

A STUDY OF SAFETY, RANGE, USEFULNESS AND SATISFACTION OF NEW ENERGY VEHICLE (NEV) AMONGST GEN Y IN SHENZHEN CITY, CHINA

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ABSTRACT

In China, new energy vehicles (NEVs) are becoming more important as a solution against the environmental and energy crisis. This phenomenon is also an advantage to reduce petrol cost and more economic sustainability. Subsequently, this paper attempts to examine the elements of satisfaction amongst the Gen Y who owned and experienced driving NEV. DOI theory is used as a foundation in this study. A survey of 394 NEV drivers in the City of Shenzhen was used in the analysis. As a result, all the three variables were found to be significant to influence the experience in driving NEV. In addition, the findings of this research may provide some insight and useful information for the government and related agencies, NEV manufacturers, and academic researchers.

Keywords: *New Energy Vehicles (NEVs), Diffusion of Innovation (DOI) theory, Gen Y, Driving Satisfaction*

INTRODUCTION

New energy vehicles (NEVs) are an emerging vehicle in today's automotive market and can be divided into three main categories: pure battery electric vehicle (BEV), plug-in electric vehicle (PHEV), and fuel cell



vehicles (FCEV) (Bakhsh,2011). In today's business environments, many organizations are looking at energy efficiency in their living and working spaces which avoids wasteful energy particularly from unplanned energy costs and electricity that increases cost of services (Abdul Halim et al., 2022).

NEVs for instance are more energy efficient and environmentally friendly than conventional vehicles as they use renewable energy and provide green and clean transportation, and according to Teixeira & Sodré (2016), the carbon emissions of NEVs are 10 times lower than conventional vehicles. Thus, to preserve the environment against pollution in the air could help cool down the earth temperature and in fact the emission released will continue to warm the climate in the future (Mohd Zulkifli et al., 2021). This indicates that the development of NEVs can reduce air pollution and the greenhouse effect, while solving social and environmental problems (Coffman et al., 2017), especially today with the increasing economic globalization and industrialization, air pollution and greenhouse effect have become one of the most worrying environmental problems worldwide (Khan, et al.,2016).

Therefore, it is necessary to reduce emissions from the road transport sector to achieve a global low-emissions transport strategy, and it is widely recognized that the use of NEVs is needed to minimize CO₂ emissions from the transport sector (Zhao et al., 2022). Similarly, this idea is in line with the United Nations advocating that decarbonization of transport is a keyway to achieve the UN Sustainable Development Goals, and electric vehicles play an important role in this area (Ibata-Arens et al., 2018).

In response to the global initiatives towards protecting the environment and efforts to escape from the energy crisis, the Chinese government is also actively promoting the development of NEVs. In particular, many reports in recent years have also shown that the transportation sector is one of the major emitters of greenhouse gases (GHG) in China (Zhu and Li, 2017; Shao, 2019), and vehicle emissions are the main source of carbon emissions from the transportation sector in China (Bonsu, 2020). Thus alternative free emission from vehicles such as NEVs are vital.

Despite the Chinese government's aggressive efforts to promote the

popularity of NEVs, NEV sales in China were only 1.367 million units in 2020, accounting for only 5.4% of total vehicle sales in China (Xian et al., 2022). This largely explains the immaturity of the Chinese NEV market. Hence, this study aims to investigate the importance of proliferating NEVs more effectively and quickly in the Chinese automotive market, while also actively satisfying and improving early driver satisfaction with NEVs. The present study attempts to investigate the relationship between the factors that affect driving satisfaction among Generation Y drivers. Experienced usefulness, range and charging, safety and reliability are the factors that influence early driver satisfaction in driving NEVs.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Diffusion of Innovative

In the past literature, the concept of DOI has been widely used in the field of innovation acceptance behaviour, the theory defines innovation as an idea, object, or practice that is perceived by an individual, and diffusion is the process by which the innovation communicates the social system (Ali & Pua, 2017). The attributes (characteristics) that influence acceptance and innovation can be studied in five ways: relative advantage, compatibility, complexity, trialability, observable results. DOI diffusion and adoption in the population, which are divided into different situations by different adopters. Rogers (2014) revealed that DOI adopters can be subdivided into five major categories: innovators, early adopters, early majority, late majority, and laggards. Since NEV is an automotive product, its service targets are people i.e., adopters, and among the DOI theory's adopter categories, early adopters play an important role in diffusion because they have certain social prestige, economic status, and leadership, and their behavior is more likely to infect others in the community (Rogers, 2014). As early adopters of NEV-drivers, they are able to determine whether or not to diffuse NEVs in the automotive market by the overall perceived experience, quality, and level of satisfaction with the technology that NEVs give them. However, NEVs as innovative products are not popular in the automotive market today, and their penetration rate in the Chinese automotive market is only 5.4%. Therefore, this study will shed light on NEV penetration in the Chinese auto

market by increasing early driver satisfaction with driving NEVs based on the DOI theory.

