ADOPTION OF ELECTRIC MOTORCYCLES BY UNIVERSITY STUDENTS: A TAM PERSPECTIVE

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Abstract - To reduce air pollution, more Asian consumers are adopting electric motor vehicles, so this research chose to study the factors affecting the acceptance of electric motorcycles. This study uses the technology acceptance model (TAM) to explore the attitude and intention of university students towards electric motorcycles. Using questionnaire responses from 272 participants in Taiwan, the results find that the proposed model predicts 61% of the variance in adoption intention. The results show that students are more likely to consider an electric vehicle if the students perceive the vehicles to be useful and easy to use and if the students have a positive attitude towards electric vehicles. In addition, this study finds that the gender of the student significantly affects their attitudes but not their intention to use electric motorcycles. This research uses empirical analysis to illustrate the factors that affect purchase intention and provide information to government officials and practitioners to guide efforts towards increased adoption of electric motorcycles.

Keywords -Technology Acceptance Model(TAM); Electric motorcycle; University student; Adoption

I. INTRODUCTION

The popularity of the motorcycle in Asian countries is widespread. Taiwan has the highest user density in Asia with 378 motorcycles per square kilometer (Chen, Chen, Chen, & Hsieh, 2012). According to Taiwanese regulations, people may start applying for a motorcycle license test once they reach 18 years of age. Therefore, many students who graduate from high school will be able to use motorcycles for transport when they start college.According to the Environmental Protection Agency (EPA), vehicle emissions are responsible for one-third of air pollution.

Therefore, Taiwan will implement regulations for motorcycle emissions in 2020 (Taiwan Environmental Information Center, 2018). To help reduce air pollution, the government has recently decided to promote electric motorcycles to replace traditional gasoline-powered motorcycles. Although consumers are aware of the environmental issues and that their behavior impacts the environment when choosing products (Kucher et al., 2019), few consumers have adopted the electric motorcycle. Previous research pointed out that, although the consumers are willing to pay more for green energy (Marketing Charts, 2017; Miremadi et al., 2012), the market share of green energy products and services is still growing slowly (Gan et al., 2007). The technology acceptance model (TAM) was first proposed by Davis (1989) and was quickly verified and applied by industry and academia to a large amount of related research (Davis, 1989; Davis et al., 1989). Researchers have applied the model to study consumer adoption of new technologies or new products and to explore the factors affecting behavior and intention (Agarwal & Karahanna, 2000; Henderson & Divett, 2003; Paetz et al., 2012; van der Heijden et al., 2003). The TAM can effectively predict and explain whether a particular information system is acceptable by users and is therefore used as a tool for developing user-specific IT acceptance strategies.

Because university students are potential new users of motorcycles and have a high willingness to accept new technology (Chen et al., 2012), their attitudes and intentions towards electric vehicles are likely to affect their future behavior. Since green transportation is a relatively new issue for consumers (Schniederjans & Starkey, 2014), few researchers have focused on the acceptance of electric motorcycles from the perspective of university students. In this study, this study use the TAM to explore intention and other factors that influence university students when they decide whether to use electric motorcycles. The findings could provide enterprises and the government with data to improve their strategies toward acceptance and utilization.

This study divide into several parts. First, to review the literature and propose the research hypotheses. Next, to describe the research method. The final sections contain the research results followed by conclusions and suggestions.

II. LITERATURE REVIEW

Davis (1989) proposed the technology acceptance model (TAM) that he based on the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975) and mainly used to predict behavior based on information technology acceptance factors. The TAM provides a

theoretical basis for understanding how external factors affect a user's beliefs, attitudes, and intentions, which in turn affects their adoption of technology (Davis, 1989). To improve the predictive power of the technology acceptance model, scholars have suggested additional variables like human and social change factors (Legris et al., 2003).

Personal beliefs in the TAM include both perceived ease of use and perceived usefulness. Davis (1989) emphasized that perceived usefulness and perceived ease of use are the main factors that directly affect user attitude and intention towards information technology (IT).

Perceived ease of use is the degree to which a user is subjectively convinced that the product is easy to use. Since users that believe that the device is easy to operate will more readily accept the device (Davis et al., 1989), the perceived ease of use enhances the perceived usefulness of a product (Benbasat & Dexter, 1986; Venkatesh & Davis, 1996).

Perceived usefulness is the degree to which a user expects their job performance to improve once they start using a particular piece of information technology (Venkatesh & Davis, 2000). Higher levels of perceived usefulness increase the willingness of users to adopt the system. A study of electric vehicle purchase intention in Taiwan confirmed that perceived usefulness is an essential predictor of purchasing decisions (Wu et al., 2015).

