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Adding Innovation Diffusion Theory to Technology Acceptance Model: Understanding Consumers' Intention to Use Biofuels in Viet Nam

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Abstract

Biofuels are drawing increasing attention on worldwide as substitutes for fossil fuels to help address energy cost, energy security and global warming. Vietnam is an agricultural country and high rates of economic growth last decade led to growing energy demands. When the fossil fuel is becoming exhausted, petroleum price is continuously increasing; finding new power resource, renewable power, to replace fossil fuels is an essential solution. This study aims to investigate factors affecting consumers' adoption and intention to use biofuels. Combining the Innovation Diffusion Theory with the Technology Acceptance Model (TAM), the present study proposed an extended technology acceptance model. The proposed model was tested with data collected from 302 consumers using biofuels in Vietnam. The structural equation modeling (SEM) technique was employed with the Amos program to explain the acceptance process. We explored the relationships between five innovative characteristics and the perceived usefulness (PU), perceived ease of use (PEU), as well as between PU, PEU, attitude and intention to use biofuels. Overall, the research model and the hypotheses were confirmed. PU is positively affected by relative advantage, compatibility and complexity. On the other hand, observatability and trialability have significant relationships with PEU. The results also show that the TAM holds true for biofuels in Vietnam. We showed that PU, PEOU have positive relationship with attitude of biofuel, whereas attitude significantly influenced intention to use it. The authors suggested that there was potential for application and development of biofuels in Vietnam. Thus, it was necessary that the government should help consumers confirm or increase their perception positively through biofuels.

Key Words: *Biofuels, Technology Acceptance Model (TAM), Innovation Diffusion Theory (IDT), Structural Equation Modeling (SEM).*

Introduction

Energy is one of the most important sectors in the economy of the country and the dynamics of the process for national development. Biofuels are drawing increasing attention on worldwide as substitutes for petroleum-derived transportation fuels to help address energy cost, energy security and global warming concerns associated with liquid fossil fuels. The term "biofuels" is used here to mean any liquid fuel made from plant material that can be used as a substitute for petroleum-derived fuel. Biofuels can include relatively familiar ones, such as ethanol made from sugar cane or diesel-like fuel made from soybean oil, to less familiar fuels such as dimethyl ether or Fischer-Tropsch liquids made from lignocellulose biomass (Larson, 2007). Biofuels can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles. Stimulating biofuels use is an important candidate policy option for increasing the sustainability of the transport system. Both public support and public opposition may influence the implementation of biofuels stations. According to Worldwatch Institute (2011), worldwide biofuels production reached 105 billion liters (28 billion gallons US), up 17% from 2009, and biofuels provided 2.7% of the world's fuels for road transport. Global ethanol fuel production reached 86 billion liters (23 billion gallons US) in 2010, with the United States and Brazil as the world's top producers, accounting together for 90% of global production. The world's largest biodiesel producer is the European Union, accounting for 53% of all biodiesel production in 2010 (Koltuniewicz, 2014). The mandates for blending biofuels exist in 31 countries at the national level and in 29 states or provinces (REN21, 2011). The International Energy Agency has a goal for biofuels to meet more than a quarter of world demand for transportation fuels by 2050 to reduce dependence on petroleum and coal (Shimasaki, 2014). The production of biofuels also led into a flourishing automotive industry, where by 2010, 79% of all cars produced in Brazil were made with a hybrid fuel system of bio-ethanol and gasoline (Hall, et al., 2014).

Biofuels in Vietnam

Higher rates of economic growth in Vietnam led to growing energy demands. Annual energy demand has expected to increase approximately 12.1% from 2010 to 2020 in combination with the fossil source situation has been exhausted yearly (Nguyen, et al, 2013). Vietnam is an agricultural country and annually has to import a huge capacity of oil products to satisfy the domestic demand. When the fossil fuel is becoming exhausted, petroleum price is continuously increasing; doing research in finding new power resource, renewable power, to replace fossil fuels is an essential solution.

With economic growth as the sweeping social, in the development process, Vietnam has been considering energy security at top priority. With the limitation in exploitation and use of new fossil energy, renewable energy sources are considered as an important alternative, with exploitable renewable energy resources. The Vietnam National program for development biofuels is up to 2015, with a vision to 2025 (Decision No.177/2007/QD-TTg of the Prime Minister dated 20 November, 2007). The Government has affirmed the policy of renewable energy as the key task during the industrialization and modernization of the country. It strives to increase the share of renewable energy in total commercial primary energy from 3% in 2010 to 5% in 2020 and 11% in 2050. The government decides to produce biofuel to replace 5% of total demand for petroleum- through blending to attain E5 and B5 starting 2010 up to 2025 (AFD Hanoi, 2012).

