International Journal of Transport Development and Integration
Vol. 7, No. 4, December, 2023, pp. 273-281
Journal homepage: http://iieta.org/journals/ijtdi

Understanding Consumer Adoption of Electric Vehicles in Rome: Insights from a Structural Equation Model

Muhammad Khaleel[1*], Ali Aljofan[2], Noura Saeed Ahmed Khalaf Alhammadi[3], Mohd Isa Rohayati[1], Shankar Chelliah[2]

[1] National Higher Education Research Institute, Universiti Sains Malaysia, Penang 11900, Malaysia
[2] School of Management, Universiti Sains Malaysia, Penang 11800, Malaysia
[3] Abu Dhabi Vocational Educational & Training Institute, Abu Dhabi, United Arab Emirates

Corresponding Author Email: mkhaleel@usm.my

https://doi.org/10.18280/ijtdi.070401

Received: 12 July 2023
Revised: 13 September 2023
Accepted: 21 September 2023
Available online: 28 December 2023

Keywords:
environmental friendliness, electric vehicle, TAM, JASP, SEM, perceived fun to use, consumer behavior, technology adoption, sustainable transportation

ABSTRACT

This research elucidates the influence of environmental and hedonic motivations on the adoption of electric vehicles (EVs). A framework was constructed to scrutinize the impacts of perceived environmental friendliness on an extended technology acceptance model (TAM), with an added element of perceived enjoyment. A sample of 391 residents in Rome was surveyed, and findings were extracted using structural equation modeling (SEM) in JASP, a statistical software. The results indicated a significant influence of perceived environmental friendliness on TAM factors. Moreover, the perceived enjoyment associated with using an EV significantly correlated with consumer intention to adopt such vehicles. These insights suggest that understanding and promoting the environmental advantages and enjoyment of EV usage could potentially stimulate consumer adoption. Strategies such as government procurement of EVs and expansion of charging infrastructure may also prove beneficial. This research augments existing literature by emphasizing the importance of environmental friendliness perceptions and hedonic motivations in consumer adoption of EVs, contributing unique insights into consumer mobility needs. To the best of our knowledge, such an extensive examination has not been previously undertaken.

1. INTRODUCTION

Escalating environmental concerns have catalyzed the emergence of green behaviors, prompting individuals to adopt environmentally friendly products [1]. Despite electric vehicles (EVs) being touted as such products for several decades, the EV market remains nascent. Some researchers assert that this is attributable to persisting outdated perceptions of EVs, including issues linked to government policies and technologies integral to EVs [2]. Such concerns could deter public acceptance of EVs, even in the face of changing government interventions. It is noteworthy, however, that contemporary EVs incorporate significant technological advancements and offer substantial power reserves, benefiting not only consumers but also the environment [3]. A lack of familiarity with the environmental benefits of EVs and a poor understanding of green technology may make customers hesitant to purchase or use EVs. Therefore, customers who are better informed about the environmental friendliness of EV technologies are more likely to adopt EVs. With the rapid advancements in EV technology, it remains to be elucidated whether green technology innovations can enhance the perceived value of vehicles and stimulate EV adoption.

Previous studies have indicated that public acceptance of EVs is largely influenced by consumer psychological perceptions [4-6]. However, these studies have primarily focused on economic principles, conventions, beliefs, and attitudes of consumers. In these studies, EVs were often viewed as economically beneficial alternatives rather than socially ideal and environmentally friendly products. It has been observed that EVs, being technologically more advanced than conventional vehicles, hold greater appeal for consumers [7]. Moreover, for customers who value innovation, technological growth, and enhancement, technophilia has emerged as a significant selling feature, overshadowing other key environmental and hedonic motivation factors [8]. Thus, it is evident that the impact of the environmental friendliness of EVs on consumer adoption has not been extensively investigated in recent years.

The effect of emotional drivers on the purchase of EVs also remains ambiguous. Huang et al. [8] reported that the enjoyment derived from driving (hedonic motives) could increase EV adoption, but this was not found to be significant in a population composed mostly of individuals from low-income backgrounds. However, Zhou et al. [9] argued that hedonic motives do play a role in vehicle purchase intentions. Rezvani et al. [10] found that without a strong social norm supporting pro-environmental behavior, hedonic motives were not preferred. Hence, the influence of non-functional, emotional values on EV adoption intentions remains unclear, indicating a need for further investigation into whether hedonic motives such as perceived fun to use (PFU) affect consumers' willingness to adopt EVs.

In light of the above, this study aims to examine the impact of product environmental friendliness (PEF) and product functional utility (PFU) on consumers' intentions to adopt EVs. An updated technology acceptance model (TAM) is proposed to elucidate why consumers might choose to purchase electric cars. Three variables were evaluated to assess PEF and adoption intention: perceived fun to use (PFU), perceived usefulness (PU), and perceived ease of use (PEU).

2. LITERATURE REVIEW

This section focuses on the conceptual framework that underlies in the current research. To begin, authors provide an overview of the electric vehicle (EV) adoption and its related factors. This is followed by an explanation of the study's framework.

2.1 Intention to adopt EV

The widespread use of electric vehicles (EVs) is one of the most important steps towards more environmentally friendly transportation systems and reduced carbon emissions [5, 11]. For a smooth transition, it is essential to understand the many factors that influence consumer adoption of electric vehicles. This comprehensive literature review focuses on a number of important variables that, collectively, determine how consumers feel and what they do with regard to EV adoption.