Customer Satisfaction

Customer satisfaction is a subjective assessment that represents the relationship between customers' expectations and their actual perceptions of the items and services they receive (Oliver, 1993). User satisfaction is an emotional response, defined as "the assessment between what is received and what is expected" (Parker, 2001). According to Jedin and Balachandran (2021), consumers are freely giving their feedback on satisfaction when they have experienced services and compare the outcomes with their expectations.

Consumers appear to be crucial in the consumer market, especially for emerging products like NEVs. Early consumer (driver) satisfaction is a key determinant of the life cycle of a new product and a core element of corporate profitability (Huiming, 2020). The NEV industry should ensure that the quality of the products offered to meet the requirements of NEV drivers, here known as satisfaction, is a key indicator of the quality of NEVs and a major strategic variable in the alternative energy vehicle sector to build a strong impression in the minds of consumers (Cronin & Taylor, 1992). As the NEV industry becomes increasingly competitive, the survival of NEV companies depends on increasing early user (driver) satisfaction, and only when the early drivers are satisfied with the NEVs, they will be continuously spreading the word of mouth about the NEVs through positive communication (Reimann, 2010; Pansari & Kumar, 2017). This will continue to attract more customers to buy NEVs, thus changing the low sales of NEVs in the Chinese auto market.

Numerous academics have looked at the topic of customer satisfaction, including Mastoi et.al. (2019); Churchill et al., (1982) and most of them believe that satisfied customers will be more likely to promote the development of NEVs. Hence, a NEV customer experience can be expressed as experienced usefulness (Chen et al.,2017). Ma & Fen (2017) mentioned that technology has a large impact on the

proliferation of NEVs, and this paper reflects the product characteristics (technological factors) of NEVs in range and charging, safety and reliability (Schmalfuß et al., 2017; Haustein & Jensen, 2018; Abotalebi et al., 2019).

Experienced Usefulness

Experienced usefulness refers to whether a user finds a product to be useful when using it, or vice versa. Davis (1989) refers to experienced usefulness as the extent to which users feel that they can improve their outcomes when using a particular IT. Experienced usefulness is described as the belief of an individual that using a particular system will improve their performance (Van der Heijden, 2003). The concept of experienced usefulness evolved from being applied to individual assessments to organizational contextual assessments (Chen & Arpan, 2017).

The definition of Experienced usefulness is directly linked to the relative advantage property of DOI as proposed by Roger E.M. Singhal A. in 2014. In the relative advantage property proposed, Rogers suggested that if innovation is seen as a source of value, it will spread more quickly. When early drivers find NEVs useful in their daily lives, they also actively spread a lot about NEVs through word of mouth, thus increasing their satisfaction with innovations like NEVs (Hernandez et al., 2009). Additionally, Gofen (2003) found that the behavior of experienced usefulness was positively related to business behavior. Therefore, this paper proposes the hypothesis that:

H1+: There is a significant and positive relationship between experienced usefulness and satisfaction in driving NEVs.

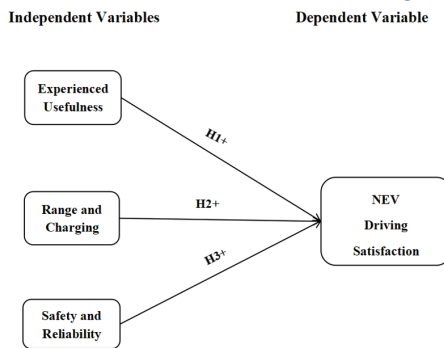


Figure 1. Conceptual Framework

Source: Authors

Range and Charging

Range and Charging is a specific property of NEVs. Range refers to the driving range or range of NEVs while charging refers to the power replenishment of NEVs, unlike conventional fuel vehicles, which take longer as they require electric power replenishment rather than gasoline refueling (Schmalfuß et al., 2017).