After surging between 2004 and 2008, the invention of biofuel technologies was slow considerably, and in many countries went into decline. Global trends point to an uncertain future, in particular, for advanced biofuels (Albers, Berklund & Graff, 2016). Many studies have discussed the benefits of biofuels in Vietnam (Nguyen, 2008; Nguyen, 2009). Although price of biofuels is lower than gasoline for VND500 per liter at the same time, the trading volume only reached about 4.200m3 after 5 months, very low compared to potential demand in Vietnam (Nguyen, 2008). Researches predicting the behaviors and factors affecting the behavior of consumers towards biofuels are essential. Current research on biofuels behavior and adoption, however, is limited.

Compared with traditional products, biofuels is an invention that has derived from different resources, produced in new technique. Suppliers should understand what factors effect on consumers' adoption process as well as what channels facilitate biofuels communicate with consumers. We used Innovation

Diffusion Theory (IDT) to interpret the effect of control variables on the awareness and acceptance of biofuels. In addition, biofuels are used through a system of internal combustion engines of vehicles. With different components and features from gasoline, biofuels are used for engines by completely new technique. It is likely to cause dissimilar attitudes and behaviors of consumers. To further clarify and predict the acceptance of a new technological innovation, we used Technology Acceptance Model (TAM).

For those reasons, this study contributed to the Technology Acceptance Model literature by examining the relationships between the Innovation Diffusion Theory and TAM variables in the same model. We proposed to examine the effects of motivational determinants on TAM constructs using IDT as a background theory. Thus, we employed five factors: relative advantage, compatibility, complexity, trialability and observability as determinants of perceived usefulness and perceived ease of use. This empirical study could be useful for developing and testing theories related to biofuels acceptance, as well as to buyers for understanding strategies for designing and promoting biofuels.

Literature Review

Technology Acceptance Model

One of the well-known models related to technology acceptance and use is the Technology Acceptance Model, originally proposed by Davis in 1985. Based on theories in social psychology, such as the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975) and the Theory of Planned Behavior (TPB) (Ajzen, 1985), TAM has been validated as a powerful and parsimonious framework (Davis, 1989; Davis et al., 1989). TAM has proven to be a theoretical model in helping to explain and predict user behavior of technology (Legris, Ingham, & Collerette, 2003). Davis (1989), Davis et al. (1989) proposed TAM to explain why a user accepts or rejects technology by adapting TRA. According to Davis (1985), a "potential user's overall attitude toward using a given system is hypothesized to be a major determinant of whether or not he actually uses it. Attitude toward using, in turn, is a function of two major beliefs: perceived usefulness and perceived ease of use". TAM provides a basis with which one traces how external variables influence belief, attitude, and intention to use. Two cognitive beliefs are posited by TAM: perceived usefulness (PU) and perceived ease of use (PEU). According to TAM, one's actual use of a technology system is influenced directly or indirectly by the user's behavioral intentions (IN), attitude (AT), perceived usefulness of the system, and perceived ease of the system. TAM also proposes that external factors affect intention and actual use through mediated effects on perceived usefulness and perceived ease of us.

According to Davis (1985), perceived usefulness indicates the extent to which individuals believe the use of particular systems would improve their performance, whereas the factor perceived ease of use indicates to which extent individuals believe the use of particular systems would exclude physical or mental effort. Due to these attributes, the Technology Acceptance Model is a commonly accepted model in order to explain as well as to predict individuals' attitude towards technological innovations. For these reasons, the Technology Acceptance Model was considered to be suitable for this research topic.

Innovation Diffusion Theory

Research on the diffusion of innovation has been widely applied in disciplines such as education, sociology, communication, agriculture, marketing, and information technology, etc (Rogers, 1995; Karahanna, et al., 1999; Agarwal, Sambamurthy, & Stair, 2000). An innovation is "an idea, practice, or object that is perceived as new by an individual or another unit of adoption" (Rogers, 1995). Diffusion, on the other hand, is "the process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1995). Therefore, the IDT theory was argued that "potential users make decisions to adopt or reject an innovation based on beliefs that they form about the innovation" (Agarwal, 2000).

