. First, the studies performed in Korea demonstrates that a subsidy is considerably effective in prompting the penetration of eco-vehicles if the monetary savings are large enough to decrease the vehicle price to the level of gasoline vehicles[7], and that even a temporary subsidy could encourage the selection of EFVs[8]. The investigation conducted in China also showed that the subsidy granted by a government plays a pivotal role in encouraging people to consider the purchase of battery electric vehicles favorably by lowering the purchase price of the vehicles[6]. The works performed in Netherlands then revealed that the Toyota Prius could increase its sales volume with the introduction of a tax subsidy[9]. The investigation conducted in Switzerland similarly showed that sales volume of Toyota Prius decreased with the reduction of subsidies[10].

However, there are still some pessimistic views surrounding the effect of subsidies. Actually, the possibility still remains that subsidy alone might not be attractive enough to persuade people to prefer electric vehicles to conventional vehicles[11], and thus the measure of vehicle purchase tax credit might fail to reduce emissions[12] Rather, the emphasis on symbolic values of EFVs or the consideration of individual consumer characteristic might exert stronger effect on the purchase of EFVs than the provision of subsidies.

To resolve this controversy over the effect of subsidy, Coad et al.[13] proposes that market segmentation could help design more effective policy and plans to prompt the acceptance of EFVs. Namely, some consumers are more sensitive to financial incentives such as subsidies than other consumers in their decision making of EFVs adoption.

Parallel to these industry developments and governments' intensive support, there has been a growing body of research on the economic, environmental, and market impact of sustainable technology. Some studies have approached this issue from the perspective of government policy[2][13-15], and others have focused on the effect of sustainable technology on consumer product evaluations and purchase intention[16][17]. Heutel and Muehlegger[1] examine how consumers learn about sustainable technology and how it diffuses into the market, focusing on the related externalities. Lastly, Takeda and Tomozawa[18] examine how a move into sustainable products affects the stock prices of the said firms.

Most previous studies have used data from a single country, usually either the US[1][14][17], Japan[2][18], Germany[16], or Switzerland[13]. To a certain extent, Nemry and Brons[19] broaden this regional limitation by expanding the unit of analysis to the European Union (EU) in their forecast of the long-term demand for electric cars.

In contrast, our study collects data from the US, Germany, and Japan. Based on consumers' self-reported responses, our goal is to illuminate the antecedents that affect adoption-timing intention for EFVs. Specifically, we pool the data for the three countries to estimate a general model of adoption timing, after which we run the same model for each country separately to assess country differences. We explore three broad categories of factors that affect the adoption timing of EFVs: affective, cognitive, and behavioral. This approach illuminates the important dimensions in individual decision-making processes regarding the adoption of EFVs.

Ⅱ. Literature review and hypotheses

1. Affective factors: Involvement with environmental issues

Environmental concern is an evaluation of, or an attitude toward, the consequences for the environment of one's own or others' behavior[20][21]. Environmental concerns can arise from people's self-interest or their eco-centric values[22]. Although some people only attempt to behave in an environmentally responsible way after perceiving personal threats caused by environmental deterioration[23], others are concerned about the ecosystem for its own sake based on their eco-centric values[21][24][25].

Evidently, consumers are increasingly more sensitive to environmental concerns[26][27]. Imkamp [16] demonstrates that between 1988 and 1998 there was increasing demand for information about the environmental benefits of ecological products. Other studies have linked consumers' environmental concerns to the adoption of EFVs. Kahn[17] uses the dominance of registered Green Party voters in initial hybrid penetration to show that environmentalists are more likely to buy hybrid cars. Similarly, Turrentine and Kurani[28] find that early hybrid adopters are primarily motivated by non-economic considerations such as being a pioneer or an environmentalist. As the choice of EFVs helps to abate the cognitive dissonance caused by the conflict between consumers' material wants and their eco-centric orientation, an involvement with environmental concerns should also positively affect the adoption of EFVs.