Cost of ownership, range, charging infrastructure, and recharging time are examples of technical considerations that are fundamental to the EV adoption decision [12]. Numerous studies demonstrate that price is a significant determinant of whether consumers will purchase electric vehicles [8, 13]. Consumers are typically deterred from purchasing EVs due to their high initial cost; therefore, novel pricing structures and incentives are being researched to mitigate this issue. Concerns about the range of electric vehicles have recently gained attention [13]. Despite the fact that EVs are sufficient for short distances, consumers continue to desire vehicles with longer ranges [3]. Addressing this knowledge gap is essential for increasing acceptance. The charge problem, which is characterised by a lack of charging infrastructure and lengthy recharging times [14], is another technological obstacle. To allay customer concerns and encourage wider adoption, this issue must be resolved promptly.

Adoption of EVs is greatly aided by governmental funding. Financial and non-financial incentives are two main categories that can be used to classify government actions. Non-monetary incentives include things like free parking and driving privileges, while financial incentives include things like purchase subsidies, purchase tax exemptions, and VAT relief.

The influence of government policies on the willingness of consumers to use EVs has been the subject of a number of research [5, 15, 16], all of which have drawn similar conclusions. Stronger policies lead to higher rates of consumer adoption, with monetary incentives typically outperforming non-monetary ones [2]. Consumer demographics and psychosocial factors are crucial in determining the rate of EV adoption. Typical examples of control variables used in EV adoption research include gender, age, education, income, car ownership, and occupation. Many studies have found that middle-aged, college-educated, and technologically-active people are the most likely to adopt EVs [10]. Psychological factors strongly impact a person's decision to begin using electric vehicles. Several theoretical frameworks, including the Technology Acceptance Model (TAM), the Theory of Planned Behaviour (TPB), and the Theory of Innovation Diffusion, have been used to explore these qualities. Cognitive variables such as knowledge, risk perception, and perceived usefulness are usually at the focus of such a study. The Norm Activation Model (NAM) has also been used to investigate how intellectual and emotive processes influence pro-environmental conduct. The available literature has largely focused on psychological concerns, with less emphasis on environmental ones [17]. Although emotional factors are significant, research reveals that cognitive factors may be more effective in inspiring pro-environmental conduct [3]. As a result, this study acknowledges that both internal and external forces influence customers' decisions about EV adoption. Awareness of this association is critical for encouraging ecologically responsible transport options and easing the transition to greener mobility solutions. Hence, the current study focuses on the TAM and environmental friendliness to assess the EV adoption.

2.2 Theoretical underpinning

The psychological aspects that influence people's intention to buy new technologies have been examined with various technology adoption models including UTUAT, TRA, TAM and DTPB [18]. The TAM describes how PU, PEU, and behavioural intents are linked [19]. By analysing perceived behaviour control, attitude, and subjective norms, the TPB can assist forecast users' intents [20]. According to Yang and Zhou [21], the two major theoretical developments TAM and TPB sufficiently provides the foundation for the intention to adopt, in line, TAM is more effective in measuring the satisfaction of the users. However, among all technology acceptance and adoption models, UTUAT and TAM2 are the most widely accepted technology models. But the foundations of both models are derived from TAM. In the prior researcher, authors adopted these models to assess the people reaction to new technology [22].

TAM has been effectively predicted individual behaviours for a wide range of computer technologies and information [23, 24]. It signifies the casual relationship between the belief-attitude-intent-behaviour. TAM and its variants have been used in recent studies to assess public acceptability of EVs and to draw policy and management effects in a variety of research contexts [11, 25]. Additionally, Hu et al. [26] and Song [27] applied TAM to investigate current financial subsidies impact on customers' intentions to purchase electric vehicles. In current study, PEF about Electric Vehicles is a key psychological aspect that may trigger the consumer to adopt EV technology. In a nutshell, to predict the acceptance of Electric Vehicles in market, the current study developed the model by considering TAM as the foundation of this study.

The suggested model, which is based on both theoretical and empirical studies in the context of Electric Vehicles and TAM, is designed to look at the impact of Product Environmental Friendliness on consumers' intentions to adopt electric cars (CIAEVs) (Figure 1). Two additional parameters, PEF and PFU, should be included when predicting EV acceptability, First and foremost, the environmental friendliness of EV technology is a critical factor in a person's decision to adopt EVs. When people are concerned about the environment, they are more likely to accept environmentally friendly products. Second, PFU can play a key role in persuading customers to switch to electric vehicles. Electric vehicles are advancing at a faster rate than gasoline-powered vehicles. Additionally, new technology may enable EVs to have characteristic and functionalities that are appealing to the EV consumers [27]. The result obtained from perceived fun to use, and PEF may drastically change the marketing strategy of EV adoption from the economic aspects. As, prior studies have proved that people are willing to pay more for the products which satisfy their needs and wants.

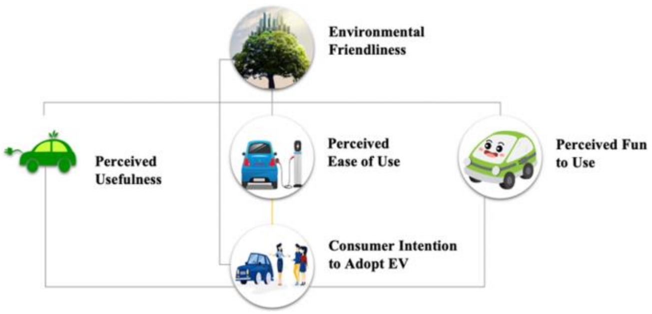

Figure 1. Conceptual framework of the study

2.3 Hypotheses

2.3.1 Perceived usefulness

Perceived usefulness is regarded as the main factor of TAM, which is described as the extent to which a certain technology will increases the efficiency and help individual to achieve their goals PU [19]. The PU of technology is inextricably linked into a person's attitude toward and technology acceptance. In case, if new technologies have been proved to be efficient and beneficial, people are more likely to have a good attitude toward using them. Undoubtedly, electric vehicles are generally predicted to become the major transportation mode in the coming future and hold enormous promise for making society cleaner and more environmentally friendly [13]. Families and individuals can save money on travel and living expenditures by using electric vehicles to change their travel habits and lives. In prior studies, vehicle-to-grid (V2G) technologies hypothesised a theory that EVs parked may produce money by injecting additional electricity into the grid during peak hours and charging during off-peak periods [12]. As per Huang et al. [8], EVs can save money on transportation while simultaneously refining standard of life and travel efficacy. As a result, it is plausible to consider that EV. PU is positively associated to customers' readiness to embrace electric vehicles. Therefore, this study hypothesises that:

H1: Perceived usefulness of the electric vehicles develops the consumer intention to adopt EVs.

