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Research on the influencing factors of new energy vehicles Based on VAM theory and Environmental awareness theory

Wei-jia Li*, Zi-Yang Liu*, Qiao Yang*

*Student, Dept. of Global Business, Graduate School, Kyonggi University, Suwon, Korea
*Professor, Dept. of Global Business, Graduate School, Kyonggi University, Suwon, Korea
*Student, Dept. of Global Business, Graduate School, Kyonggi University, Suwon, Korea

[Abstract]

Based on the VAM model of the consumer behavior research framework, combined with the altruistic variable of environmental awareness, this paper constructs a research model on the impact of perceived value, perceived risk and environmental awareness on purchase intention, and deeply analyzes the driving factors of perceived value and perceived risk. By collecting 612 valid questionnaires, data was analyzed by using SPSS 24.0 and AMOS 24.0, the results were concluded. Perceived usefulness, perceived entertainment, Technicality, and Energy Awareness all have a significant positive impact on the purchase intention of new energy vehicles; Perceived Fee has a negative impact on purchase intention. The results of this study can provide strategies for companies to improve marketing, reduce consumers' perceived risks, provide beneficial supplements to companies in promoting the environmental protection attributes of new energy vehicles and their own environmental protection efforts, and promote the balance of economic and environmental benefits.

▸ **Key words**: New Energy Vehicles, Environmental Awareness, VAM model, Perceived Benefit-Perceived Risk Model, Purchase Intention

[요 약]

본 연구는 소비자 행동 연구 프레임워크인 VAM 모델을 기반으로 환경 인식이라는 이타적 변수를 결합하여 지각된 가치, 지각된 위험 및 환경 보호 의식이 구매 의도에 영향을 미치는 연구 모델을 구축하여 지각된 가치 및 지각된 위험의 요인을 깊이 분석한다. 612개의 유효한 설문지를 수집하고 실증 분석을 수행한 결과는 지각된 유용성, 지각된 오락성, 기술성 및 환경 보호 의식이 모두 신에너지 차량 구매 의도에 뚜렷한 긍정적인 영향을 미치고 지각된 요금은 구매 의도에 부정적인 영향을 미치는 것으로 나타났다. 본 연구의 결과를 통해 기업의 마케팅 개선 전략을 제공하고 소비자 지각된 위험을 줄이며 기업이 신에너지 차량의 환경 보호 속성을 홍보하고 기업 자체의 환경 보호 노력을 촉진하는 데 유익한 보완을 제공하고 경제적 이익과 환경적 이익의 균형을 촉진할 수 있다.

▸ **주제어**: 신에너지 차량, 환경 보호 의식, VAM 모델, 지각된 유익-지각된 위험 모델, 구매 의도

• First Author: Wei-jia Li, Corresponding Author: Zi-Yang Liu
*Wei-jia Li (weijia1006@naver.com), Dept. of Global Business, Graduate School, Kyonggi University
*Zi-Yang Liu (morninglzy@hotmail.com), Dept. of Global Business, Graduate School, Kyonggi University
*Qiao Yang (erqic2727@gmail.com), Dept. of Global Business, Graduate School, Kyonggi University
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I. Introduction

New energy vehicles change the kinetic energy mode of traditional vehicles and achieve almost zero exhaust emissions, which can reduce greenhouse gas emissions and alleviate the greenhouse effect. New energy vehicles are environmentally friendly and low-carbon in nature, which are in line with the requirements of the World Health Organization and the needs of the development of the current era. As a substitute for traditional vehicles, new energy vehicles have great development prospects, which makes new energy vehicles favored by developed countries around the world. However, as consumers' awareness of the quality, functions and potential risks of new energy vehicles is still in the process of forming, the purchase intention has not been fully released.

Reviewing the previous literature, Liu Xueyuan and others analyzed the current problems in the Chinese market through the comparative analysis of respondents' attitudes towards new energy vehicles in five countries, including China, Japan, South Korea, the United States and Germany. It also discusses the development prospects and advantages and disadvantages of China's new energy vehicles from the perspective of consumers[1]. Abdul-Rahim et al. (2022) found that perceived risk will hinder consumers from adopting fintech behaviors. Consumer behaviors are affected not only by perceived risks but also by perceived benefits[2]. Therefore, the adoption of fintech behavior is the result of perceived risk and perceived benefit trade-offs. In addition to exploring consumers' purchase intention from the perspective of egoism, it also needs to be studied from altruistic factors such as environmental cognition. The research was concluded by Medeiros, Ribeiro, & Cortimiglia (2016) shows that people are willing to pay a premium for green products such as new energy vehicles[3]. Haq, F., Adnan, A., & Ali, A. (2021), in the research on green marketing, noted that environmental awareness has a regulatory role in green marketing and consumer buying behavior[4]. Alamsyah et al. (2020) demonstrated that Environmental awareness is the sum of information people have about ecological challenges and their ability to consider and measure their effect on the environment and the community[5].