Kahn[17] claims that symbolic values dominate purely monetary cost-savings for buyers of hybrid cars. Moreover, a survey of Swiss Prius buyers by de Haan et al.[29] suggests that the primary motivation behind the purchase of hybrid cars is not to save money but to purchase symbolic value. Gallagher and Muehlegger[14] argue that conspicuous consumption, the desire to appear "green" to other environmentalists by driving a noticeably hybrid vehicle, may exert a critical influence on the adoption of the EFVs. Other studies have also shown that highly involved individuals are more likely to try innovative items[30]. Hence, consumers with high levels of involvement in environmental issues and consumers with a greater desire to be perceived as environmentally responsible people are expected to adopt EFVs earlier than others because they wish to exhibit their commitment to environmental concerns. In accordance with these arguments, we derive the following hypotheses.

H1. High personal sense of the importance of the environment leads to earlier EFV adoption intent.

H2. Greater concern with a "green image" leads to earlier EFV adoption intent.

2. Cognitive factors: Knowledge

According to Rogers[31], awareness of a new product or new technology is a pivotal variable in consumer behavior. As prior knowledge of a product class increases consumers' ability to detect superior new products in that class, it can contribute to the probability of adoption[32]. Several researchers have found evidence of this positive effect of knowledge on adoption decisions, especially in the categories of consumer packaged goods[33], electronic commerce [32], and innovative investment products[30].

The role of knowledge has also attracted the attention of researchers in environmental psychology and management. Peattie[34] demonstrates that increased awareness of "green" information sources influences consumers' purchasing decisions. Likewise, Amyx et al.[35] find that consumers' subjective knowledge of the environment can be a good predictor of ecological purchasing decisions. Barber et al.[36] explains that this positive effect of knowledge on pro-environmental behavior can be achieved through the mediation of attitude. Specifically, increased knowledge can change environmental attitudes, thereby positively affecting environmental behavior[36]. Bradley et al.[37] also find a significant correlation between environmental knowledge and attitudes.

This study investigates this role of knowledge in innovation adoption in two ways; one by focusing on the concept of general knowledge and the other by concentrating on the concept of domain-specific knowledge. The knowledge literature so far divide the knowledge concept into general knowledge and domain-specific knowledge. While general knowledge indicates knowledge that is useful to learners across domains and topics, domain-specific knowledge indicates knowledge that is compressed within a particular domain of learning[38]. Based on this conceptualization of knowledge taxonomy, we define general knowledge as knowledge pertaining to a broad range of environmental issues, while defining domain-specific knowledge as knowledge more specific to environmental friendly vehicles. That is, in this context of EFVs adoption, general knowledge relates more to knowledge concerning a broader range of environmental topics such as climate change, alternative energy sources, or toxic chemical waste, whereas domain-specific knowledge relates more to knowledge regarding more limited scope of product categories of motor vehicles, i.e., environmental friendly vehicles. Indeed, several works demonstrate that general knowledge about environmental issues prompts the adoption and use of recycling centers [39] and of environmentally friendly vehicles[40]. Also, domain specific knowledge about environmentally friendly vehicles proved to facilitate the purchase intention of hybrid cars[41][42]. Thus, we predict that:

H3. Greater knowledge of environmental issues leads to earlier EFV adoption intent.

H4. Greater knowledge of EFVs leads to earlier EFV adoption intent.

3. Behavioral factors: Driving habits

EFVs' higher fuel efficiency may be attractive to drivers burdened by lengthy travel distances. As greater travel distances cause car owners to be more sensitive to gasoline prices, such drivers are likely to have stronger preferences for hybrid cars, as such cars can reduce their fuel bills[14]. Goolsbee and Klenow's[43] study of the diffusion of home computers shows that the peer effect is greater for heavy computer users. Similarly, greater travel distances would accelerate the adoption of EFVs.