Attitude is the individual's positive or negative feeling toward a product (Davis et al., 1989; Lau & Woods, 2008), so positive attitudes will raise purchase intention (Fishbein & Ajzen (1975). When a consumer evaluates a product positively, the consumer will plan to use the product and may end up purchasing it (Ajzen & Fishben, 1980). Chen et al. (2012) found that consumer attitudes significantly affect purchase intention of hydrogen-electric motor vehicles. Customer attitudes are more influential than knowledge when predicting behaviors that benefit a sustainable environment (Michalos et al., 2012).

Intention is the likelihood that a consumer will choose a particular behavior (Fishbein & Ajzen, 1975). Purchase behavior occurs when consumers evaluate product information and consider a product to be valuable; users tend to use systems when they believe that using the system will improve their performance in the future (Ong et al., 2004). In recent years, consumer attitudes have shifted towards greater intention to use green transportation (Schniederjans & Starkey, 2014).

The future development of green energy still requires marketing to improve consumer perception (Truffer et al., 2001). Consumer purchases of green energy products may be affected by psychological factors (Wu et al., 2015) since consumer attention towards the environment affects their actions. Research of the hotel industry found that women are more aware of green consumption than men and women are more likely to consume in environmentally-friendly ways (Huang et al., 2014). Conversely, Mostafa (2007) indicates that men are more concerned about environmental issues than women and are more likely to buy green products. Past studies of university student attitude towards energy issues have focused on energy conservation (Senbel et al., 2014). Although green transportation can reduce fuel emissions and benefit human health (Yang & Chang, 2013), previous research does not indicate what factors lead university students to buy or use electric vehicles.

This study uses TAM as a theoretical framework to explorethe relationship between beliefs, attitudes, and intentions. The study proposes the following research frameworks (Figure1) and assumptions to explore factors that influence university students' attitude and intention to use electric motorcycle:

H1: University students' perceived ease of use has a positive impact on perceived usefulness of the electric motorcycle.

H2: University students' perceived usefulness has a positive impact on attitude toward use electric motorcycle.

H3: University students' perceived ease of use has a positive impact on attitude toward use electric motorcycle.

H4: University students' attitude toward use the electric motorcycle has a positive impact on intention of use.

The research framework is shown in Fig. 1. The control variables include gender, disposable income and commute vehicle.

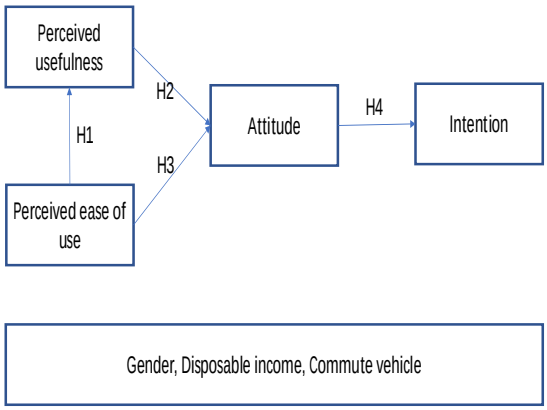


Figure1 Research Framework

III. METHODOLOGY

A. Research sample

This research collected data using an online questionnaire that targeted university students. The study retrieved a total of 277 samples, and after eliminating questionnaires with incomplete answers, there were left with 272 valid questionnaires. The study includes the sample structure as Table 1. 52.2%

of the respondents are males while 47.8% are females and 52.8% of the students use a motorcycle as their primary means of transport and 21% use public transportation.

Demographic characteristics		Number	Percentage
Gender	Male	142	52.2%
	Female	130	47.8%
Monthly disposable income	< NTD$ 5000	176	64.7%
	NTD$ 5,001~10,000	81	29.8%
	NTD$ 10,001~15,000	10	3.7%
	>NTD$ 15,001~	5	1.8%
commuting vehicle	Public transportation	57	21.0
	walk	60	22.1
	car	4	1.5
	e motorcycle	7	2.6
	motorcycle	144	52.8

Table 1 Respondents' demographic information

B. Measurements

The research structured questionnaire measured the main research variables using a 5-point Likert scale ranging from 'strongly disagree' to 'strongly agree', based on research by Davis (1989). Davis, Baggozi & Warshaw (1989) further pointed out that, in addition to attitude, there are other external variables that affect user behavior, such as user characteristics (including cognitive and personality), and task traits. These variables may also influence attitudes or behavioral intentions and could be added to the technology acceptance model (Davis, Baggozi & Warshaw, 1989). Since previous research indicated that gender affects green consumption behavior (Hwang, 2010), consumers are willing to pay higher prices for green commodities (Jang et al., 2011), and commute vehicle affect barriers to adoption like performance and safety (Byrne & Polonsky, 2001), this study incorporate control variables of gender, disposable income, and commuting vehicles.