2.3.2 Perceived ease of use

Perceive ease of use describes the extent to which a person perceives that the new technology is easy to use [28]. A different product or system will have a different impact on adoption intentions based on their ease of use [14]. Past research on new technology adoption revealed that PEU has a strong and significant influence on consumer intention [29]. An effective way of enhancing understanding of new technologies and increasing the intention to adopt them is to focus on participation and interactions with the technology to operate. Based on the prior research and the useability of EV it can be contended that consumers can have an easy time with EVs. Therefore, the researcher believes that PEU is critical in encouraging the adoption of electric vehicles, and that it is directly linked to usefulness of the technology. Hence, this study hypothesis that:

H2: Perceived ease of use of the electric vehicles is related to the Perceived usefulness of EVs.

H3: Perceived ease of use of the electric vehicles develops the consumer intention to adopt EVs.

2.3.3 Perceived fun to use

Individuals' readiness to adopt the latest technology is typically determined by their internal-emotions, which are features of interest and thus motivate them to do so [30, 31]. According to Huang et al. [8], products' emotional characteristics are usually the result of the psychological demands positioned on consumers by the products. It might even be more direct than the link between emotion and behaviour [32]. However, there is little evidence that emotional motivations have a significant impact on EV adoption. A study by Schuitema et al. [16] discovered that driving pleasure contributes to the desire to adopt EVs. According to Herberz et al. [29], hedonic motives may play a role in mobility purchase intentions. Van der Werff et al. [33], on the other hand, suggested that pleasure motives had no effect on intentions to engage in pro-environmental behaviour among individuals who did not perceive high social norms. Additionally, Huang et al. [8] noted that, while emotional factors do not have a direct effect on EV adoption intentions, they do have an indirect effect on a non-functional value. For the purposes of this study, we assumed that EV drivers could enjoy a more thrilling driving experience, which would increase consumer interest in EVs. Therefore, this study hypothesises that:

H4: Perceived fun to use have a significant impact on the consumer intention to adopt EVs.

2.3.4 Environmental friendliness of electric vehicles

Understanding people's environmental concerns is critical for understanding their behaviour, and it's also an essential part of learning how people make environment friendly behaviours [17, 34, 35]. Consumers are increasingly aware of the direct and significant impact their purchases have on the environment, and the number of environmentally conscious consumers has increased in recent years. To demonstrate their commitment to the global environment, they incorporate environmental considerations into their purchasing behaviours [36]. Even if environmentally friendly products are more expensive, consumers are more willing to pay the higher price. Prior research has been conducted on people's desires to act in an environmentally friendly manner (EFB). Willingness to pay a premium for environmentally friendly products or services [13], commitment to environmentally friendly services [37] and word of mouth about environmentally friendly communications [38] are all examples of intentions adopt to environmentally friendly products & services. Values have been used as predictors of environmentally friendly behaviour (EFB) in the context of altruistic behaviour in the past [38]. Energy conservation, recycling, and environmental action have all been investigated previously using personal norms, moral obligation sentiments, and altruism. Environmentally friendly products are market-driven products that cause the least amount of environmental damage, and their development is linked to a process of product development that examines the product's potential environmental consequences throughout its life. The PEF for EVs represents the proportion of customers who believe electric vehicles are environmentally friendly [39]. According to a previous survey [39], consumers are willing to pay a premium for environmentally friendly services and products. Consumers' environmental awareness of electric vehicles is an antecedent of their accepting them, and those with additional knowledge are more likely to do so if they are aware of the benefits. As previously stated, EVs that integrate multiple technologies are becoming more prevalent. Inline, consumers are more likely to use EVs if they have additional information about the technology's environmental friendliness. The following hypotheses are advanced in this study.

H5: Environmental Friendliness of the electric vehicles develops the consumer intention to adopt EVs.

Regardless of the environmental impact, the benefits of long lasting electric storage and the opportunities provided by integrating EVs with Information and Communication Technology are important factors in increasing EV acceptance [40]. In addition to V2G, other possible combinations include car internet and car-to-car communication [41]. These models create an environment that is automatically integrated, data-driven and service-oriented to meet the growing connected needs of consumers. According to Choi and Koo [42], a combination of EV and autonomous driving technology will lead to future transportation as it improves driving, charging and travel. Such features of ICT vehicle technology have attracted the interest of potential and existing EV buyers, which has increased the public interest in smart EVs. As mentioned earlier, environmental friendliness is a key factor in developing customer decisions and has a strong influence on their choices. People who value the environmental benefits and usefulness of electric vehicles are interested in learning more about them and believing that they will benefit from them. Based on this, the following three hypothesis are made.

H6: Perceived environmental friendliness of Electric Vehicle influences the Perceived usefulness of Electric Vehicle.

H7: Perceived environmental friendliness of Electric Vehicle influences the Perceived ease of use of Electric Vehicle.

H8: Perceived environmental friendliness of Electric Vehicle influences the Perceived fun to use of Electric Vehicle.