Innovation Diffusion Theory includes five significant innovation characteristics: relative advantage (ADV), compatibility (CPA), complexity (CPL), and trialability (TRI) and observability (OBS). Relative advantage is defined "The degree to which an innovation is perceived as better than the idea it supersedes. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be (Rogers, 2003)." This construct is found to be one of the best predictors of the adoption of an innovation. Compatibility is "The degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An idea is incompatible with the values and norms of a social system will not be adopted as rapidly." (Rogers, 2003). Complexity is defined "The degree to which an innovation is perceived as difficult to understand and use. New ideas that are simple to understand are adopted more rapidly than innovations required new skills and understandings." (Rogers, 2003). Trialability is "The degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on an installment plan will generally be adopted more quickly than innovations that are not divisible." (Rogers, 2003). Observability is defined "The degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt." (Rogers, 2003).

Theoretically, the diffusion of an innovation perspective does not have any explicit relation with the TAM, but both share some key constructs (Lee, Hsieh, & Hsu, 2011). It was found that the relative advantage construct in IDT is similar to the notion of the PU in TAM, and the complexity construct in IDT captures the PEU in the technology acceptance model, although the sign is the opposite (Moore & Benbasat, 1991). Additionally, in terms of the complexity construct, TAM and IDT propose that the formation of users' intention is partially determined by how difficult the innovation is to understand or use (Davis, et al., 1989; Rogers, 1995). In other words, the less complex something is to use, the more likely an individual is to accept it. Compatibility is associated with the fit of a technology with prior experiences, while the ability to try and observe are associated with the availability of opportunities for relevant experiences. These constructs relate to prior technology experience or opportunities for experiencing the technology under consideration. Compatibility, and the ability to try and observe can be treated as external variables, which directly affect the constructs in the technology acceptance model. After the initial adoption, the effects of these three constructs could be diminished with continuous experience and reduced over time (Karahanna et al., 1999).

Research Model and Hypotheses

We propose an integrated theoretical framework, which blends TAM and IDT theories. The research model holds that the five innovative characteristics (compatibility, complexity, relative advantage, ability to try and observe) exert an important effect on the consumers' PU and PEU of biofuels. We thus tested the validity and applicability of the proposed model based on the following hypotheses. Figure 1 shows this study's model and hypotheses.

Relative advantage

In TAM and IDT research, the relationships among relative advantages, PU, and PEU are supported in study of Lee, Hsieh, and Hsu, 2011. They revealed that when the users perceived higher relative advantages, they perceived a higher level of usefulness and ease of use of the systems. Accordingly, we hypothesized:

H1a, b: The relative advantage has a direct positive effect on PU/PEU of biofuels.

Compatibility

Agarwal and Prasad (1999) asserted a positive relationship between an individual's prior compatible experiences and the new technology acceptance. They found that the extent of prior experience with similar technologies was positively associated with an ease of use belief about a technology innovation. Likewise, prior studies have investigated compatibility from different aspects, resulting in support for its impact on PU, PEU (Hardgrave et al., 2003). Based upon the preceding research, the following hypotheses were proposed:

H2a, b: Compatibility has direct a positive effect on PU/ PEU of biofuels.

Complexity

A relationship between complexity and PU was also revealed in a study conducted by Hardgrave, et al. (2003).There is less empirical evidence about relationship between complexity and PEU. We decide to test the effect of complexity on PU, PEU with hypotheses:

H3a, b: Complexity has a direct positive effect on PU/PEU of biofuels.

Trial ability

There are limited research has been conducted to investigate the relationship among trialability, PU and PEU. There was only one research reported that when the users perceived higher trialability, they perceived higher levels of usefulness, and ease of use of the system (Yang, 2007). Accordingly, we tested the following hypotheses:

H4a, b: Trialability has a direct positive effect on PU/PEU of biofuels.

Observability

With previous studies combining TAM and IDT, when the employees perceived the systems as being easier to be observed or described, they tended to perceive the systems more useful and easier to use (Huang, 2004; Yang, 2007). Therefore, we proposed that observability would have a positive effect on PU and PEU. The following hypotheses tested these assumptions:

H5a, b: Observability has a direct positive effect on perceived PU/PEU of biofuels.

Attitude of biofuels

TAM theorized that individual's PU and PEU have direct effect on their behavior. A relationship between PU/PEU and attitude was also revealed in previous studies (Park, 2009; Ashraf, Thongpapanl & Auh, 2014). Thus, we have hypotheses:

H6: PU will have a direct positive effect on the attitude of biofuels.
H7: PEU will have a direct positive effect on the attitude of biofuels.

Intention to use biofuels

Previous research has argued that attitudes can be strong or weak (Priester et al. 2004) and, therefore, can be either a strong or weak predictor of corresponding behavior. Park (2009) asserted a positive relationship between an attitude and intention to use a system. The following hypothesis tested this relationship:

H8: Attitude will have a direct positive effect on intention to use biofuels.