Consumers are generally dissatisfied with the range and charging performance of NEVs (Kester et al., 2018; Chen et al., 2020). The limited range and long charging time of NEVs have been consistently cited as the cause of low consumer satisfaction with NEVs, and the resulting diffusion of NEVs is then slower (Egbue & Samaranayake, 2017; Mruzek et al., 2017; Hausteijn & Jensen, 2018). The driving range and charging time of NEVs are greater than that of conventional fuel vehicles: NEVs can travel 400 km on a full charge with a good battery while charging time is half an hour at a fast-charging station, but conventional fuel cars can fill up and travel about 600 km in less than 4 minutes (Glerum et al., 2014). And when the range and charging of NEVs can meet the daily needs of early drivers, the satisfaction of early drivers with NEVs will be increased, which means the long driving range and short charging time of NEV can improve the early drivers' satisfaction with NEVs. Therefore, it is proposed that:

H2+: There is a significant and positive relationship between range and charging and satisfaction in driving NEVs.

Safety and Reliability

Safety and reliability are also among the properties of NEVs, and they are closely related (Kubie, 1985). They refer to the probability that adequate safety against hazards and the performance of its intended function under specified conditions will be ensured by the ability to limit risks to acceptable limits when using a product (Schneider, 2006).

In the field of economics and marketing, quality is often seen as the degree of dependence on product characteristics (Hauser & Shugan, 1983), and numerous empirical researches have revealed that product quality has a positive impact on consumer satisfaction (Cretu & Brodie, 2007;

Askariazad & Babakhani, 2015). The market growth rate of NEVs depends on the product characteristics (technological factors) of NEVs: safety and reliability, which play an important role in driving the diffusion of NEVs (Zhang et al., 2012; Rezvanizani et al., 2014). NEVs as emerging products are still not mature enough in terms of technology, and some technological failures occur from time to time, especially the failures of electrical components and batteries in trams, which account for 54% of tram failures (Suciu, 2017). The failures, consequently, can lead to low satisfaction of early drivers with the presence of NEVs. Therefore, it is proposed that:

H3+: There is a significant and positive relationship between safety and reliability and satisfaction in driving NEVs.

RESEARCH METHODOLOGY

Survey Design

The study used survey methodology. Purposive sampling with non-probability sampling was applied as the study focused on NEV drivers in the city of Shenzhen, China. The questionnaire was distributed directly to the respondents who are NEV drivers. The items in the questionnaire were adapted from studies by Su et al. (2020), Schmalfuß et al. (2017) and Salazar et al. (2015). The questionnaire was divided into two parts: demographic profile and a section on the four variables (experienced usefulness; charging and range; safety and reliability; and NEV driving satisfaction). And the items in the variable section of the questionnaire were measured using a 7-point Likert scale (1 - strongly disagree, 7 - strongly agree).

Data Collection

The survey was conducted mainly at NEV after-sales service centers and some NEV charging stations. We approached the NEV drivers in person then requested them to participate in the study. Some NEV drivers were reluctant. However, as we focused on Generation Y NEV drivers, they were very cooperative and able to participate. We managed to collect responses from the young NEV drivers. NEV drivers were asked to answer the questionnaire directly using WeChat, QQ or other social networking

apps. NEV after-sales service centers and charging stations were chosen because they could be easily and quickly found to meet the requirements of the respondents of this study. After more than two months of research, 394 valid questionnaire responses were finally collected and subsequently analyzed using SPSS.

Data Analysis and Reliability Test

The measured values of all independent and dependent variables for this study are shown in Table 1, with mean responses ranging from 4.3223 to 5.3249 for all variables and SD values ranging from 1.35599 to 1.83558. Table 1 shows the result of Cronbach's Alpha values for all the variables are excellent (all are ≥ 0.81), and this indicates positive results, which means that the variables in this study are highly reliable.

Table 1. Descriptive Statistics and Reliability Results

Constructs	Measure	Mean	SD	Cronbach Alpha
Experienced Usefulness	New energy vehicle (NEV) improved my quality of life	5.2234	1.52698	0.907
	NEV improved efficiency of my travel activities	4.9543	1.58490	
	NEV gave me greater control over my energy saving	5.2284	1.53785	
Range and Charging	I have no problem with longer battery charging	4.6269	1.83558	0.923
	I have no problem with accumulating charging everyday	4.5584	1.75551	
	I am satisfied with the NEV mileage range	4.7360	1.69459	
	I have no problem with the limited mileage range of a NEV	4.5051	1.78094	
	My NEV range is sufficient for my mobility needs everyday	5.0635	1.60899	
Safety and Reliability	I feel safe in an NEV compared to conventional compact car	4.9391	1.55848	0.906
	I feel not safe driving a NEV	4.3223	1.77347	
	Safety procedures is given in my NEV	5.1294	1.44659	
	My NEV will take me safely to my destination	5.3249	1.45537	
	My NEV has new technology and reliable	5.1802	1.45694	
	My NEV is so reliable	5.1168	1.46774	

