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The Influence of Knowledge Management on Adoption Intention of Electric Vehicles: Perspective on Technological Knowledge

Abstract

Purpose of this paper – Technological innovation is one of the remarkable characteristics of electric vehicles. This study aimed to analyze how consumers' technological knowledge affects their intention to adopt EVs.

Design/methodology/approach – Original data were collected via a survey of 443 participants in China. An extended technology acceptance model was constructed to identify the factors influencing consumers' intention to adopt EVs, and related technological knowledge pathways.

Findings - The results show that consumer technological knowledge is positively and significantly related to EVs' perceived usefulness, perceived ease of use, perceived fun to use, and consumers' intention to adopt EVs. In addition, no direct and significant relationship is found between perceived fun to use and willingness to adopt EVs, from the technical knowledge dimension.

Practical implications – Imparting consumers with EV technological knowledge and usefulness may be an effective way to enhance their awareness and willingness to use EVs. Moreover, the role of females in the decision to adopt EVs should not be ignored, especially in decisions to purchase a family car.

Originality value: Prior studies lack a technological knowledge-based view, and few studies have discussed how to explore the effects of consumer technological knowledge about EVs on their adoption intention. This study fills the research gap.

Keywords Intention to adopt EVs, Technology Acceptance Model, Consumer technological knowledge, Perceived fun to use, Mediating effects

Paper type Research paper

1 Introduction

Consumer knowledge management and acceptance of electric vehicles (EVs) have been two significant subjects of study in recent years; the former plays an important role in the public's intention to adopt EVs (Wang et al., 2017; Lin and Wu, 2018; Wang, N. et al., 2018; Xu et al., 2019). However, owing to the immaturity of the EV industry and the prevalence of existing technology, consumers' knowledge about EVs remains stuck in the old stereotype of EVs as "vehicles + batteries + many government policies." Such a limited knowledge could threaten the public's intention to adopt EVs, especially when government policies change. In fact, today's EVs have high power reserves and embody much technological innovation (Ullah et al., 2018; Zhang et al., 2018; Wu et al., 2019). Consumers hesitate to purchase or use EVs, probably because they are unfamiliar with EV technologies and have limited knowledge of these technologies; thus, consumers with greater knowledge about EV technologies are more likely to embrace EVs. However, against the background of the rapid updating of EV technology, whether EV technological innovation can become the vehicles' functional value and motivate EV diffusion has not been examined.

The literature states that public acceptance of EVs depends to a great extent on the consumers' psychological perception of EVs, and the low level of their enthusiasm for EVs is related to their lack of understanding of EVs (Zhang and Yang, 2016; Wang, S. et al., 2018; Xu et al., 2019; Zhou et al., 2019b). However, these studies have so far focused primarily on the role of consumer attitudes, values, beliefs, and norms pertaining to the environment with regard to their purchase intentions. These studies regard EVs as more environmentally friendly than ideal social products. Compared with conventional vehicles, EVs embody significantly more technology innovation, which

increases its value to the individual (Todorovic et al., 2017; Robledo et al., 2018; Zhang et al., 2018). Technological progress and enhancement have become an important attraction for EV consumers who value innovation; an attitude referred to as technophilia (Robledo et al., 2018; Schluter and Weyer, 2019). To the best of our knowledge, existing studies have not examined the potential impact of the technological aspects of EVs on the willingness of consumers to adopt them.

The impact of emotional motivations on adopting EVs does not appear to have been finalized. For example, Schuitema et al. (2013) argued that the pleasure of driving (hedonic attributes) contributes to an increase in the willingness to adopt EVs. Herberz et al. (2020) also believed that hedonic motives contribute to the prediction of mobility purchase intentions. However, Rezvani et al. (2018) indicated that hedonic motivations have no effect on the adoption intention of those who do not perceive high social norms in relation to pro-environmental behavior. Han et al. (2017) also argued that emotional factors, as a non-functional value, have no direct effects on EV adoption intentions. Therefore, perceived fun to use (PFU), as a construct, still needs validation as an influence on consumer willingness to adopt EVs.