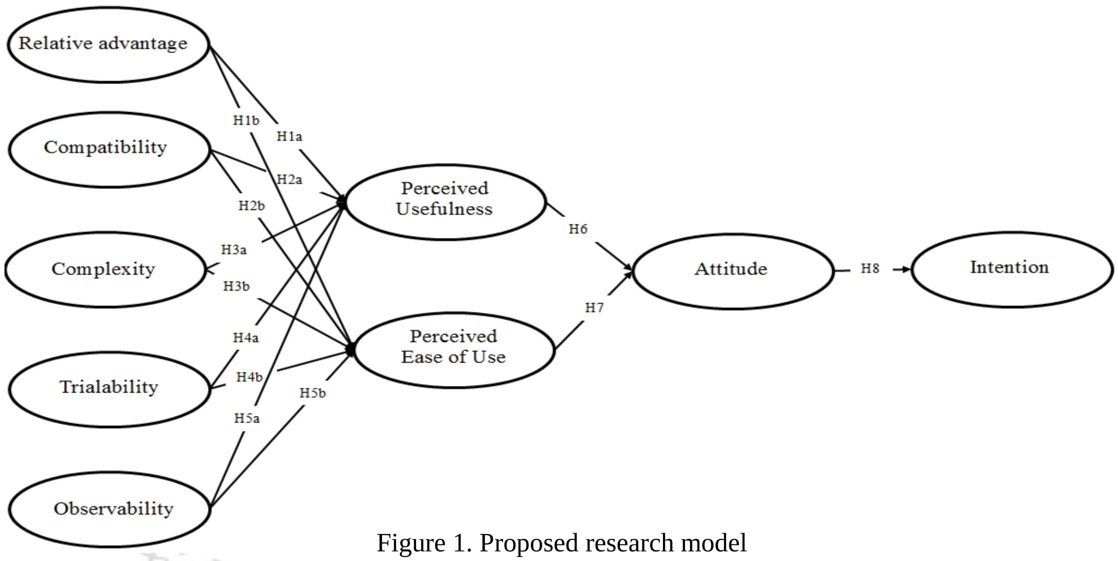

Figure 1. Proposed research model

Methodology

Survey Development

We used data drawn from a survey of consumers using biofuels in Vietnam. This study utilized a web-based and mailed survey to collect data for quantitative testing of the research model. Because of the lack of a reliable sampling frame, it proved difficult to conduct a random sampling for all the end users in the Vietnam.

All the variables used in this study are operationalized according to previously validated measurement scales. Five-point Likert-type scales (1 = "strongly disagree," and 5 = "strongly agree") were used to record participants' responses. We adapted measures for PU from Emsenhuber (2012) and for PEU from Park (2009), measures for attitude from Emsenhuber (2012), measures for intention to use from Park (2009) and Emsenhuber (2012). We also adapted measures for relative advantage from Al-Jabri and Sohail (2012), for compatibility, complexity, trialability and observability from Tran (2012).

We obtained a total of 310 responds from consumers in Vietnam. Of these, 8 responses were missing responses on two or more constructs. These questionnaires were removed, leaving 302 usable responses. Table 1 presents the respondents' profile.

Structural equation modeling (SEM)

SEM was performed to test the fit between the research model and the obtained data. This technique was chosen for its ability to simultaneously examine a series of dependence relationships, especially when there were direct and indirect effects among the constructs within the model (Hair, et al., 2006). The first step in interpreting SEM results includes reviewing fit indices, which provide evidence on how well the fit is between the data and the proposed structural model. If the model fits the data well enough, a second step involves reviewing the feasibility of each path in the model by examining whether the weights are statistically significant and practically significant. Practical significance is evaluated on the basis of whether the effect size estimation (the R^2) regarding a given path in the models is large enough (Lee, Hsieh, and Hsu, 2011).

In this study, we used Amos version 20.0 to do the Confirmation Factors Analysis and test Causal model. A similar set of fit indices was used to examine the structural model. We selected Amos for several reasons. First, Amos has a unique graphical interface, and is specifically designed to make fitting SEMs easier (Bacon, 1997). Second, in addition to provide statistical efficiency, Amos is also an appropriate method for addressing multiple relationships simultaneously (Bacon, 1997). Amos also can deal with missing data (McDonald and Ho, 2002).