3. METHODS

3.1 Data collection procedure

The data for this study were gathered using a web-based questionnaire. For example, at the beginning of the questionnaire, the researchers presented respondents with a variety of EV and ICT application scenarios, both in text and image form, to assist them in comprehending the advancement of EVs and ICT over time, which they found beneficial. Convenience sampling technique was employed to reach to the respondents. Initially, 35 participants participated in a pilot study in February 2021 to determine the reliability and validity of questionnaire designs. The pilot survey pilot survey has provided the opportunity in achieving a high level of content validity [43]. Respondents received the final version of the questionnaire during the last week of April, 2021, which was spread out using web-based platform particularly the city's prominent web pages. Social media was used to look for community members from the Rome to distribute the questionnaires.

Several techniques were designed to ensure the legitimacy of the data. (1) To provide respondents with sufficient time to read the introduction, responses should be collected in more than 5 minutes. (2) Delete data from five consecutive questions that have the same response. (3) Non-serious responses were omitted from the data set. (4) Valid respondents were those who had prior experience with EVs and interested in the latest technologies.

A total of 710 questionnaires were submitted and 578 responses were received after monitoring and validating the data collection process, with 391 of them resulting in valid responses. This equates to a 55.19% response rate. Along with their age several other demographic questions were asked. Additionally, respondents were also asked about their preferred mode of transportation.

3.2 Measurements

3.2.1 Consumers' intentions to adopt electric vehicle

Respondents assessed their intentions to adopt electric vehicle using the survey adopted from Huang et al. [8]. All the items were measured on the 7point Likert scale from strongly disagree to strongly agree. A sample item of the scale is "I am willing to use an intelligent EV in the near future". Reliability of the scale was measured with two criteria's including Cronbach's α and MacDonald ω. The test results showed that Cronbach's α was 0.896 and MacDonald ω was 0.894.

3.2.2 Perceived environmental friendliness

Perceived environmental friendliness was adopted from the study of Chen et al. [44]. All items were measured on the 5point Likert scale from strongly disagree to strongly agree. A sample item of the scale is "I believe that electric vehicles are environmentally friendly". The reliability test results showed that Cronbach's α was 0.805 and MacDonald ω was 0.805.

3.2.3 Perceived fun to use

Perceived fun to use was adopted from the study of Huang et al. [8]. All items were measured on the 5point Likert scale from strongly disagree to strongly agree. A sample item of the scale is "I think the experience of driving intelligent EVs is interesting". The reliability test results showed that Cronbach's α was 0.825 and MacDonald ω was 0.821.

3.2.4 Perceived ease of use

Perceived ease of use to was adopted from the study of Venkatesh [14]. All items were measured on the 5point Likert scale from strongly disagree to strongly agree. A sample item of the scale is "I rarely need to consult others with the use of intelligent EVs". The reliability test results showed that Cronbach's α was 0.907 and MacDonald ω was 0.906.

3.2.5 Perceived usefulness

Perceived usefulness was adopted from the study of Venkatesh [14]. All items were measured on the 5point Likert scale from strongly disagree to strongly agree. A sample item of the scale is "Intelligent EVs are useful to reduce carbon emission and alleviate the energy shortage problems". The reliability test results showed that Cronbach's α was 0.802 and MacDonald ω was 0.794.

3.3 Analysis

Microsoft Excel 2014 was used to collect the raw data. All the data was gathered with complete anonymity. SPSS Statistics version 24 was used in all statistical analyses except SEM. Data was checked with normality and missing values. The missing values were less than the 5% of the data hence, the data was not imputed to treat missing value. Next, we carried out a discriminant analysis to determine if the data collected was reliable. In the next stage we ran JASP with R's lavaan package to analyse constructs that are correlated (Jasp Team, 2018; Rosseel, 2012). The JASP Team's SEM calculation was performed using JASP) (2020). JASP (version 0.12.2) [45]. We thus created one overall CB-SEM that can be used to test our theories. Using the maximum likelihood estimation method and applying the standard error calculation procedure to models, we confirmed the goodness-fitness of the model. The proposed models were validated using the fit indices outlined in the literature. Common method variance was calculated using Harman's Single Factor [46]. Following are the LaVan codes were used in this study.

```
#Measurement
PFU=~PFU1+PFU2+PFU3
PEU=~PEU1+PEU2+PEU3+PEU4
PU=~PU1+PU2+PU3+PU4
PEF=~PEF1+PEF2+PEF3+PEF4
CIAEV=~CIAEV1+CIAEV2+CIAEV3+CIAEV4
#Regression
PEU~PEF
PU~PEF
PFU~PEF
PU~PEU
CIAEV~PEF+PU+PFU+PEU
```

3.3.1 Common method bias

The Harman one-factor test was used to determine the degree of bias in the data. By employing Principal Component Analysis (PCA), 6 components accounted for more than 72.5% of the variance. However, the first factor was accounted for 27.8 percent of the total variance. This implies that there is an overarching dominant general factor that contributes to at least 50% of the total variance. Therefore, it is assumed that there is no biasness in the data found.

3.3.2 Profile of the respondents

The data gathered revealed that among the total valid participants 62.66% were male. Majority of the respondents falls under the age group of 26-30 years old. Most of the respondents had acquired at least bachelor's degree. 51.19% of the respondents were employed. And 16.11% were self-employed. Based on the income of the respondents, 45.013% of the respondents were earning more than 2001 USD, as shown in Table 1.