However, greater driving distances may also incur range anxiety. Range anxiety refers to the omnipresent concern, or even fear, of becoming stranded due to a discharged battery in a limited-range vehicle[44]. The relatively sparse charging infrastructure, the long charging times, and the still inadequate battery performance levels are often pegged as primary causes of this anxiety[45]. Thus, in terms of behavioral considerations, the range issue may pose a barrier to the mass adoption of EFVs [4][44]. Furthermore, range anxiety may drive users to underuse existing range resources[46]. Nemry and Brons[19] thus predict that the diffusion of electric vehicles might be limited until at least 2020 due to the limited size of the existing charging infrastructure.

Faced with these two opposing influences of driving distance, this study explores the antecedents of consumer range anxiety. We predict that the absolute driving distance is not the critical factor driving range anxiety. Rather, it is the predictability of the driving distance that has the most significant influence on range anxiety. Specifically, if a given driving distance is regularly maintained, drivers are freed from range anxiety because the required battery level is known. As noted by Boulanger et al.[4], if reliable places to charge the vehicles were assured, range anxiety would be diminished considerably.

Clearly, increased uncertainty decreases the diffusion rate and adoption level of new products[31]. The diffusion of birth control pills and microwave ovens was delayed due to the uncertainty accompanying the use of such products[47]. Likewise, Stern et al.[48] show that the level of risk tolerance is positively correlated with behavioral intention to use relatively innovative online auction interfaces.

This implies that a reduced level of risk tolerance may aggravate anxiety, thereby hindering the adoption of innovative products.

Thus, if people use vehicles mainly to commute, range anxiety will not be a major concern. Usually, commuting distances are stable and car owners can predict the charge needed to travel a regular route or distance. Conversely, outdoor activities or visiting friends may involve unpredictable driving distances, as unexpected events can arise. Cocron et al.[49] demonstrate that 250 km is regarded as an optimal target range value and that 80% of daily trips could be completed with an EFV. Therefore, vehicle use for utilitarian purposes(commuting) enhances consumers' intention to adopt EFVs. In contrast, vehicle use for hedonic purposes (e.g., outdoor activities, visiting friends) suppresses consumers' intention to adopt EFVs. Thus, we have the following hypotheses.

H5. Drivers with longer commute distances have an earlier EFV adoption intent.

H6. Drivers who more frequently use cars for utilitarian purposes have an earlier EFV adoption intent.

Ⅲ. Method

1. Sampling procedures and data collection

Car owners from the US, Germany, and Japan participated in an online survey. Initially developed in English, the questionnaire was translated into German and Japanese. It took approximately 20 minutes to complete the questionnaire online, and a global professional data collection agency, Global Market Institute(GMI), collected the data at the authors' request. The final sample consisted of 1538 valid responses, with 526 US responses, 514 German responses, and 498 Japanese responses. In each country, the data were sampled from the four largest metropolitan areas; hence, various locations in each country were represented.

2. Measures

The measurement of the affective factor consisted of two variables: "Personal importance of the environment (IMP_ENV)" and "Concern with green image (IMAGE)." IMP_ENV was measured using the item "Environmental issues are important to me" (1 = strongly disagree, 7 = strongly agree). IMAGE was assessed with the question, "How important is it to show others that you are an environmentally responsible person?" (anchored by 1 = "not important at all," 4 = "very important"). The cognitive factor was assessed using two variables: "Knowledge about environmental issues" (KNOW_ENV) and "Knowledge about EFVs" (KNOW_EFVS). KNOW_ENV was assessed using the item "I consider myself knowledgeable about environmental issues" (1 = strongly disagree, 7 = strongly agree). KNOW_EFVS was measured by the item "Which type of environmentally friendly cars do you know? Check all that you are familiar with," where the presented categories included hybrid vehicles, electric vehicles, plug-in hybrid electric vehicles, hydrogen fuel-cell vehicles, and clean diesel vehicles. The number of types that respondents checked was used as a proxy for their knowledge of EFVs. The behavioral factor was measured using two variables: "Commute distance" (COMM_DIST) and "Usage context" (UTILIT; whether utilitarian or hedonic). COMM_DIST was assessed in terms of miles/kilometers, whereas UTILIT was assessed by asking, "What is the main use of your car?," where the examples included commute and business, shopping, outdoor activities, and visiting friends.