Therefore, in order to promote the integration of new energy electric vehicle industry and low-carbon economy and to expand the market scale, this research introduces the altruistic variable of environmental awareness based on the perceived benefit-perceived risk model to investigate the impact of perceived value, perceived risk and environmental awareness on the purchase intention of new energy vehicles. On how to eliminate consumers' perceived risk of new energy vehicles, to meet to the needs of consumers, and provide reference for enterprises to develop marketing strategies.

II. Literature review and research hypotheses

1. Research Model

The value-based VAM model regards the maximization of value for the individual consumer as an important perspective , then the perceived value is exchanged through the benefits and costs in the "payment" and "acceptance" attributes of the product (Dodds and Monroe 1985)[6]. Zeithaml's (1988) definition of perceived value is the most widely accepted, according to which a consumer's perceptions of what is received and what is given determine the consumer's overall assessment of the utility of a product. Perceived value is a general evaluation of what is received (benefits) in relation to what is given (sacrifice) by the customer. Kim et al. (2007) proposed Value-based Adoption Model (VAM) which contains both benefits and costs of accepting new technology. From this, perceived benefit and perceived cost are defined as

important factors of perceived value to analyze the behavioral intention of consumers to purchase.

Based on the basis of comprehensive Perceived Benefit-Risk Model and VAM models, combined with environmental awareness, the theoretical model of this paper is constructed as follows. In order to make the expression consistent, in this study, the variables are adjusted to the expression of VAM model:

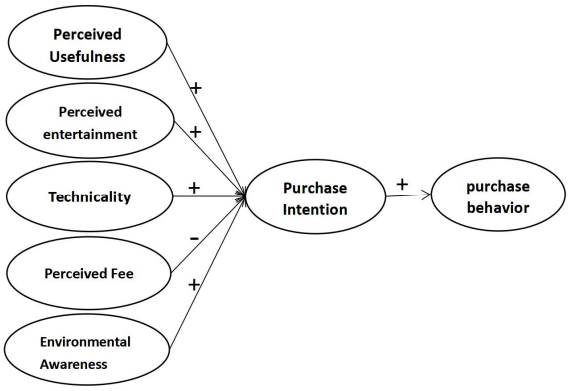

Fig. 1. Research Model

2. Research Hypotheses

Venkatesh (2008) defines perceived usefulness as a consumer's subjective perception of whether something is useful, which will determine the consumer's final buying behavior[8]. Combined with the characteristics of new energy vehicles, perceived usefulness refers to that users feel that using new energy vehicles can bring convenience to their work or life. The extent to which individuals use new technologies depends on the extent to which the technology helps them accomplish their tasks, and individuals' attitudes toward using new technologies are more positive as individuals' perceived usefulness increases[9]. Research by Jamal & Sharifuddin (2015) shows that perceived usefulness positively promotes product purchase intention[10]. CHEN et al. (2016) verified that perceived usefulness significantly affects usage attitudes in the car-sharing sector[11]. The study by He Weiyi and He Rui (2015) demonstrated that consumers' perceived usefulness and perceived ease of use of new energy vehicle innovative technologies can significantly positively affect their intention to buy new energy vehicles[12]. Therefore, the following hypotheses are proposed:

H1: Perceived usefulness has a significant positive impact on the purchase intention of new energy vehicles.

H2: Perceived usefulness positively affects purchasing behavior through purchase intention.

User's positive attitude towards information technology is an influencing factor of willingness to accept information technology. Users' consumption preferences for cars are gradually transformed from traditional functions to personalized and experiential ones. A high degree of entertainment perception and immersion will lead to users' satisfaction in human-computer interaction[13]. Hirschman & Holbrook (1982) pointed out that a positive consumption experience in an entertainment environment is likely to produce high levels of customer commitment and repurchase intention.Chiuetal (2009) also believed that entertainment has a significant effect on online customer behavior, such as increasing customers' intention to use again.When researching the Chinese mobile game market, Jiang, G., Peng, L., & Liu, R. (2015) argued that perceived usefulness and perceived entertainment would significantly affect usage attitudes, leading to behavioral intentions to adopt mobile games[14]. Therefore, the following hypotheses are proposed:

H3: Perceived entertainment has a significant positive impact on the purchase intention of new energy vehicles.

H4: Perceived entertainment positively affects purchase behavior through purchase intention.