Given the findings of these previous studies, the purpose of this study was to identify the factors influencing consumers' intentions to adopt EVs, and the related knowledge pathways, by investigating the impact of consumer technological knowledge (CTK), and the perceived fun to use (PFU) as antecedents. Moreover, an extended technology acceptance model (TAM) was proposed to explain consumers' intentions to embrace EVs. Three factors (i.e., perceived ease of use (PEU), perceived usefulness (PU), and PFU) were considered as possible mediators between CTK and

adoption intention. This study answered the following questions: (1) What are the factors influencing the intentions to adopt of EVs that are affected by CTK? (2) What is the route via which CTK affects consumer adoption intentions? (3) Can consumers' technology-aware pleasure be an important internal driver of their acceptance of EVs?

2 Theoretical framework and hypotheses

2.1 Theoretical framework

As stated above, there is a growing recognition of the need to understand which psychological factors affect consumers' willingness to adopt EVs. Three types of model are widely used to explore public acceptance of new technologies: the TAM, the Theory of Planned Behavior (TPB) (Xu et al., 2019), and their derivative versions (Wu et al., 2019). The TAM explains the relationship between PU, PEU, and behavioral intentions (Davis, 1989). The TPB can help predict users' intentions by analyzing attitude, subjective norms, and perceived behavior control (Ajzen, 1991). According to Mathieson (1991), both the TPB and the TAM are good at explaining the user's intentions, and TAM is better at measuring overall satisfaction. As for derivative models, the most famous are the TAM2 and the unified theory of acceptance and use of technology (UTAUT), both of which are derived from TAM. These models have been widely used to study the acceptance of new technologies (Wu et al., 2019).

Overall, the TAM has been shown to successfully interpret user behavior for a variety of information and computer technologies (Lin et al., 2017; Liu et al., 2018). Underlying the TAM is a causal relationship between belief-attitude-intent-behavior. Prior studies have used TAM and its variants to analyze public acceptance of EVs and

obtain policy and management implications in specific study context (Wang et al., 2017; Higuera-Castillo et al., 2019; Wu et al., 2019). For example, Wang, S.Y. et al. (2018) used an extended TAM to analyze the impact of current financial subsidies on consumers' willingness to adopt EVs. Wu et al. (2019) used the TAM to analyze the impact of environmental concerns on public acceptance of autonomous EVs. In this study, CTK about EVs is an important psychological factor in their perception of EV technologies that may affect their decision to purchase EVs. Therefore, an extended TAM is also developed as the theoretical foundation of this study to predict consumer acceptance of EVs.

Based on the TAM and empirical studies in the EV context, the proposed model aims to assess the role that technological knowledge plays in consumers' intention to adopt EVs (CIAEVs) (see Figure I). To explain EV acceptance, this study argues that two other factors are also worth considering: CTK, and PFU. First, individual knowledge of EV technology is an important determinant of a person's intention to adopt EVs. When individuals have more technical knowledge, they are more aware of the advantages of technology and are more willing to embrace it. Second, PFU may be an important factor in attracting consumers to adopt EVs. EVs are being updated more rapidly than fossil fuel-powered vehicles, and new technologies could provide EVs more features and make them more interesting to use (Ullah et al., 2018). If perceived pleasure can be shown to be an important psychological motivator for adopting EVs, the marketing strategy that drives them would change dramatically. Therefore, CTK and PFU may play a vital role in shaping consumers' attitudes and intentions to embrace EVs.

Figure I. The proposed theoretical model and hypotheses.

2.2 Hypotheses

(1) Perceived usefulness

PU, as one of the core variables of the TAM, is defined as the extent to which people believe that utilizing a particular technology will improve their workplace efficiency and lead to achieving worthwhile goals (Davis, 1989; Liu et al., 2018). The PU of technology is closely related to an individual's attitude and acceptance of technology (Liu et al., 2018). Individuals are more likely to sustain a positive attitude toward employing a new technology if it has been proven to be useful and efficient (Liu et al., 2018; Wang, S. et al., 2018). In reality, EVs are widely expected to be the mainstream means of transportation in the future, and they have extraordinary potential to contribute to a more sustainable and cleaner society (Wu et al., 2019; Zhou et al., 2019a). As for individuals and families, EVs have the potential to alter their travel patterns, lifestyles, and to reduce travel and living costs. For instance, Zhang et al. (2018) suggested that parked EVs can generate income by charging during off-peak periods and injecting extra power into the grid during peak hours, based on vehicle-to-grid (V2G) systems. Wang, S. et al. (2018) indicated that EVs are useful for reducing household transportation costs and improving travel efficiency and quality of life. Therefore, it is reasonable to believe that, in the field of EV diffusion, the PU of EVs is positively correlated with consumers' willingness to adopt EVs. Accordingly, this study hypothesizes that:

H1. PU is positively correlated with consumers' intention to adopt EVs.