Finally, the dependent variable, “Timing of adoption” (TIMING) was measured by asking, “When will you buy an environmentally friendly car?” (1 = I already have one, 2 = I would like to be one of the first, 3 = When 1/3 of people have one, 4 = When ½ of people have one, 5 = When 2/3 of people have one, 6 = I would like to be one of the last, 7 = I will never buy one). The scale was then reverse-coded so that a larger figure indicated an earlier adoption of EFVs.

Ⅳ. Results

Table 1. Factors affecting adoption timing of environmentally-friendly vehicles

Factors	Variables	Abbreviations
Affective	Personal importance of the environment	IMP_ENV
	Concern with “green image”	IMAGE
Cognitive	Knowledge about environmental issues	KNOW_ENV
	Knowledge about EFVs	KNOW_EFVS
Behavioral	Commute distance	COMM_DIST
	Usage context (hedonic or utilitarian)	UTILIT
Dependent Variable: Adoption Timing Intention		TIMING

The descriptive statistics show that the average commuting distance (COMM_DIST) is the highest in the US (53 km) and the lowest in Japan (16 km). Knowledge about environmental issues (KNOW_ENV) is also the lowest in Japan (4.06), whereas knowledge about EFVs (KNOW_EFVS) is the highest (3.64). Germany ranks first in both personal importance of the environment (IMP_ENV; 5.70) and adoption timing of EFVs (TIMING; 4.20).

We perform a linear regression analysis to test Hypotheses 1 through 6. The results for all of the hypotheses except H5 are significant (ps < .01, R2=.20;[Table 3]). Specifically, the affective factors “Personalimportanceoftheenvironment”(IMP_ENV)(ß = .186, t = 7.187, p <.01) and “Concern with green image” (IMAGE) (ß = .278, t = 6.830, p <.01) exert a positive impact on early adoption of EFVs. Furthermore, knowledge of environmental issues (KNOW_ENV; ß = .120, t = 4.354, p <.01) and environmental friendly vehicles (KNOW_EFVs; ß = .136, t = 5.855, p <.01) positively affects the early adoption of such vehicles. However, the behavioral factors yield quite mixed results. Although commute distance has no impact on the early adoption of EFVs (p >.60), the greater use of vehicles for utilitarian purpose does exert a positive effect on early adoption (ß = .260, t = 3.754, p <.01). This implies that people who use their cars more for commuting or business are more inclined to adopt EFVs earlier than otherwise.

The results of the analysis of country-specific data are similar[Table 4]. Regression analyses performed separately for the US, German, and Japanese samples suggest that IMP_ENV, IMAGE, and KNOW_ENV all prompt consumers’ adoption of EFVs (ps<.01). However, knowledge of EFVs (KNOW_EFVs) only has a positive impact on earlier adoption in Germany and Japan. Moreover, for UTILIT, the analysis shows no significant impact on adoption intention in Germany and Japan, but exerts a significantly positive impact in the US. These seemingly quite different results in the US might pertain to the fact that the average commute distance is much longer in the US than in Germany or Japan. As [Table 2] indicates, the average commute distance in the US is 53 km, but only 22 km and 16 km in Germany and Japan, respectively. This almost double distance for commuting might aggravate the burden of fuel cost more severely in the US than in Germany or Japan. Furthermore, the proportion of people using vehicles for commuting is higher in the US (66 %) than in the other two countries (56% and 24%). This heavier use of vehicles for commuting and the longer distances for commuting should make the benefits of adopting EFVs for commuting, especially in terms of fuel cost saving, higher in the US than in Germany or Japan, as heavy users (US consumers) can save more by adopting cheaper alternatives. Thus, US consumers—heavy users—are more likely to vary their adoption intention according to their commuting patterns than German or Japanese consumers—light users—who will save less by adopting EFVs.