3.4 Measurement model analysis

To examine the measurement model's effectiveness reliability and validity see Table 2 and Figure 2. The α and MacDonald ω coefficients were calculated for each of the psychometric instruments PU, PEF, PEU, PFU, and CIAEV to assess their consistency. According to Nunnally and Bernstein [47], the coefficient alpha provided a good estimate of internal consistency, because it was above the minimum standard of 0.70. The factor loadings were used to identify the validity of the five constructs [15]. Each of the reflecting indicators loaded between 0.61 and 0.89, and it was recommended that they have a value of at least 0.50. Hence the loading on each construct were greater than 0.50, each construct's convergent validity was established, which means that each construct in this study had a clear notion of construct validity. The AVE ranged from 0.523 to 0.670 when computing discriminant validity for FIVE constructs.

Table 1. Respondents profile (N=391)

Variable	Frequency	Valid Percent
Gender		
Female	146	37.34
Male	245	62.66
Age		
18-25	97	24.808
26-30	123	31.458
31-35	96	24.552
36 And above	75	19.182
Education		
Diploma	51	13.043
Bachelors	194	49.616
Postgraduate	146	37.34
Occupation		
Unemployed	91	23.274
Employed	203	51.918
Self-Employed	63	16.113
Income		
Less than 500 USD	99	25.32
501-1000 USD	42	10.742
1001-1500 USD	31	7.928
1501-2000 USD	43	10.997
More than 2001 USD	176	45.013

Table 2. Convergent validity

Variable	Factor Loading	AVE	CR
PFU	0.79 0.84 0.73	0.62	0.72242399
PEU	0.81 0.87 0.89 0.82	0.72	0.91119639
PU	0.61 0.80 0.83 0.64	0.523	0.81069616
PEF	0.77 0.65 0.73 0.70	0.508	0.80369883
CIAEV	0.79 0.81 0.85 0.84	0.678	0.89351252

Table 3. Discriminant validity

Var	M	Std.	1	2	3	4	5
PEF	3.653	0.747	0.713***				
PFU	3.789	0.774	0.515	0.887***			
PEU	4.447	0.753	0.273	0.351	0.849***		
PU	3.844	0.864	0.351	0.403	0.402	0.723***	
CIAEV	5.573	1.258	0.396	0.530	0.474	0.500	0.823***

Table 3 demonstrates the construct's discriminant validity by the square root of the AVE (i.e. the sum of the product of the coefficients of each pair of factors) is greater than the correlation coefficient between factors, which confirms the construct's discriminant validity [48]. The results revealed that discriminant validity was established.

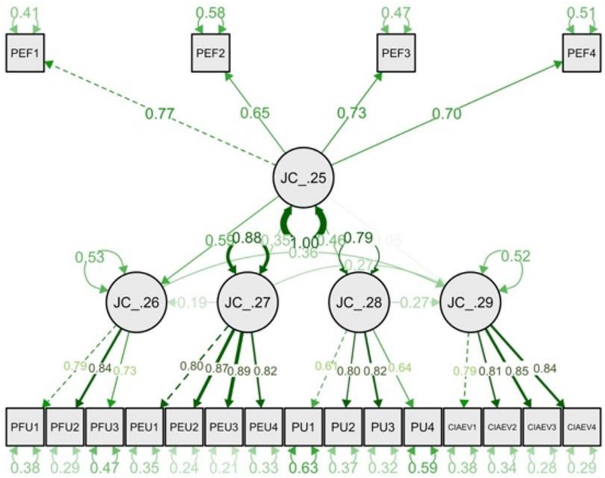

Figure 2. Model extracted from JASP

3.5 Structural model results

The SEM module in JASP is based on Rosseel's great R package lavaan [49]. It uses the intuitive and straightforward syntax from this package for specifying models. The results from the SEM in JASP revealed that all the developed hypothesis were found to be significant. The results shows that $PU_{0.521}$, $PEU_{0.479}$, $PFU_{0.529}$ and $PEF_{0.073}$ have significant relationship with CIAEV hence it can be contended that all the hypothesis were found to be accepted, as shown in Table 4 and Figure 3.

Table 4. Direct effect results

Path	Est	Se	t	p	CI (lower)	CI (upper)
PU→CIAEV	0.521	0.111	4.692	<0.001	0.303	0.738
PEU→PU	0.226	0.063	3.608	<0.001	0.103	0.348
PEU→CIAEV	0.479	0.09	5.332	<0.001	0.303	0.656
PFU→CIAEV	0.529	0.11	4.83	<0.001	0.314	0.744
PEF→CIAEV	0.073	0.023	3.173	<0.001	0.168	0.315
PEF→PU	0.384	0.057	6.756	<0.001	0.273	0.496
PEF→PEU	0.319	0.054	5.907	<0.001	0.213	0.424
PEF→PFU	0.636	0.07	9.076	<0.001	0.499	0.773

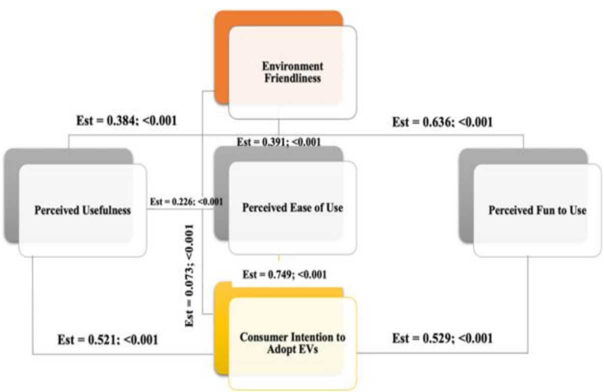

Figure 3. Structural equational modelling results

4. DISCUSSIONS

This research adds to the body of knowledge by examining the impact of PEF and PFU, on intention of adoption of EV. The research emphasises the significance of a wider conceptualization of PEF for electric vehicles that includes green behaviour and environmental friendliness. According to the structural model's results (Table 4), PEF has a strong influence on customer intent to accept Electric Vehicles. This study supports recent findings by Chen et al. [44] that emphasise the prominence of environmental friendliness in people's desire to buy products like electric vehicles.