(2) Perceived ease of use

PEU refers to the degree to which an individual considers it effortless to use a new

technology or system (Davis, 1989). Unlike PU, the impact of PEU on adoption intention has not been established, and different technology products or systems have different impacts (Wu et al., 2019). Chen (2016a, 2016b) reported that PEU of electric bikes is likely to have a weak or insignificant effect on consumer intention to adopt the technology, while other surveys have shown that PEU has a potent and important influence on consumer intention (Kaplan, 1991; Wu et al., 2019). For new technologies, high participation rates and interactions between consumers and new technologies are effective ways of improving the understanding of technology and increasing consumers' intention to adopt it. EVs are a high-interaction product, and their technology is easy for consumers to operate. Both factors provide consumers a greater sense of participation and interaction (Ullah et al., 2018). Therefore, the study is inclined to believe that PEU has an important role in promoting the adoption of EVs, and is strongly correlated with consumers' willingness to adopt them. Hence, this study hypothesizes that:

H2. PEU is positively correlated with consumers' intention to adopt EVs.

H3. PEU is positively correlated with consumers' PU of EVs.

(3) Perceived fun to use

Referring to Chen (2016a, 2016b), PFU is the degree to which individuals believe that the use of EVs can engage their interest and facilitate relaxation. Usually, the willingness to use new technologies is influenced by individual emotions, in which positive expectations (happiness, excitement, satisfaction, pride, self-confidence, and relaxation) have a positive effect on this desire, and these emotions lead to the use of technology (Chen, 2016a; Rezvani et al., 2018; Higuera-Castillo et al., 2019; Xu et al.,

2019). Higuera-Castillo et al. (2019) indicated that emotional factors generally involve the psychological demands of consumers related to products. The link between emotion and behavior may be stronger and more direct than between attitude and behavior (Bagozzi et al., 2002; Moons and de Pelsmacker, 2012). However, with regard to EVs, the impact of emotional motivation on adoption does not appear to have been established. For example, Schuitema et al. (2013) argued that the pleasure of driving (hedonic attributes) contributes to an increase in the willingness to adopt EVs. Herberz et al. (2020) also believed that hedonic motives contribute to mobility purchase intentions. However, Rezvani et al. (2018) indicated that hedonic motivations had no effect on adoption intentions of those who do not perceive high social norms in relation to pro-environmental behavior. Han et al. (2017) also argued that emotional factors, as a non-functional value, have no direct effect on EV adoption intention. In this study, we assumed that the technology integration potential of EVs may provide EV drivers a more interesting driving experience, and so may be an important motivator for consumers to adopt EVs. Therefore, this study used perceived fun as a psychological factor to analyze consumers' EV adoption intention. The following hypothesis is put forward:

H4. PFU is positively correlated with consumer intention to adopt EVs.

(4) Consumer technological knowledge about EVs

Understanding individuals' knowledge is important in understanding their behavior, and it has also become an effective means of understanding the consumer decision mechanism (Park et al., 1994; Liu et al., 2018; Wang, S. et al., 2018). Knowledge of a product can be divided into two types: objective knowledge, which

refers to accurate information about the product in individual memory; and subjective knowledge, which refers to the degree of individual understanding of the product (Park et al., 1994). Because it is easier to measure subjective knowledge than objective knowledge, and because subjective knowledge is more reliable than objective knowledge in predicting pro-environmental behaviors, the CTK investigated in this study is subjective knowledge. CTK about EVs is defined as how much consumers believe they know about EV technologies. A large number of studies have shown that consumer knowledge has positive effects on the intention to use EVs (Degirmenci and Breitner, 2017; Wang et al., 2017; Wu et al., 2019; Xu et al., 2019). These studies regard EVs as environmentally friendly, rather than ideal, social products, and the consumer knowledge covered also focuses mainly on the environmental knowledge of EVs, ignoring the role of technological knowledge. Consumers' environmental knowledge about EVs is a positive predictor of consumer willingness to adopt EVs, and those who know more about the advantages of EVs are more likely to embrace them (Wang, S. et al., 2018). As mentioned earlier, the multi-technology integration of EVs is becoming a new feature. Based on the same logic, consumers are more likely to accept EVs when they know more about EV technologies. This study hypothesizes as follows.