IV. DATA ANALYSIS AND RESULTS

C. Descriptive analysis

The study use statistical analysis with SPSS 24 to analyze the mean, standard deviation, and correlation of each construct. As shown in Table 2, the mean attitude toward use is 3.636 with a standard deviation of 0.991 and the mean intention to use is 3.275 with a standard deviation of 0.875. The results see a significant correlation between gender and perceived ease of use, attitude toward use ($p<0.01$). The results do not find a significant correlation between gender and perceived usefulness and intention of use.

Attitude toward use and Perceived usefulness ($r=0.500$, $p<0.01$) and perceived ease of use ($r=0.167$, $p<0.01$) are significantly positively correlated, as are attitude toward use and intention of use ($r=0.633$, $p<0.01$). The results are similar to previous research that also applied technology acceptance models (Md Gapar & Awalluddin, 2011; Juarez Collazo, Wu, Elen, & Clarebout, 2014).

Furthermore, this research find that attitude toward use is positively correlated with respondent's age and significantly negatively correlated with use of a commuter vehicle ($r=-0.135$, $p<0.05$), while there is no significant correlation between intention to use and age of the commute vehicle. Monthly disposable income is significantly negatively correlated with gender ($r=-0.129$, $p<0.05$). Next, this study performs a statistical test for each hypothesis.

	Descriptive statistics		Correlation analysis						
	Mean	S. D.	A1	A2	A3	A4	B1	B2	B3
A1 perceived usefulness	2.765	1.020	1						
A2 Perceived ease of use	4.085	0.873	0.185**	1					
A3Attitude toward use	3.636	0.991	0.500**	0.167**	1				
A4 Intention of use	3.275	0.875	0.653**	0.373**	0.633**	1			
B1 Gender	1.48	0.50	0.092	-0.273**	0.203**	0.076	1		
B2 Commute vehicle	3.445	1.736	-0.161**	0.197**	-0.135*	-0.096	-0.292**	1	
B3 Disposable income	1.4265	0.655	-0.041	0.029	-0.046	0.030	-0.129*	0.047	1

Table 2 Descriptive statistics and correlation analysis

D. Confirmatory factor analysis

This study check the adequacy of the data through factor analysis and reliability analysis. The KMO value is 0.906 in the factor analysis and the factor loading of each item is over 0.5. These values indicate that all observed variables reflect the construct and that the research scale has convergence validity (Bentler, 2006). In the composition reliability (CR), the reliability of each construct is between 0.81 and 0.93, indicating good reliability. The average variation extraction (AVE) is over 0.51. Bagozzi & Yi (1988) and Fornell & Larcker (1981) suggested that, if the AVE of a latent variable exceeds 0.50, the error contribution of the latent variable is more than the observed variable. These results summarize in Table 3.

	Factor loading	Reliability	Eigen value	SMC	AVE	CR	Cronbach's alpha
Perceived easy to use							
Easy1	0.914	0.835	2.470	0.165	0.823	0.933	0.915
Easy2	0.944	0.891		0.109			
Easy3	0.862	0.743		0.257			
Perceived useful							
Useful1	0.846	0.716	2.221	0.284	0.740	0.895	0.929
Useful2	0.868	0.753		0.247			
Useful3	0.867	0.752		0.248			
Attitude							
ATT1	0.885	0.783	2.292	0.217	0.764	0.907	0.937
ATT2	0.850	0.723		0.278			
ATT3	0.887	0.787		0.213			
Intention							
INT1	0.648	0.420	3.608	0.580	0.515	0.881	0.929
INT2	0.643	0.413		0.587			
INT3	0.714	0.510		0.490			
INT4	0.848	0.719		0.281			
INT5	0.785	0.616		0.384			
INT6	0.712	0.507		0.493			
INT7	0.650	0.423		0.578			