Additionally, according to the findings of Huang et al. [8], the PFU has a significant role in promoting environment friendly products, such as electricity driven automobiles. In line to this there is strong correlation between perceived fun to use (PFU) and customer intention to adopt electric vehicles. Prior researches mainly focused on the characteristics of the electric vehicle when explaining their hedonic motivation such as price of the car and functionalities in the car. Our study further deepens the approach by examine the hedonic factor fun to use. Results of the study were found significant and consistent with Schuitema et al. [16]. This is because individuals who have willingness to drive the electric vehicle are also excited to change from the traditional mode of transportation. They are considering enjoyment factor as well from the hedonic perspectives. The environmental friendliness is more stringer when the individuals find the vehicle useful, easy to use and enjoyable.

This research has a number of significant managerial implications. Given the advantages of PEF and PU, increasing consumer willingness and awareness to use Electric Vehicles by providing a better understanding of the technology and utility of EVs, such as government purchases of Electric Vehicles and expanding the number of charging stations, could be a good strategy. EV makers may communicate green technology data about EVs, such as how Electric Vehicles connect with EV environmental performance, technical application scenarios for EVs, and intelligent networking technologies, all of which would improve customers' desires for EVs. Secondly, the goal of this research was to find out if PEF is involved in CIAEVs. PEF and PFU were used as antecedents in the building of an extended TAM. The findings back up the notion by demonstrating that there are mediating effects between PEF and EV adoption plans.

This research added to the corpus of knowledge in a number of ways. Such as, earlier research examined how customers' attitudes, values, beliefs, and norms about technology growth influenced their purchasing decisions. They see electric vehicles as cutting-edge technology rather than flawless, ecologically friendly vehicles, which could slow their acceptance. However, the purpose of this study was to see if the environmental friendliness of EVs will be a major element in persuading customers to accept them, as these technologies will suit consumers' mobile mobility needs. To our knowledge, this has never been thoroughly investigated in previous study. Next, the report looked at the relationship between EV adoption plans and PFU, concluding that there is direct link between the two, based on technological understanding. This study's findings add to the growing body of research tying PFU to EV adoption goals.

The study's most important findings are presented below. For starters, PEF can be viewed as a technique for influencing people's purchasing decisions and thereby promoting the growth of the electric vehicle market. Second, popular acceptance of electric vehicles is contingent on public comprehension of the vehicles' environmentally friendly technological innovation. Lastly, PU and PEU amplify the impacts of PEF on consumer purpose to acquire electric vehicles. When it comes to Electric Vehicles, however, PFU has strong mediating effects between PEF and CIAEVs. When purchasing green items that require a significant financial investment, such as electric automobiles, this research reveals that individuals are more persuaded by the technology's utility, ease of use and aesthetic appeal than its functional values.

There are a few limitations in this research. Firstly, the current research focused on customers' intention rather than actual behaviour, limiting its ability to elaborate real adoption behaviour. Secondly, Chinese customers may have a different level of environmental awareness than customers in other nations when it comes to EV technology. As a result, the findings have limited generalizability, yet they are nevertheless significant to governments around the world. Future research could look into the real-world adoption trends of respondents. Sample data from different countries or locales might be utilised to compare results, and multiple data collection methods could be employed to assess the findings' robustness. Third, future research might include more group trials to learn more about how different populations influence EV adoption.

5. CONCLUSION

This study adds significantly to the current literature by clarifying the critical roles of environmental friendliness perceptions and hedonic motives in the spread of electric car use. This not only highlights the importance of adapting strategies to meet the distinct demands of different groups of people, but also provides novel insights into the mobility needs of consumers. This study fills a gap in the literature by providing the first comprehensive examination of these aspects with the goal of guiding future efforts to advance sustainable transportation.

AUTHOR CONTRIBUTIONS

Conceptualization, Muhammad Khaleel. and Ali Aljofan.; methodology, Muhammad Khaleel.; software, Ali Aljofan.; validation, Dr Shankar Chelliah., Muhammad Khaleel. and Rohayati Mohd Isa.; formal analysis, Muhammad Khaleel.; investigation, Muhammad Khaleel.; resources, Muhammad Khaleel.; data curation, Ali Aljofan.; writing—original draft preparation, Muhammad Khaleel.; writing—review and editing, Ali ALjofan.; visualization, Noura Saeed Ahmed Khalaf Alhammadi.; supervision, Dr Shankar Chelliah and Rohayati Mohd Isa.; project administration, Muhammad Khaleel. All authors have read and agreed to the published version of the manuscript.

REFERENCES

[1] Wang, H.Y., Wang, X.L., Sarkar, A., Zhang, F.H. (2021). How capital endowment and ecological cognition affect environment-friendly technology adoption: A case of apple farmers of Shandong province, China. International Journal of Environmental Research and Public Health, 18(14): 7571. https://doi.org/10.3390/ijerph18147571

[2] Li, J.J., Jiao, J.L., Tang, Y.S. (2020). Analysis of the impact of policies intervention on electric vehicles adoption considering information transmission-based on consumer network model. Energy Policy, 144: 111560. https://doi.org/10.1016/j.enpol.2020.111560

[3] Tran, M.K., Sherman, S., Samadani, E., Vrolyk, R., Wong, D., Lowery, M., Fowler, M. (2020). Environmental and economic benefits of a battery electric vehicle powertrain with a zinc-air range extender in the transition to electric vehicles. Vehicles, 2(3): 398-412. https://doi.org/10.3390/vehicles2030021

[4] Asadi, S., Nilashi, M., Samad, S., Abdullah, R., Mahmoud, M., Alkinani, M.H., Yadegaridehkordi, E. (2021). Factors impacting consumers' intention toward adoption of electric vehicles in Malaysia. Journal of Cleaner Production, 282: 124474. https://doi.org/10.1016/j.jclepro.2020.124474