H5. CTK about EVs is positively correlated with their intention to adopt EVs.

In the context of EVs, factors important in encouraging their uptake are the benefits of larger battery capacity and the potential offered by combining EVs with information and communications technology (ICT) (Ullah et al., 2018). There are several potential combination paradigms in addition to V2G, such as vehicle-to-vehicle and Internet of Vehicles. These paradigms provide a data-driven, service-oriented, and

auto-connected environment to meet customers' more connected needs (Robledo et al., 2018; Ullah et al., 2018; Zhang et al., 2018). For instance, Shin et al. (2015) and Yi et al. (2018) suggested that the combination of autonomous driving technology and EVs will dominate future transportation, because it makes for easier charging, easier driving, and safer, more efficient travel. Such ICT vehicle technology characteristics have already received significant attention from potential and current EV consumers, and have contributed to increased consumer involvement in smart EV technologies; this appreciation of innovativeness is called technophilia (Shin et al., 2015; Lin et al., 2017; Schluter and Weyer, 2019). As mentioned above, knowledge is an important support for consumers' decision-making behavior and has a significant impact on their decision making (Kaplan, 1991). Those who know more about EV technologies are more likely to hold a positive attitude toward understanding and learning such technologies, and are more willing to believe that EVs will be useful to them. Hence, the three hypotheses related to consumers' technological knowledge are as follows:

H6. CTK about EVs is positively correlated with the PU of EVs.

H7. CTK about EVs is positively correlated with their PEU of EVs.

H8. CTK about EVs is positively correlated with the PFU of EVs.

3 Methodology and data

3.1 Survey design and sample data processing

This study used online questionnaire for data collection¹. At the beginning of the questionnaire, the study added a variety of application scenarios of EVs and ICT

¹ the questionnaires used by the study can be obtained in the website <<https://github.com/xhuang-1121/questionnaire>>.

technology, using text and pictures, to provide respondents a better understanding of EV technology innovation. A pilot study that tested 100 participants was conducted in March 2020, to test the reliability and feasibility of questionnaire designs. The survey could achieve the high content validity of the questionnaire due to this process (Haynes et al., 1995; Chen, 2016b). After the questionnaire was revised, the final version of the questionnaire was distributed in April 2020 over a period of one week. Potential respondents who live in the same administrative area were contacted via social media channels (e.g., WeChat, QQ, and web-based social platforms).

In terms of sample data processing, several screening rules were developed to ensure data quality. (1) The overall time spent on questionnaire responses should not be less than 5 minutes, due to the introduction of the lead paragraph before the questionnaire starts. (2) Removing sample data with the same answer for 5 consecutive questions. (3) Removal of sample data for those respondents who did not respond seriously (The question in the questionnaire is: Please select "1" for this question). (4) Respondents who have been exposed to EVs or are concerned about the development of new technologies were considered valid (The question in the questionnaire is: Do you have experience with EVs or are you concerned about the current status and trends of EV technology?). Finally, 601 responses were received, 443 of which were deemed valid after the data quality control process: a 73.71% valid response rate. The questionnaire also covered the demographic characteristics of the respondents, including age, monthly income, gender, military control, household size and education level, and main travel mode, as shown in Table I.

Table I. Demographic characteristics.

3.2 Research measurements

This study includes five constructs, namely: CTK, PU, PEU, PFU, and consumer intention to adopt EVs (CIAEVs). Nineteen specific items included in the five constructs were modified from previous studies, as shown in Table II.

Table II. The statements of constructs measurements.