According to the VAM model theory, perceived sacrifice includes two dimensions of perception of the technical characteristics of the product and perceived price. Perceived price is consumers' perception of the objective price of a product or service, and its negative impact on intention to use

has been confirmed by a large number of studies[15]. For example, Tian Lei (2009) found that consumers' perceived cost has a negative impact on the use intention of services. When consumers believe that the higher the perceived cost, the lower their use intention. Technological is defined as the degree to which a new technology is considered technically superior in the provision of services. Currency prices are not the only sacrifice that consumers may perceive. With the continuous improvement of original products by automobile companies using certain technologies, such as adding functional attributes that the original product does not have, so that new energy vehicles are constantly being updated. When consumers know more about the technicality characteristics of new energy vehicles, the more they perceive the help of new energy vehicles to themselves, and then generate purchase intention on the new energy vehicles and influence consumers' purchase behavior of it. Therefore, the following hypotheses are proposed:

H5: Technicality has a significant positive impact on the purchase intention of new energy vehicles.

H6: Perceived Fee has a significant negative impact on the purchase intention of new energy vehicles.

H7: The Technicality positively affects the purchase behavior through the purchase intention.

H8: Perceived Fee negatively affects the purchase behavior through the purchase intention.

Green consumption is an environmental protection behavior, and environmental awareness has an important influence on the process of guiding consumers to green consumption. Previous studies on environmental awareness, environmental responsibility and environmental concerns have been confirmed to have a significant impact on the intention to take new energy vehicles to adopt [16]. Mei et al. (2012)who found that the energy purchase intentions can be predicted by the level of environmental awareness and with the findings of Buchanan et al. (2014)who also suggested a positive influence of the environmental awareness on the purchase intention of EEP. Consumers' adoption of new energy vehicles can reduce the environmental damage of the automobile industry, which is a kind of environmentally friendly behavior, which is both egoism and altruistic. Environmentally conscious consumers tend to buy products that are in line with their values, and new energy vehicles have green value, so environmental awareness usually promotes consumers' willingness to consume new energy vehicles. Therefore, the following hypotheses are proposed:

H9: Environmental awareness has a significant positive impact on the purchase intention of new energy vehicles.

H10: Environmental awareness positively affects the purchase behavior through the purchase intention.

Fishbein, Martin and Leek (1977) defined purchase intention as the subjective probability of consumers to make purchases, which is the result of the combined effect of consumers' attitudes, evaluations and other factors, and is the most critical factor in predicting consumer behavior[17]. Venkatesh et al. (2003) found that behavioral intention has a significant impact on use behavior[18]. Therefore, the following hypothesis is proposed:

H11: Purchase intention has a significant positive impact on the purchase behavior of new energy vehicles.

III. Empirical Analysis

1. Questionnaire design

The respondents of this questionnaire survey are consumers who are willing to buy or have purchased new energy vehicles. The questionnaires were collected online, and 612 valid questionnaires were finally returned. Among the respondents, 237

were male and 375 were female.

The age of the respondents was mainly in their 20s and 30s, accounting for 57.4% and 16.5% respectively, and most of them were graduate students (currently studying/graduating), accounting for 64.9%.Here, the collected data for the reliability analysis, factor analysis, and structural equation model analysis were performed using SPSS V23.0 and AMOS V23.0.

2. Reliability Analysis and Validity Analysis

Exploratory factor analysis was conducted to confirm the validity of the measurement variable. The results of exploratory factor analysis and reliability analysis of independent variables and dependent variables show that all factor values were over 0.5, showing a total explanatory power of 76.568%, indicating that each variable has validity.

Confirmatory factor analysis was conducted to confirm the convergent validity of each measurement variable. The goodness of fit of the measurement model is shown as GFI=0.961, AGFI=0.949, NFI=0.965, CFI=0.992, and RMSEA=0.022. Therefore, the fitness of the measurement model to be used in this study is quite satisfactory. In addition, the measurement model to be used in this study was CMIN/DF=1.298 (usually recommended when CMIN/DF is 2-3 or less), and the measurement model to be used in this study was found to be excellent.

In addition, composite reliability was also calculated. In all measurement items, the acceptance criterion of 0.8 was generally exceeded and each variable was found to be reliable. Another measure of convergence validity is the average variance extraction (AVE), which is the magnitude of the variance that the indicator can explain for each measurement variable, which is 0.5 or more and is valid. In this study, it was determined that the convergence validity of each variable was secured as the AVE values of all measurement variables were 0.5 or more.