[5] Song, R.Q., Potoglou, D. (2020). Are existing battery electric vehicles adoption studies able to inform policy? A review for policymakers. Sustainability, 12(16): 6494. https://doi.org/10.3390/su12166494

[6] Omahne, V., Knez, M., Obrecht, M. (2021). Social aspects of electric vehicles research-trends and relations to sustainable development goals. World Electric Vehicle Journal, 12(1): 15. https://doi.org/10.3390/wevj12010015

[7] Thiel, C., Tsakalidis, A., Jäger-Waldau, A. (2020). Will electric vehicles be killed (again) or are they the next mobility killer app? Energies, 13(7): 1828. https://doi.org/10.3390/en13071828

[8] Huang, X.J., Lin, Y., Lim, M.K., Tseng, M.L., Zhou, F.L. (2021). The influence of knowledge management on adoption intention of electric vehicles: Perspective on technological knowledge. Industrial Management & Data Systems, 121(7): 1481-1495. https://doi.org/10.1108/IMDS-07-2020-0411

[9] Zhou, M., Long, P., Kong, N., Zhao, L.D., Jia, F., Campy, K.S. (2021). Characterizing the motivational mechanism behind taxi driver's adoption of electric vehicles for living: Insights from China. Transportation Research Part A: Policy and Practice, 144: 134-152. https://doi.org/10.1016/j.tra.2021.01.001

[10] Rezvani, Z., Jansson, J., Bengtsson, M. (2018). Consumer motivations for sustainable consumption: The interaction of gain, normative and hedonic motivations on electric vehicle adoption. Business Strategy and the Environment, 27(8): 1272-1283. https://doi.org/10.1002/bse.2074

[11] Singh, V., Singh, V., Vaibhav, S. (2020). A review and simple meta-analysis of factors influencing adoption of electric vehicles. Transportation Research Part D: Transport and Environment, 86: 102436. https://doi.org/10.1016/j.trd.2020.102436

[12] Guille, C., Gross, G. (2009). A conceptual framework for the vehicle-to-grid (V2G) implementation. Energy Policy, 37(11): 4379-4390. https://doi.org/10.1016/j.enpol.2009.05.053

[13] González-Rodríguez, M.R., Díaz-Fernández, M.C., Font, X. (2020). Factors influencing willingness of customers of environmentally friendly hotels to pay a price premium. International Journal of Contemporary

Hospitality Management, 32(1): 60-80. https://doi.org/10.1108/IJCHM-02-2019-0147
[14] Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. Information Systems Research, 11(4): 342-365. https://doi.org/10.1287/isre.11.4.342.11872
[15] Otieno, E.O., Wausi, A.N., Kahonge, A.M. (2020). A theoretical model for information security policy compliance culture. International Journal of Applied Information Systems (IJAIS), 12(33): 6-14.
[16] Schuitema, G., Anable, J., Skippon, S., Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. Transportation Research Part A: Policy and Practice, 48: 39-49. https://doi.org/10.1016/j.tra.2012.10.004
[17] Steg, L., Bolderdijk, J.W., Keizer, K., Perlaviciute, G. (2014). An integrated framework for encouraging pro-environmental behaviour: The role of values, situational factors and goals. Journal of Environmental psychology, 38: 104-115. https://doi.org/10.1016/j.jenvp.2014.01.002
[18] Alghazi, S.S., Kamsin, A., Almaiah, M.A., Wong, S.Y., Shuib, L. (2021). For sustainable application of mobile learning: An extended UTAUT model to examine the effect of technical factors on the usage of mobile devices as a learning tool. Sustainability, 13(4): 1856. https://doi.org/10.3390/su13041856
[19] Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3): 319-340. https://doi.org/10.2307/249008
[20] Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2): 179-211. https://doi.org/10.1016/0749-5978(91)90020-T
[21] Yang, H.W., Zhou, L.N. (2011). Extending TPB and TAM to mobile viral marketing: An exploratory study on American young consumers' mobile viral marketing attitude, intent and behavior. Journal of Targeting, Measurement and Analysis for Marketing, 19: 85-98. https://doi.org/10.1057/jt.2011.11
[22] Adamuthe, A.C., Mane, S.U. (2019). Analyzing the adoption of recent IT technologies in undergraduate engineering project course. Journal of Engineering Education Transformations, 34: 50-56. https://doi.org/10.16920/jeet/2021/v34i0/157105
[23] Mustafa, M.H., Ahmad, M.B., Shaari, Z.H., Jannat, T. (2021). Integration of TAM, TPB, and TSR in understanding library user behavioral utilization intention of physical vs. E-book format. The Journal of Academic Librarianship, 47(5): 102399. https://doi.org/10.1016/j.acalib.2021.102399
[24] Park, S.U., Kim, D.K., Ahn, H. (2021). A predictive model on the intention to accept taekwondo electronic protection devices. Applied Sciences, 11(4): 1845. https://doi.org/10.3390/app11041845
[25] Jaiswal, D., Kant, R., Singh, P.K., Yadav, R. (2022). Investigating the role of electric vehicle knowledge in consumer adoption: Evidence from an emerging market. Benchmarking: An International Journal, 29(3): 1027-1045. https://doi.org/10.1108/BIJ-11-2020-0579
[26] Hu, Y., Wang, Z.Y., Li, X.R. (2020). Impact of policies on electric vehicle diffusion: An evolutionary game of small world network analysis. Journal of Cleaner Production, 265: 121703. https://doi.org/10.1016/j.jclepro.2020.121703
[27] Song, Y.K., (2020). An empirical study on the influencing factors of consumers' willingness to use pure electric vehicle based on TAM model. In 2020 16th Dahe Fortune China Forum and Chinese High-educational Management Annual Academic Conference (DFHMC), Zhengzhou, China, pp. 289-292. https://doi.org/10.1109/DFHMC52214.2020.00063
[28] Davis, F.D., Bagozzi, R.P., Warshaw, P.R. (1989). User acceptance of computer technology: A comparison of two theoretical models. Management Science, 35(8): 982-1003. https://doi.org/10.1287/mnsc.35.8.982
[29] Herberz, M., Hahnel, U.J., Brosch, T. (2020). The importance of consumer motives for green mobility: A multi-modal perspective. Transportation Research Part A: Policy and Practice, 139: 102-118. https://doi.org/10.1016/j.tra.2020.06.021
[30] Igbaria, M., Schiffman, S.J., Wieckowski, T.J. (1994). The respective roles of perceived usefulness and perceived fun in the acceptance of microcomputer technology. Behaviour & Information Technology, 13(6): 349-361. https://doi.org/10.1080/01449299408914616
[31] Maier, C. (2020). Overcoming pathological IT use: How and why IT addicts terminate their use of games and social media. International Journal of Information Management, 51: 102053. https://doi.org/10.1016/j.ijinfomgt.2019.102053
[32] Song, H., Ruan, W.J., Jeon, Y.J.J. (2021). An integrated approach to the purchase decision making process of food-delivery apps: Focusing on the TAM and AIDA models. International Journal of Hospitality Management, 95: 102943. https://doi.org/10.1016/j.ijhm.2021.102943
[33] Van der Werff, E., Steg, L., Keizer, K. (2013). It is a moral issue: The relationship between environmental self-identity, obligation-based intrinsic motivation and pro-environmental behaviour. Global Environmental Change, 23(5): 1258-1265. https://doi.org/10.1016/j.gloenvcha.2013.07.018
[34] Steg, L., Lindenberg, S., Keizer, K. (2016). Intrinsic motivation, norms and environmental behaviour: The dynamics of overarching goals. International Review of Environmental and Resource Economics, 9(1-2): 179-207. https://doi.org/10.1561/101.00000077
[35] Zavareh, M.F., Mehdizadeh, M., Nordfjærn, T. (2020). Active travel as a pro-environmental behaviour: An integrated framework. Transportation Research Part D: Transport and Environment, 84: 102356. https://doi.org/10.1016/j.trd.2020.102356
[36] Barber, N., Taylor, C., Strick, S. (2009). Wine consumers' environmental knowledge and attitudes: Influence on willingness to purchase. International Journal of Wine Research, 59-72. https://doi.org/10.2147/IJWR.S4649
[37] Chia-Jung, C., Chen, P.C. (2014). Preferences and willingness to pay for green hotel attributes in tourist choice behavior: The case of Taiwan. Journal of Travel & Tourism Marketing, 31(8): 937-957. https://doi.org/10.1080/10548408.2014.895479
[38] Konuk, F.A., Rahman, S.U., Salo, J. (2015). Antecedents of green behavioral intentions: A cross-country study of