Table 3 Factor loading, Eigen Value and CR

E. Hypotheses testing

Before testing the research hypothesis, this research use the mean-centering approach from Aiken & West (1991) to solve the problem of collinearity and perform hypothesis testing. This research chooses hierarchical regression analysis (Table 4) to explore the relationships between perceived usefulness, perceived ease of use and attitude towards use, as well as how perceived usefulness, perceived ease of use, and attitude toward use relate to intention to use. First, Model 1 uses perceived usefulness as a dependent variable; after including the control variable, only the commute vehicle control variable reaches statistical significance (β=-0.146; t=-2.326; p<0.05). When this study adds perceived ease of use in Model 2, obtaining a significant result (R^2=0.086; F value=6.242; p<0.001) and both the commuting vehicle (β= -0.178; t=-2.891; p<0.01) and perceived ease of use (β=0.249; t=4.063; p<0.01) variables reach significant level. This demonstrates that perceived usefulness is significantly affected by perceived ease of use, which proves Hypothesis 1. Model 3 uses control variables with attitude toward use as the dependent variable and shows that the model is significant (R^2=0.048; F value=4.495; p<0.001) and gender is significant (β=0.177; t=2.813; p<0.01). In Model 4, this study includes independent variables to probe the effect of perceived ease of use (β=0.255; t=4.210; p<0.01) on attitude and see a significant correlation (R^2=0.107; F value=8.013; p<0.01). In Model 5, this research probes the effect of attitude toward use on perceived usefulness and also see significant correlation (R^2=0.275; F value=25.277; p<0.01); gender (β=0.154; t=2.811; p<0.01) and perceived usefulness (β=0.483; t=9.136; p<0.01) similarly achieve significance. These results show that, for university students, perceived ease of use and perceived usefulness have a positive and significant impact on their attitude towards using the electric motorcycle, which supports Hypotheses 2 and 3. Model 7 shows the effect of the control variables on attitude (R^2=0.013; F value=1.214; p=0.350). Model 8 includes perceived ease of use, perceived usefulness and attitude with significant correlation (R^2=0.608; F value=68.384; p<0.001). These results show that attitudes towards using a motorcycle have a significant impact on intention to use, which supports Hypothesis 4.

	Perceived usefulness		Attitude towards use				Intention to use	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	β	β	β	β	β	β	β	β
Control variable								
Gender	0.046	0.105	0.177**	0.237**	0.154**	0.190**	0.058	0.029
vehicle	-0.146*	-0.178**	-0.082	-0.115	-0.012	-0.035	-0.081	-0.020
Disposable income	-0.029	-0.027	-0.019	-0.018	-0.006	-0.006	0.042	0.063
Independent variable								
Perceived ease of use		0.249**		0.255**		0.143*		0.243**
Perceived usefulness					0.483**	0.450**		0.415**
Attitude towards use								0.379**
R^2	0.029	0.086	0.048	0.094	0.275	0.292	0.013	0.608
Adjusted R^2	0.018	0.072	0.037	0.107	0.264	0.279	0.002	0.599
ΔR^2	0.029	0.057	0.048	0.059	0.227	0.185	0.013	0.102
F	2.667*	6.242**	4.495**	8.013**	25.277**	21.964**	1.214	68.384**
F change	2.667*	16.505**	4.495**	17.725**	83.473**	69.542**	1.214	68.660**
df	(3,268)	(4,267)	(3,268)	(4,267)	(4,267)	(5,266)	(3,268)	(6,265)

Table 4 Regression analysis

Note: "*" p<0.05(two-tailed test for the hypotheses). "**" p<0.01(two-tailed test for the hypotheses). β=standardized path coefficients. N=272

F. Differences in the backgrounds of the respondents

To investigate how the gender differences of the student respondents affected their attitude toward and intention to use electric motorcycles, this research conducted an independent sample t-test. The mean of intention to use was 3.212 for men and 3.345 for women, which shows no significant difference between the genders (t=-1251; p=0.212). Regarding attitude, the results found a significant difference between men and women (t=-3.410; p<0.01) with women having a more positive attitude (Table 5).

Dependent variables	Gender	N	Mean	S.D.	T value	P-value
Intention	Male	142	3.212	0.979	-1.251	0.212
	Female	130	3.345	0.743		
Attitude	Male	142	3.443	1.114	-3.410	0.000
	Female	130	3.846	0.787		

Table 5 t –test for gender differences of university students

V. CONCLUSIONS AND SUGGESTIONS

This research use the technology acceptance model to explore the intention of university students to use electric motor vehicles. The study targeted university students because of their quick acceptance of new technologies (Evanschitzky & Wunderlich, 2006) and the likelihood that they will become important future consumers. The research model explains 61% of the effects, showing that the TAM can be used to predict the intention of university students to use electric motorcycles.

According to the TAM results, university students have a positive attitude towards electric motorcycles and consider those vehicles easy to use and useful. University students have a somewhat positive belief that electric motorcycles are easy to use and practical to operate, so they have a higher intention to use electric motor cars.

However, the main influencing factor on student attitude is the perceived usefulness, which means that many students who believe that motorcycles are useful will have a more positive attitude towards using an

electric motorcycle. Therefore, marketing of the electric motorcycle should target the impression and experience of usefulness.

This research finds a significant gender difference in attitudes toward using electric motorcycles but no significant gender difference in the intention or willingness to use electric motorcycles. Therefore, to influence intention to use, research should explore other possible factors in the future.

Perceived ease of use, perceived usefulness, and attitude each have significant explanatory power for the intentions of university students to use electric motor vehicles; perceived usefulness is the most important factor. Therefore, enterprises need to use marketing to demonstrate usefulness to students.

This research mainly investigated university students in this study, so it is impossible to generalize the results to other groups of people. Future studies could consider different social and ethnic groups, as well as other essential variables like the impact of social interactions and environmental factors.

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