Table 1. Respondents' demographic

	Frequency	Percentage
Gender		
Male	167	55.3
Female	135	44.7
Age (years)		
18 or below	3	1
18-25	117	38.7
26-35	74	24.5
36-45	63	20.9
45 or above	45	14.9
Education		
High school	20	6.6
Undergraduate	88	29.2
College/ Diploma	143	47.4
Master	39	13
PhD	12	3.8
Region		
Northern	100	33.2
Middle	101	33.4
Southern	101	33.4

Measurement Model

Confirmation Factor Analysis was used to test our factors. The results show that the chi-square $\chi 2/df = 2.64$ (<3) and significant, comparative fit index (CFI) = .88 (should be greater than .9), goodness-of-fit index (GFI) = .79 (should be greater than .9), root mean square error of approximation (RMSEA) = .07 (should be smaller than .05), standard root mean square residual (SRMR) = .07 (<.08). For this reason, these model fit indices are not good for measure model. Therefore, we decided to eliminate items which have modification indices upper than 20, such as ADV1, CPA3, CPA4, OBS2, PU1, PEU3, AT1, IN2.

After the elimination, we run Confirmation Factor Analysis again. As the results, the chi-square $\chi 2/df =$ 1.68 (<3) and significant, comparative fit index (CFI) = .96 (>.9), goodness-of-fit index (GFI) = .902 (>.9), root mean square error of approximation (RMSEA) = .04 (<.05), root mean square residual (SRMR) = .05 (<.08). To assess construct validity, we conducted convergent and discriminant analysis as recommended by Chin (1998) and Fornell and Larcker (1981). We assessed convergent validity using individual item reliability and construct reliability in Table 2.

Table 2. Convergent validity

	Cronbach's Alpha	Factor Loadings
Relative Advantage (ADV) (AVE = .69, CR = .87)	**.85**	
Extremely low switching cost is an advantage of using this product		.88
Environment profitability is an advantage of using this product.		.71
Using biofuels is better way to reduce greenhouse gases.		.89
Compatibility (CPA) (AVE = .69, CR = .90)	**.83**	
Biofuels is positioned as compatible the way I like to protect environment.		.91
Biofuels is positioned as compatible with user's needs.		.91
Complexity (CPL) (AVE = .83, CR = .91)	**.90**	
I have no difficulty to find biofuels on the market.		.83
I have no difficulty to know how to use biofuels.		.80
I have no difficulty to understand the information about biofuels.		.85
I have no difficulty to know how biofuels work with vehicle's engine.		.85
Trialability (TRI) (AVE = .61, CR = .86)	**.86**	
I want to be able to try out biofuels before deciding whether I like it or not.		.75
Being able to try out biofuels is important in my decision buying it.		.75
Being able to try out biofuels is important in my decision using it.		.74
I nearly will not lose anything by trying biofuel.		.85
Observability (OBS) (AVE = .50, CR = .76)	**.84**	
Other people seem to be interested in biofuels when I used it.		
I have no difficulty in telling others using biofuels.		
Perceived Usefulness (PU) (AVE = .61, CR = .86)	**.87**	
Using biofuels would be useful for me.		.75
Using biofuels would be convenient for me.		.82
Using biofuels would be advantageous for me.		.84
I will consider using biofuels as a way to protect environment.		.70
Perceived Ease to Use (PEU) (AVE = .72, CR = .88)	**.90**	
I believe biofuels will be easy for me to use.		.87
It is easy to find a biofuel's station when I want fill fuels.		.94
I do not need to change my vehicles whenever using biofuels.		.72
Attitude (AT) (AVE = .64, CR = .78)	**.82**	
I like the idea of using biofuels.		.96
I have desire to use biofuels.		.71
Intention to Use (IN) (AVE= .51, CR = .73)	**.75**	
I intend to use biofuels if it is available.		.72
I will recommend others to use biofuels.		.90

All the individual factors loading are exceeded the recommended value of .7 (MacCallum et al., 1999). We used two internal consistency indicators, average variance extracted (AVE) and composite reliability (CR), to assess construct reliability. As the results, AVE scores (ranging from .501 to .832) exceeded the recommended value of .50 (Fornell and Larcker 1981). Similarly, the CR (ranging from .73 to .93) was well above the commonly used cutoff of .70 (Straub, Boudreau, and Gefen 2004).

To assess discriminant validity, we conducted the cross-loading method (Chin 1998). Each item had a higher loading on its intended construct than on its cross-loading with other constructs. This result shows at Table 3. Thus, our measurements satisfy the criteria for discriminant validity suggested by Chin (1998) and Gefen and Straub (2005).