Turkey, Finland and Pakistan. International Journal of Consumer Studies, 39(6): 586-596. https://doi.org/10.1111/ijcs.12209
[39] Tanwir, N.S., Hamzah, M.I. (2020). Predicting purchase intention of hybrid electric vehicles: Evidence from an emerging economy. World Electric Vehicle Journal, 11(2): 35. https://doi.org/10.3390/wevj11020035
[40] Will, C., Schuller, A. (2016). Understanding user acceptance factors of electric vehicle smart charging. Transportation Research Part C: Emerging Technologies, 71: 198-214. https://doi.org/10.1016/j.trc.2016.07.006
[41] Tahir, M.N., Fatima, S., Bashir, N. (2020). Car-to-car communication using ITS-G5 & 5G. In 2020 IEEE 5th International Conference on Intelligent Transportation Engineering (ICITE), Beijing, China, pp. 331-335. https://doi.org/10.1109/ICITE50838.2020.9231349
[42] Choi, H., Koo, Y. (2021). Effectiveness of battery electric vehicle promotion on particulate matter emissions reduction. Transportation Research Part D: Transport and Environment, 93: 102758. https://doi.org/10.1016/j.trd.2021.102758
[43] In, J.Y. (2017). Introduction of a pilot study. Korean Journal of Anesthesiology, 70(6): 601-605. https://doi.org/10.4097/kjae.2017.70.6.601
[44] Chen, Y.S., Lin, C.Y., Weng, C.S. (2015). The influence of environmental friendliness on green trust: The mediation effects of green satisfaction and green perceived quality. Sustainability, 7(8): 10135-10152. https://doi.org/10.3390/su70810135
[45] Goss-Sampson, M. (2019). Statistical analysis in JASP: A guide for students. https://doi.org/10.6084/m9.figshare.9980744
[46] Podsakoff, P.M., MacKenzie, S.B., Lee, J.Y., Podsakoff, N.P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. Journal of Applied Psychology, 88(5): 879-903. https://doi.org/10.1037/0021-9010.88.5.879
[47] Nunnally, J.C., Bernstein, I. (1978). The role of university in the development of entrepreneurial vocations: A Spanish study. Psychometric Theory, 387-405.
[48] Collier, D.A., Fitzpatrick, D., Brehm, C., Hearit, K., Beach, A. (2020). Structuring first-year retention at a regional public institution: Validating and refining the structure of bowman's SEM analysis. Research in Higher Education, 61: 917-942. https://doi.org/10.1007/s11162-020-09612-w
[49] Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling. Journal of Statistical Software, 48(2): 1-36. https://doi.org/10.18637/jss.v048.i02