Table 1. Reliability and validity statistics

Construct	Code	Loadings	Average variance extracted(AVE)	Composite Reliability (CR)	Cronbach's α
Technicality	Tec2	0.896	0.729	0.915	0.900
	Tec4	0.857			
	Tec1	0.838			
	Tec3	0.822			
Perceived Fee	PF2	0.847	0.687	0.898	0.875
	PF1	0.838			
	PF3	0.822			
	PF4	0.807			
Purchase Intention	PI4	0.812	0.613	0.863	0.860
	PI3	0.803			
	PI1	0.76			
	PI2	0.754			
Perceived Usefulness	PU1	0.878	0.759	0.904	0.876
	PU2	0.871			
	PU3	0.865			
Environmental Awareness	EA2	0.852	0.721	0.886	0.866
	EA3	0.851			
	EA1	0.844			
Perceived entertainment	PE2	0.901	0.740	0.895	0.864
	PE1	0.877			
	PE3	0.799			
purchase behaviour	PB2	0.825	0.636	0.839	0.860
	PB1	0.792			
	PB3	0.774			
KMO and Bartlett's Test	Kaiser-Meyer-OlkinMeasureofSamplingAdequacy.				0.871
	Bartlett's Test of Sphericity		Approx.Chi-Square		8376.307
			df		276
			Sig.		0

Reliability means dependability, which refers to the degree of reliability and the consistency of the scale can be obtained according to the measurement tools. This paper uses the α coefficient (ie Cronbach's Alpha) to measure the reliability of the questionnaire. The larger the Alpha coefficient, the higher the reliability of the questionnaire, that is, the higher the reliability and stability of the questionnaire.

Devellis (1991) proposed that if the Alpha coefficient value is between 0.70 and 0.80 is quite good; The alpha coefficient value between 0.80 and 0.90 means very good. As can be seen from the Table 1: The overall Cronbach's Alpha coefficient was 0.791, and the Cronbach's Alpha coefficient of the six variables was greater than 0.8, which indicates a good reliability.

3. Hypothesis testing

Baumgartner and Homburg's research shows that only when the number of samples is more than 5 times the estimated parameters, it is suitable to use SEM for data analysis. There are 24 estimated parameters in this model, and the data obtained in this paper is 612, which is greater than the required number of samples. Therefore, the data collected in this study meet the requirements of the structural equation model test. Through the calculation of AMOS 23.0 software, the obtained modified structural equation model fitting index is shown in the table. The measured values of the six indicators are within the fitting standard range, indicating that the model has a good fitting degree with the sample data. The model can effectively explain user behavior.

A structural equation model was used to verify the research hypothesis. The path coefficients of the structural model can be found in Table 2. The goodness of fit index for the structural model used in this study is P=.000, CMIN/DF=1.865, GFI=0.942, AGFI=0.926, NFI=0.948, CFI=0.975, TLI=0.971 and RMSEA=0.038. The goodness of fit of the structural model used in this study has no major problems and it can be judged to be at an acceptable level.

Table 2. Structural Equation-AMOS Model Path Analysis Results

			Estimate	S.E.	C.R.	P
PU	→	PI	0.315	0.039	8.135	***
PE	→	PI	0.123	0.044	2.818	0.005**
Tec	→	PI	0.096	0.029	3.319	***
PF	→	PI	-0.247	0.033	-7.389	***
EA	→	PI	0.27	0.039	6.838	***
PI	→	PB	0.637	0.056	11.284	***

***p<.001, **p<.01, *p<.05

Structural equation model analysis was performed using AMOS 23.0 software to verify the proposed research hypotheses. After analyzing the sample data, the fitting index of the model is obtained, and the standardized regression coefficient (path coefficient) and significance of each path are calculated. The parameter estimation results of its structural equation model are shown in Fig.2.

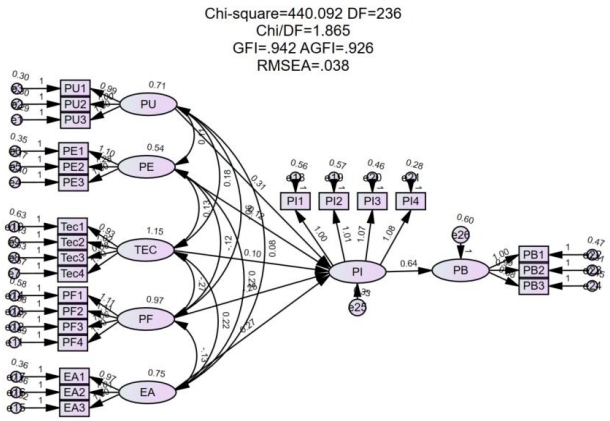

Fig. 2. structural equation model

4. Mediating effect analysis

This paper also studies the mediating role of purchase intention between antecedent variables and purchase behavior. Bootstrapping confidence intervals are used to test the mediating effect.