Table 3. Discriminant validity

	AT	PU	PEU	TRI	CPL	ADV	CPA	IN	OBS
AT	**0.803**								
PU	0.437	**0.780**							
PEU	0.370	0.156	**0.848**						
TRI	0.204	0.200	0.592	**0.776**					
CPL	0.177	0.552	0.056	0.134	**0.835**				
ADV	0.358	0.448	0.208	0.209	0.257	**0.833**			
CPA	0.636	0.638	0.242	0.199	0.278	0.373	**0.912**		
IN	0.649	0.459	0.261	0.085	0.230	0.287	0.589	**0.702**	
OBS	0.438	0.415	0.396	0.257	0.160	0.142	0.257	0.367	**0.781**

Research Findings

Structural Model and Hypothesis Testing

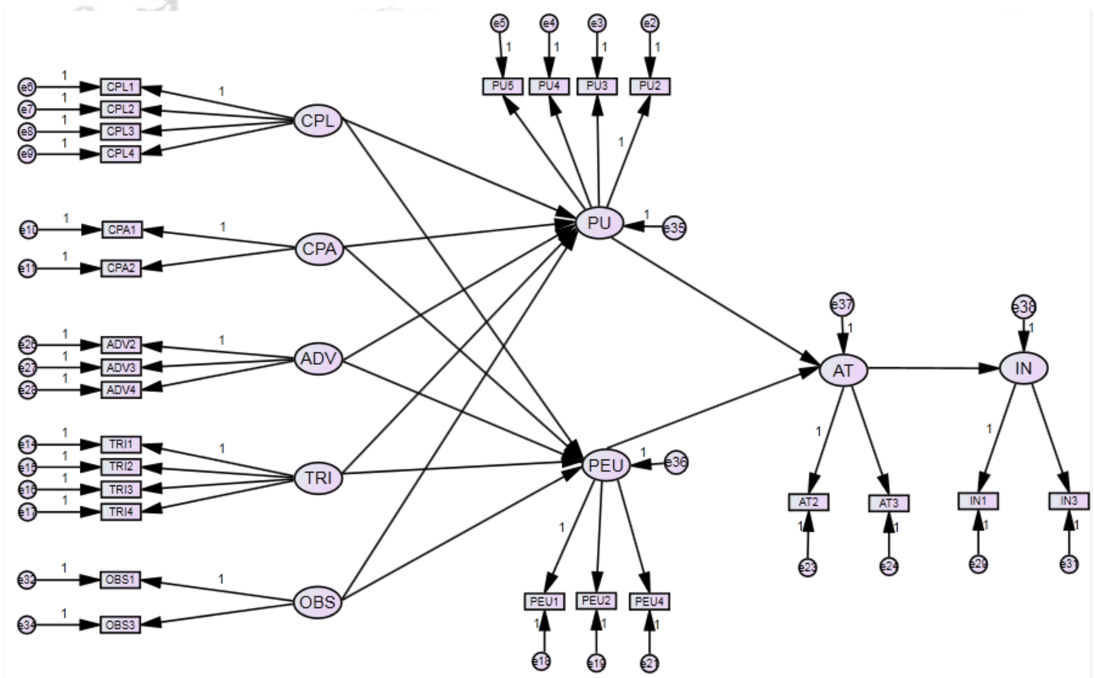

Figure 2. Path test of the research model

Table 4 reveals the results that the variance explained (R2) in the endogenous variables ranges from .332 to .712. The model fit indices for our model as follow: $\chi 2/df = 1.88$ and significant, CFI = .95, GFI = .89, RMSEA = .06, SRMR = .06.

Table 4. Results of Path Coefficients

Dependent Variable	Independent Variable	Hypothesis	Regression Weight	Standard Regression Weight	t_value
PU (R^2= .621)	**ADV**	H1a	.121**	.152**	2.496
	CPA	H2a	.329***	.479***	7.679
	CPL	H3a	.431***	.368***	6.824
	TRI	H4a	.000	.000	.002
	OBS	H5a	.066	.067	.965
PEU (R^2= .422)	**ADV**	H1b	-.046	-.054	.784
	CPA	H2b	.053	.056	.883
	CPL	H3b	-.063	-.066	1.187
	TRI	H4b	.694***	.527***	8.135
	OBS	H5b	.295***	.279***	3.421
AT (R^2= .332)	**PU**	H6	.561***	.445***	7.444
	PEU	H7	.342***	.289***	5.247
IN (R^2= .712)	**AT**	H8	.254***	.844***	6.047
** p<.05 *** p <.01					