4 Results

4.1 Reliability and validity analysis

The confirmatory factor analysis (CFA) were used to detect the reliability and validity of the measurement model (Wang, S. et al., 2018). Reliability presents the consistency and stability of the measurement results. Cronbach's alpha values and composite reliability (CR) are applied to assess the reliability of the constructs (Fornell and Larcker, 1981). The Cronbach's alpha values and CR values of all constructs meet the .7 criteria (see Table III), suggesting strong internal reliability. The average variance extracted (AVE) values of the five constructs exceed the .5 criteria, indicating the scale has good convergent validity at the construct level (Fornell and Larcker, 1981). Finally, the outer variance-inflating factor (VIF) of the sample data is less than 5, indicating weak covariance of the sample data.

Table III. Statistics of the measurement model.

Table IV shows the results of correlation matrix and the Fornell-Larcker / Heterotrait-monotrait (HTMT) ratio of correlations all constructs. HTMT is a new discriminant validity assessment criterion in variance-based structural equation models (Henseler et al., 2016; Lin et al., 2017). Henseler et al. (2016) proved that this

new criterion performs better than the traditional Fornell-Larcker criterion. Model good discriminant validity requirements: Fornell-Larcker criterion loadings exceed cross-loadings, and HTMT significantly smaller than 1 (Henseler et al., 2016). The results indicate that indicator relationships within the same construct are stronger than those between constructs measuring different phenomena, and therefore discriminant validity is achieved. Moreover, the factor analysis shows that each construct could be separated into only one factor with eigenvalues greater than 1.0, and the five constructs constitute 71.08% of the accumulated percentage of explained variance, indicating the high explanatory power of the model. Therefore, it is proved that the measurement model's reliability and validity are adequate.

Table IV. Fornell-Larcker / HTMT results and correlation matrix.

4.2 Structural model analysis

Structural equation modeling (SEM) is employed to explore the hypotheses in the theoretical framework (see Figure I). The Tucker-Lewis index (TLI), comparative fit index (CFI), root mean square error of approximation (RMSEA), standard root mean-square residual (SRMR) and chi-square ratio (CMIN/DF) are used to assess the model-fitting performance. TLI and CFI exceed .9, RMSEA and SRMR are below .08, and CMIN/DF is below 3.0, indicating the theoretical model exhibits a good model-fitting performance (Anderson and Gerbing, 1988). The results listed in Table V indicate that the model of this study exhibits a good model-fitting performance.

Table V summarizes the results of the hypotheses testing. Except H4, other hypotheses are supported in the whole sample model. Moreover, multi-group comparisons analysis (males and females) was conducted to investigate whether there

are significant differences in path coefficients of all proposed relationships, as shown in Table VI. The results show that the proposed path relationship is consistent with the overall results of the model, and that the model's cross-group is not deformed.

Table V. Results of the structural model.

Table VI. Results of multi-group comparisons of all paths.

4.3 Direct effects and indirect effects from CTK to CIAEVs

The bootstrap method, including the bias-corrected percentile bootstrap method and the percentile bootstrap method, is the most effective tool for mediating effect analysis (Bollen and Stine, 1990; MacKinnon, 2012; Henseler et al., 2016). When zero is outside the confidence intervals of the two methods, it indicates that the effects are significant (Haynes et al., 1995; MacKinnon, 2012). [Table VII lists the results of the bootstrapping test from CTK and CIAEVs. The results show that all the direct and indirect effects are significant except CTK-PFU-CIAEVs, and that mediating effects were evident for PU and PEU, but not for PFU.](#)

Table VII. Results of the bootstrapping test.

5 Discussions

5.1 Theoretical contributions

[This study contributes to the literature by exploring the influence of two antecedent variables, CTK and PFU, on adoption intentions of EVs. This study emphasizes the importance of a broader definition of CTK, to encompass more than](#)

traditional EV knowledge such as knowledge about EVs' performance and environmental advantages. The results of the structural model (see Table V) suggest that there is a significant direct positive effect of CTK on consumer intention to adopt EVs (H5: $\beta = .372$, $p\text{-value} < .001$), and that this effect is identical for males and females (see Table VI). This finding supports evidence from previous observations (Degirmenci and Breitner, 2017; Wang, S. et al., 2018) that demonstrates the importance of consumers' knowledge to their intentions to adopt environmentally friendly products, such as EVs.