Table 2. Descriptive statistics of mean scores

Variable	Pooled (N=1538)	US (N=526)	Germany (N=514)	Japan (N=498)
IMP_ENV	5.26	5.10	5.70	4.96
IMAGE	2.47	2.48	2.51	2.42
KNOW_ENV	4.66	4.94	4.96	4.06
KNOW_EFVS	3.22	2.96	3.09	3.64
COMM_DIST	31	53	22	16
UTILIT (%)	49%	66%	56%	24%
TIMING	3.96	3.94	4.20	3.70

Table 3. Factors affecting early Adoption of EFVs (Multiple regression model)

Variable	ß	SD	*t*	hypotheses
(Constant)	1.175	0.156	7.559	
IMP_ENV	0.186***	0.026	7.187	H1
IMAGE	0.278***	0.041	6.830	H2
KNOW_ENV	0.120***	0.028	4.354	H3
KNOW_EFVS	0.136***	0.023	5.855	H4
COMM_DIST	−0.007	0.027	−0.248	H5
UTILIT	0.260***	0.069	3.754	H6

Notes: R^2=0.20;N=1538 ; * p<0.1; **p<0.05; ***p<0.01

Table 4. Factors Affecting Early Adoption of EFVs: Country Differences

Country	US	
Variable	*ß*	*t*
(Constant)	1.049***	4.165
IMP_ENV	0.198***	4.409
IMAGE	0.379***	5.473
KNOW_ENV	0.069	1.342
KNOW_EFVS	0.124***	3.554
COMM_DIST	−0.008	−0.300
UTILIT	0.375***	3.001
	R^2 = 0.233	
Country	Germany	
Variable	*ß*	*t*
(Constant)	1.496***	5.354
IMP_ENV	0.147***	3.393
IMAGE	0.196***	3.218
KNOW_ENV	0.161***	3.569
KNOW_EFVS	0.172***	3.620
COMM_DIST	−0.220	−0.797
UTILIT	0.167	1.454
	R^2 = 0.171	
Country	Japan	
Variable	*ß*	*t*
(Constant)	1.139***	3.643
IMP_ENV	0.172***	3.495
IMAGE	0.280***	3.310
KNOW_ENV	0.099*	1.827
KNOW_EFVS	0.173***	3.527
COMM_DIST	0.092	0.294
UTILIT	0.102	0.650
	R^2 = 0.131	

Notes: * p<0.1; **p<0.05; **p<0.01

V. Conclusions and implications

This study examines the affective, cognitive, and behavioral factors affecting the intention to be an early adopter of environmentally friendly vehicles (EFVs). It categorizes the independent variables into affective, cognitive, and behavioral types. This categorization is different from those used in previous studies, where the independent variables affecting the purchase of environmentally friendly products are categorized as simply intrinsic or extrinsic[13]. Intrinsic motivation includes eco-centric values[21][24], and environmental responsibility[17][29]. According to this intrinsic/extrinsic framework, our affective factors of “Personal concern for the environment” and “Importance of being viewed as green” correspond to intrinsic motivation. In this context, extrinsic motivations, which primarily pertain to economic incentives, manifest as fuel-cost savings or government subsidies. Thus, our behavioral variables (i.e., “Commute distance” and “Usage context”) could count as extrinsic motivations, as commute distance affects fuel-cost savings and usage context affects the cost of charging electric vehicles.

This study also reveals that knowledge plays a critical role in prompting adoption intentions toward innovative products, as demonstrated in previous studies[30][31]. In this study, knowledge is measured at two different levels: general knowledge about environmental issues and domain-specific knowledge about EFVs. The findings show that domain-specific knowledge about EFVs has a significantly positive impact on the adoption of EFVs across the US, Germany, and Japan. However, general knowledge about environmental issues has a significant impact on adoption intention only in Germany and Japan.

Moreover, this study shows that knowledge of EFVs rather than knowledge of general environmental issues exerts stronger effects on the individual adoption of EFVs. This finding provides insights for managers and policymakers who wish to develop more persuasive promotional strategies. Specifically, campaigns that concretely explain how EFVs reduce CO_2 emissions, urban pollution, or dependence on fossil fuels are more likely to be effective in prompting consumers' adoption intention than the general campaigns about environmental issues. Such campaigns help consumers to see a more direct link between their actions and their impact on the environment.