The results in Table 4 indicate that we have some problems needed to solve for this structural model. On the one hand, in the effect of TRI on PU, regression weight is .000 (very small), whereas in Table 3, correlation between them is .2. It is suspected that there is something improper about their relationship. To verify the outcome, we conducted a single regression of TRI on PU. All the regression weight (.234) and the standard regression weight (.196) in Table 5 are approximate .2. It is consistent with previous correlation coefficient shown on Table 3. In contrast, when TRI joint in the model with ADV, CPA, CPL and OBS, its regression weight equal .000. It may be explained that the participation of other factors caused explaining power of TRI decrease. As we can see in Table 4, the TRI's coefficient in PU model is insignificant. Hence, we intended to eliminate TRI from PU equation by F-test. Further researches should analyze more about the role of TRI in the explanation for perceived usefulness.

Table 5. Result of regression line between TRI and PU

Dependent Variable	Independent Variable	Regression Weight	Standard Regression Weight	t_value
PU	**TRI**	.234***	.196***	2.926

On the other hand, since TRI and OBS are insignificant in PU equation, we intended to eliminate these independent variables from the equation. Similarly, as for PEU, we excluded ADV, CPA and CPL from the explanation for PEU because of the insignificant effects.

We used F-test to examine whether these factors are jointly statistically significant. The F statistic is often useful for testing exclusion of a group of variables when the variables in the group are highly correlated. At 95% confident level, we tested the null hypothesis that, after controlling for ADV, CPA and CPL, two factors TRI, OBS have no effect on PU. This is stated at: H_0: $\beta_{TRI} = 0$, $\beta_{OBS} = 0$. There are two exclusion restrictions to be test. The F statistic is:

$$F = \frac{(SSR_r - SSR_{ur})/q}{SSR_{ur}/(n-k-1)}$$

Where: SSR_r is the sum of squared residuals from restricted model,
SSR_{ur} is the sum of squared residuals from unrestricted model,
q is the difference in degrees of freedom between the restricted and unrestricted models,
n is sample size, k is the number of independent variables in unrestricted model.

Thus, we had $F = \frac{(167.358-164.951)/2}{164.951/(302-5-1)} = 2.16$. Since this is well below the 5% critical value (approximate 3), we failed to reject H_0. In other words, TRI and OBS are jointly insignificant in the PU equation. We confirmed the elimination.

Also, we conducted the same F-test for ADV, CPA and CPL in the relationship with PEU. We have three exclusion restrictions to be test. H_0: $\beta_{ADV} = 0$, $\beta_{CPA} = 0$, $\beta_{CPL} = 0$. The result shows that the F statistic equal $F = \frac{(201.629-198.748)/3}{198.748/(302-5-1)} = 1.43$. This is also below the value of F-critical. Therefore, we failed to reject H_0, and thus eliminated ADV, CPA and CPL from PEU equation.