NEV Driving Satisfaction	I am satisfied with my NEV	5.2893	1.38238	0.931
	I am willing to use my NEV consistently	5.2437	1.35599	
	I am willing to positively recommend my NEV to others	5.2234	1.44654	

n = 394 respondents; Seven points Likert scale were used, 1 = Strongly disagree and 7= Strongly agree.
Source: Authors

Table 2. Correlations and Discriminant Validity

Variables	1	2	3	4
NEV Driving Satisfaction	1.00			
Experienced Usefulness	0.556**	1.00		
Range and Charging	0.508**	0.506**	1.00	
Safety and Reliability	0.498**	0.572**	0.525**	1.00

**Correlation is significant at the 0.01 level (two-tailed).

Source: Authors

In addition, Table 2 demonstrates the correlation results between all the variables, from the data, the correlation coefficients between the variables are 0.556, 0.508, 0.498 and the p-values are less than 0.05, which indicates that all the variables are significant.

RESULTS AND FINDINGS

Table 3 demonstrates 394 respondents who participated: 52.8% were men (216 in total) and the rest were women. In terms of age, the majority of the respondents were at the range of 25-29, (54.8%). 394 (62.4%) of respondents had a bachelor's degree (majority). Furthermore, most of the respondents were employed (52.8%, 208), freelancers (18.0%), self-employed (15.2%), government officials (7.4%), students (4.1%), and others (2.5%). Finally, the respondents' monthly income was mainly concentrated between the RMB5001-10,000 range with 43.7% (172).

Table 3. Demographic Profile of Respondents

Characteristics of Respondents	Frequency	Percentage (%)
Gender		
Male	208	52.8
Female	186	47.2

Age Range		
25 – 29	216	54.8
30 – 34	125	31.7
35 – 39	53	13.5
Educational levels		
Bachelor Degree	246	62.4
Master Degree	52	13.2
PhD	19	4.8
Other	77	19.5
Occupation		
Company staff	208	52.8
Freelance	71	18.0
Self-employed	60	15.2
Government officer	29	7.4
Student	16	4.1
Other	10	2.5
Monthly Income		
RMB 3000 and below	19	4.8
RMB 3001-RMB 5000	130	33.0
RMB 5001 – RM10 000	172	43.7
RMB 10 001 above	73	18.5

N=394

Source: Authors

Analysis of Results

Linear regression is mainly used to measure the strength of the relationship between the dependent and independent variables. Table 4 shows a significant regression equation ($F(3,404.964) = 86.030, p < 0.000$) with an r^2 of 0.398. The results in table 4 are generally consistent with the hypotheses presented. All the variables significantly predicted NEV driving satisfaction.

Table 4. Multiple Linear Regression of NEV driving Satisfaction in NEV

Variables	Zero-Order R	Beta Coefficients	T-Value	Sig-Value
Experienced Usefulness	0.556	.328	6.536	.000**
Range and Charging	0.508	.247	5.117	.000**

Safety and Reliability	0.498	.181	3.565	.000**
df	3			
residual	404.964			
F	86.030			
r2	0.398			
adjusted r2	0.394			

Source: Authors

Discussion

The results of the study show that all three factors studied in this study (experienced usefulness; range and charging; safety and reliability) have positively influenced the satisfaction of early drivers driving NEVs in Shenzhen, China.

Experienced usefulness is the most significant factor influencing the satisfaction of early NEV drivers driving NEVs in Shenzhen, China. This finding is consistent with the findings of Su et al., (2020) who also confirmed that experienced usefulness has a positive and significant effect on the satisfaction of early NEV users, while Tandon et al., (2016) also found that experienced usefulness on customer satisfaction has a positive impact. In summary, when early drivers have higher experience of the usefulness of NEVs, their satisfaction with driving NEVs will also be at a higher level, and this also means that they will be more willing to continue using and encouraging others to buy NEVs.

Interestingly, range and charging also affect early driver satisfaction with driving NEVs. The results of a study by Su et al. (2020) and Kester et al. (2018) is similar to this result, which shows that range and charging is not a limitation in NEVs. Although most NEVs had their weaknesses in range and charging, this study shows users were satisfied with their NEVs. However, the findings of Kester et al., (2018) contradict with this result, where consumers have low satisfaction with the range and charging of NEVs. Therefore, in order to improve consumer satisfaction with NEVs, NEV suppliers and related departments should actively improve and refine the technical development of NEVs.