Similarly, PFU is found to be important to promote the development of green products, such as public bikes and EVs, supporting the findings of Schuitema et al. (2013) and Chen (2016a, 2016b). However, contrary to expectations, there is no significant influence of PFU on consumer intention to adopt EVs (see Table V, H4: $\beta = .002$, $p\text{-value} > .05$). There may be two reasons for this result. First, consumers are more likely to pay attention to functional values (monetary, performance, and convenience values) rather than the non-functional values (emotional, social, and epistemic values) (Han et al., 2017). This may be because non-functional values do not sufficiently satisfy consumer mobility motives compared to functional values. Second, the proliferation of EVs faces many practical problems, such as high costs, which also make consumers pay more attention to the practicality of EVs than their entertainment value. In other words, consumers are more motivated by subsidies or convenience factors than the fun of using EV technology. This finding is inconsistent with that of Herberz et al. (2020) and Schuitema et al. (2013). The disagreement may be caused by the latter studies' having focused more on the sustainable attributes of EVs and their preference to explore the link between these attributes and EV adoption intentions.

Thus, those with high social responsibility, strong environmental awareness, and self-image could experience fun from the use of EVs and enhance their willingness to adopt them. However, this conclusion appears to contradict the concerns of ordinary consumers about the functional value of EVs (Han et al., 2017).

5.2 Managerial implications

This study provides several important management implications. First, given the positive aspect of CTK and PU, imparting consumers with knowledge about EVs' technology and their usefulness may be an effective way to enhance consumers' awareness and raise their willingness to use EVs, such as increasing the number of charging piles and government purchases of EVs. This implication is consistent with (Silvia and Krause, 2016). EV manufacturers could release technological information about EVs, describing how EVs are integrated with intelligent networking technologies, the technological application scenarios of EVs, and the technological performance of EVs, all of which would improve consumers' perceptions of EVs.

Second, Hypothesis 1 and Hypothesis 2 in the male group (see Table VI) are not as significant as in the female group, which means that women with knowledge of EVs' usefulness and ease-of-use are more receptive to EVs than males. Therefore, the role of females in the decision to adopt EVs should not be ignored, especially in decisions to purchase a family car. Manufacturers may find it an effective strategy to invest more resources in demonstrating the usefulness and ease of use of EVs to attract more female customers.

6 Conclusions

The purpose of this study is to understand the role of CTK in consumers' intention to adopt EVs. An extended TAM was developed by integrating CTK and PFU as antecedents. The results generally support the theoretical propositions and show the mediating effects between CTK and EV adoption intentions.

This study makes several contributions to the literature. First, previous studies mainly examined the effects of consumers' attitudes, values, beliefs, and norms pertaining to the environment with regard to their purchase intentions. They regard EVs as environmentally friendly, rather than ideal, social products, which may not be conducive to the mass adoption of EVs. However, this study aimed to explore whether the technological innovation advantages of EVs will be another important factor in attracting consumers to embrace EVs, because these technologies will meet the needs of consumers for mobile travel. To the best of our knowledge, this has not been thoroughly examined in the existing research. Second, the study examined the uncertain relationship between PFU and intention to adopt EVs, and proves, from the technical knowledge dimension, that there is no direct relationship between the two. The findings of this study provided more theoretical support for the relationship between PFU and adoption intention of EVs.

The main findings of this study are as follows. First, CTK can be regarded as leverage influencing people's purchase decisions, further supporting the market development of EVs. Second, adoption of EVs relies on public understanding of the technology innovation of EVs. Finally, PEU and PU strengthen the effects of CTK on consumers' intentions to adopt EVs. However, PFU has no mediating effects on the effects of CTK about EVs on consumers' intention to adopt EVs. This result shows that

the people's decisions to buy green products that require a large investment, such as EVs, are more influenced by the usefulness and ease of use of the technology rather than pleasure.

This study has several limitations. First, it focuses on consumers' adoption intentions rather than actual adoption behavior which, to a certain extent, limits the power of the study to explain real adoption behavior. Second, Chinese consumers' knowledge of EV-related technologies may differ from that of consumers in other countries. Thus, the generalizability of the findings is constrained, though they are still of use to other countries' governments. Future studies could be conducted to further investigate the actual adoption behavior of respondents. Likewise, the sample data could be taken from different countries or regions, allowing cross-comparison of conclusions, while different data sampling methods could be used to verify the robustness of the findings. Third, future studies could conduct more group experiments to further examine the influence of different populations on the willingness to adopt EVs.

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