Behavioral factors also play a pivotal role in prompting earlier adoptions of EFVs. Our study shows that the use of a car for utilitarian purposes has a positive effect on early adoption. This finding illustrates the "range anxiety" issue: utilitarian uses of a car are often pre-planned, making it easier to predict a driving path and distance and enabling drivers to locate in advance places to recharge their electric vehicles. This finding suggests that promotions should target commuters who draw on their vehicles for commuting.

Ⅵ. Limitations and future research

In this study, we do not delve into the issue of financial incentives for going green. Previous studies have shown that higher gasoline prices and government subsidies increase consumers' intentions to buy EFVs[2][14]. Nevertheless, it should be noted that price and individuals' environment-related value beliefs will not be equally influential in their purchase decision-making. That is, individual value beliefs that determine the attitude towards a particular product or brand reportedly exert an influence over the long term before full-fledged decision-making processes start, while the economic factors such as price has a significant impact on purchase decisions when final decisions are imminent at the time of purchase. Therefore, the variables reflecting individual eco-friendly value beliefs such as "personal importance of green" or "knowledge about environmental issues", which have been introduced as leading variables in this study, may have already had a considerable impact on general attitude towards environmentally friendly vehicles before reaching the moment of purchase decisions. Considering that purchase decision making processes could be divided into (1)long-term process and (2)short-term process, individual environmentally-friendly value beliefs should have a critical impact on deciding whether to accept an environmentally-friendly vehicle as a candidate for a consideration set long before the purchase is imminent, whereas economic factors such price will have a significant impact on whether to choose environmentally friendly vehicles over conventional gasoline vehicles once after the consideration set is determined to include both vehicle types. In this vein, this study sheds more light on the individual adoption of environmentally friendly vehicles from the long term perspective by focusing more on individual environment-related value beliefs than on price. Nonetheless, as economic factors such as a price are known to have a significant impact on short-term decisions that are imminent for purchasing, future studies could trace how consumers find a balance between their support for environmental causes and price premium to be paid by incorporating both factors in their research models.

In addition, researchers could also develop an overarching framework for classifying the factors that affect the purchase of eco-friendly products. Currently, different researchers use different classification systems. For instance, we use affective, cognitive, and behavioral categories, whereas others have used extrinsic and intrinsic classifications[13]. Still others prefer symbolic and economic categories[50]. In this vein, a study of how these classification systems are related to each other would be helpful in enhancing our understanding of EFVs.

Also, the research instrument heavily depends on single indicator scales. Due to the lack of multiple indicator scales, the indices of reliability and convergent validity could not be provided. Although the main constructs captured by the scales are intuitively comprehensible even to lay consumers and thus the single indicator could be accepted as more effective and efficient way to measure constructs, the employment of multiple indicators could help improve the reliability of measures and the overall theoretical rigor of empirical results. In this vein, future research could benefit from employing multiple indicator scales in ensuring greater reliability and validity in the assessment procedure.

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저 자 소 개

노 민 정(Minjung Roh) 정회원

- 2015년 : 서울대학교 경영대학 경영학과(경영학박사)
- 2017년 ~ 현재 : 경희대학교 경영대학 빅데이터 연구센터 연구교수

<관심분야> : e-Marketing, 온라인구전, O2O 서비스, 인공지능, 소비자행동

이 한 석(Han-Suk Lee) 정회원

- 2010년 2월 : 서울대학교 경영학 박사
- 2011년 3월 ~ 2012년 2월 : 경성대학교 경영학과(전임강사)
- 2012년 3월 ~ 2018년 2월 : 상명대학교 글로벌 경영학과(조교수)
- 2018년 3월 ~ 현재 : 상명대학교 글로벌 경영학과 부교수

<관심분야> : 디지털 마케팅, 온라인 소비자 행동, 항공경영, 크라우드 펀딩