Safety and reliability factors also positively influenced early driver

satisfaction with driving NEVs. This finding is in line with the findings of Ni et al., (2020) who concluded that safety and reliability can directly affect user satisfaction. Meanwhile, Suciu (2017) suggested that NEV as an emerging product its technology is still not mature enough, and from time to time there are some technological failures which can lead to low satisfaction of early drivers with the existence of NEV. The comparison of the findings from previous studies are discussed in Table 5.

Table 5. Comparison of Findings from Previous Studies

Authors/Year	Title	Finding	Note of Comparison
Su et al., (2020)	Factors affecting user satisfaction with new energy vehicles: A field survey in Shanghai and Nanjing	experiences related to usefulness, experience of ease-of-use, total cost, driving range, and infrastructure readiness are important factors that influence user satisfaction with NEVs. PEA might strengthen the positive effects of experienced usefulness, experienced ease-of-use, driving range, and infrastructure readiness in terms of user satisfaction with NEVs. PEA in the relationship between total cost and user satisfaction is not statistically significant.	The present study had consistent findings with Su et al. (2020).
Schmalfuß et al., (2017)	Direct Experience with Battery Electric Vehicles (BEVs) Matters When Evaluating Vehicle Attributes, Attitude and Purchase Intention	practical (and also short-term) experience with BEVs has the potential to change the evaluation of BEVs and psychological factors relevant for determining behavioral intention. As many effects were positive, providing short-term BEV experience to enhance acceptance has the potential to change BEV evaluation as well as the satisfaction with such a vehicle and might be a promising strategy for promoting BEVs.	Both present study and study conducted by Schmalfuß et al., (2017) had a positive influence on the relationship between usefulness and driver satisfaction.

<p>Ni et al., (2020)</p>	<p>Influence mechanism of the corporate image on passenger satisfaction with public transport in China</p>	<p>corporate image promotes perceived quality and value directly, while it does not significantly affect the satisfaction directly. The safety, convenience, reliability, comfort, economy, and rapidity, which are described as the characteristics of perceived quality, significantly affect the perceived value and passenger satisfaction directly. The perceived value affects passenger satisfaction with PT positively.</p>	<p>There is a positive relationship between safety and reliability and driver driving satisfaction, which proves to be consistent with the findings of Ni et al.</p>
<p>Egbue et al., (2017)</p>	<p>Mass deployment of sustainable transportation: Evaluation of factors that influence electric vehicle adoption</p>	<p>willingness to pay for new appealing technology, distance driven, perceptions of electric vehicles as good for the environment, perception of EV speed are statistically significant in influencing willingness to purchase an electric vehicle.</p>	<p>Both present study and Egbue's study demonstrated that range and charging have a favourable impact on customer satisfaction.</p>

Source: Authors

CONCLUSION AND MANAGERIAL IMPLICATIONS

The results show that experienced usefulness, range and charging, safety and reliability all positively influence early drivers' satisfaction with driving NEVs. Therefore, the local government (Shenzhen) and related authorities, as well as NEV manufacturers, should actively build vehicles that meet early driver satisfaction to increase the low share of NEVs in the Chinese automotive market and alleviate the country's ever increasing environmental problems and energy crises. It is believed that the high demand and continuous developments of the NEV industry as new vehicle trends and advanced technology could increase their demands in the coming year 2025 and onwards. This is also an alternative to petrol as the main source of energy which is getting reduced year by year.

In addition, the local government (Shenzhen) and related departments should actively promote and proliferate the development of NEVs, as it is

not only in line with the 19th National Congress of the Communist Party of China report (which states that the development of NEVs is a priority for the Chinese government), but also to improve the satisfaction of drivers with NEVs to a certain extent, and thus improve the low share of NEVs in the Chinese auto market. Local governments and relevant authorities should actively introduce policies to change the status quo of NEVs, such as by encouraging research and development of core technologies and actively improving public infrastructure for NEVs. In addition, this study is hoped to assist the Chinese government to further understand the perception of NEVs in China, and determine how and where to improve, or enhance services to help NEVs attract more customers. In the perspective of manufacturers, NEV manufacturers should actively develop core battery technologies to improve NEV driving range and reduce charging time to alleviate drivers' fears of range disruption.

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AUTHOR CONTRIBUTIONS

The study's design, questionnaire survey, and writing were all contributed by all of the authors; Mohd Haniff Jedin was in charge of the questionnaire design, data cleaning, and overall study framework, while Li Jialin conducted the interviews, data survey, and other tasks. After that, the two collaborated to edit the study and polish the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
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Tuan,

PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK MELALUI REPOSITORI INSTITUSI UiTM (IR)

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

Setuju.

27.1.2023

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

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