Table 3. Mediation Effect Results

path					Bootstrapping			
					Percentile 95%CI		Bias-Corrected 95%CI	
					lower	upper	lower	upper
PU	→	PI	→	PB	0.135	0.23	0.137	0.231
PE	→	PI	→	PB	0.013	0.111	0.013	0.111
Tec	→	PI	→	PB	0.029	0.115	0.03	0.116
PF	→	PI	→	PB	-0.221	-0.117	-0.222	-0.117
EA	→	PI	→	PB	0.104	0.222	0.104	0.221

According to the test standard, under the 95 % confidence interval, if the confidence interval does not contain 0, the mediating path exists. The test results are shown in Table 3. The purchase intention plays a mediating role between the pre-variables (perceived usefulness, perceived entertainment, technicality, perceived fee, environmental awareness) and purchase behavior. We can judge that Hypothesis 2,4,7,8,10 is valid.

IV. Conclusions

1. Analysis of research results

Based on perceived benefit-perceived risk model, this paper introduces the altruistic variable of environmental awareness to examine the effects of perceived value, perceived risk and environmental awareness on the purchase intention of new energy vehicles. The results show that perceived usefulness, perceived entertainment and technicality have a significant positive impact on the purchase intention of new energy vehicles; Perceived fee has a significant negative impact on the purchase intention of new energy vehicles; Environmental awareness of altruistic variables also has a positive impact on new energy vehicles; Moreover, purchase intention significantly and positively affects the purchase behavior.

2. Discussion and the lack of research

First of all, when formulating marketing strategies for consumers, enterprises should fully consider the needs of users, and take the consumer psychology, preference, and consumption levels of users as the starting point for strategy formulation. In the marketing process of new energy vehicles, the experience marketing strategy should be “Landing”, allowing consumers to get real experience and discounts, in order to attract consumers for a long time.

Second, enterprises need to reduce consumers’ perceived risk. The uncertainty contained in innovative technologies will bring consumers a certain degree of risk perception. Therefore, it is necessary to further make consumers clearly understand the advantages of new energy vehicles in terms of technical performance and convenience, and effectively resolve consumers' risk perception, and minimize the negative psychological perception of consumers brought by the uncertainty of innovative technology.

Finally, enterprises need to pay attention to the publicity of the environmental protection attributes of new energy vehicles, and strengthen the popularization of the energy savings and reduced exhaust emissions that new energy vehicles can save by replacing traditional fuel vehicles, so as to improve consumers' psychological cognition and encourage them to generate positive intention to purchase energy vehicles. In addition, consumers not only consider their own interests, but also have a sense of social responsibility when purchasing new energy vehicles. Therefore, enterprises should enhance consumers' awareness of the environmental protection attributes of new energy vehicles, publicize the positive effects of new energy vehicles on environmental protection, and at the same time stimulate and encourage consumers' environmental awareness and promote consumers' intention to purchase new energy vehicles.

There are still some shortcomings in this study. Firstly, the main body of the research object in this paper has not been specifically analyzed. In future research, experiments can be compared to analyze the similarities and differences in the behavior of different groups of people in purchasing new energy vehicles. Secondly, in the selection and division of variables and dimensions, the rationality needs to be further improved. Finally, there is no analysis of demographic variables (gender, age, occupation, etc.) on users' perceived benefits, perceived sacrifice perceived value and behavioral intention. Further research can be expanded the respondents while expanding the sample size, and explore whether there are differences in behavioral intentions in their gender, age and other differences.

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Authors

Wei-jia Li. Received the M.A. degree in Business Administration from Kyonggi University, Korea. Currently pursuing a doctorate degree at Kyonggi University of the Global Business.

Research focuses on Global Business, E-Business and Marketing.

Zi-Yang Liu. Received the B.A. degree in Management from Army superintend institute of shijiazhuang China PLA ,China, in 2006, M.A. degree and Ph.D. degree in Management from Kyonggi University, Korea, in 2010 and 2013, reapectively. Dr. Liu joined the faculty of the Global Business Kyongggi University, Korea in 2015. He is currently an Assistant Professor in the Global Business Kgonggi University. He is interested in Quality Management. Management Information Systems, International economics, E-business etc.

Qiao Yang. She graduated from Napier University in UK with a Master's degree in Management in 2006. Since 2020, she began to study in the doctorate degree of Global Business at Kyonggi University in Korea.

She is currently working at the School of Sports Humanities and Social Sciences, Harbin Sports University in China. Her research focuses on Global Business, E-Commerce and Marketing