Final structural model

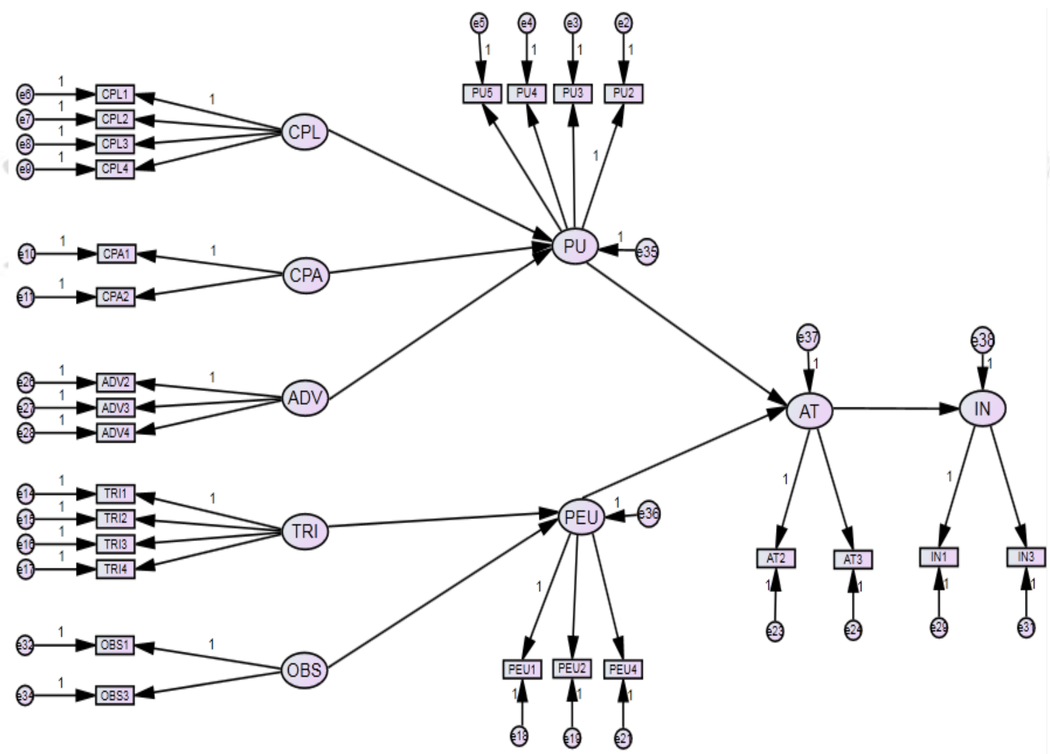

Figure 3. Significant path of the research model

After the exclusion, we have the model fit indices for our model as follow: $\chi2/df = 1.85$ and significant, CFI = .95, GFI = .90, RMSEA = .05, SRMR = .06. The results in Figure 3 and Table 6 show that ADV, CPA, CPL have directs positive relationships with PU, the standard regression weights equal .182, .501, .365 respectively, supported for H1a, H2a, H3a. We also have TRI and OBS significantly influence PEU (β = .521 and .264), H4b, H5b are supported.

H6 and H7, which hypothesize that PU, PEU have a direct positive effect on AT, are supported with β = .444 and .289. The results also reveal that attitude has significant effect on intention to use biofuels station (β = .844). We find supported for H8.

Table 6. Results of Significant Path Coefficients

Dependent Variable	Independent Variable	Hypothesis	Regression Weight	Standard Regression Weight	t_value
PU (R^2= .621)	**ADV**	H1a	.146***	.182***	3.475
	CPA	H2a	.451***	.501***	8.493
	CPL	H3a	.146***	.365***	6.779
PEU (R^2= .422)	**TRI**	H4b	.686***	.521***	8.070
	OBS	H5b	.277***	.264***	4.298
AT (R^2= .332)	**PU**	H6	.560***	.444***	7.422
	PEU	H7	.342***	.289***	5.253
IN (R^2= .712)	**AT**	H8	.254***	.844***	6.048
*** p < .01					

Conclusion

The main objective of this research was to develop a new hybrid Technology Acceptance Model by combining TAM with IDT to explore the factors affecting consumers' behavioral intentions to use biofuels in Vietnam. Based on our proposed model, we explored the relationships between five innovative characteristics and the PU, PEU, as well as between PU, PEU, attitude and intention to use biofuels. Overall, the research model and the hypotheses were confirmed.

The results are consistent with previous studies showing that relative advantages and compatibility had significant positive effects on PU. It can be implied that if profitability of using biofuels is likely to meet consumers' demands and improve their life, they will be likely to consider biofuels to be useful. On the other hand, consumers feel that the better biofuels are, the more useful it is.

Secondly, contrary to the previous studies (Lee, 2007; Hardgrave, et al., 2003), our results show that complexity had a significant positive effect on PU. The reason for this reverse is while the previous researchers proposed a positive questionnaire for complexity, our questions are all negative (for example "I have no difficulty to know how to use biofuels"). It means that whenever biofuels have no complexity, consumers believe in its usefulness. Consumers were familiar with gasoline after long time using it. If new products make them confused, they will assess whether biofuels are convenient and helpful.

This study results also indicate that trialability and observability has no significant effect on PU, which was inconsistent with prior studies (Huang, 2004; Yang, 2007). The possible reason is that although there are trials and observation, consumers perceived biofuels are less useful. The advantages of biofuels are only for environment, not connect with consumers' vehicle engine. Further rigorous follow-up studies should be conducted to investigate the precise role of these factors in this area.

In contrast, our results strongly support the hypothesis that trialability has a significant positive effect on PEU. This result is consistent with previous research findings (Yang, 2007; Hardgrave et al., 2003). It means when the consumers have more opportunities to try biofuel, they are more likely to view them as being easier to use. In other hand, observability also has a positive relationship with PEU. This result is supported by previous researches (Huang 2004; Yang, 2007). It can be implied that observing other people using biofuels make consumers evaluate this product ease of use. Using biofuels seem to be the same as using original fuels, consumers can easily find the station that sold biofuels and fill it.

This study finds that compatibility, complexity, relative advantages had no significant effects on PEU. The results are not consistent with previous researches (Lee, Hsieh, & Hsu, 2011, Hardgrave et al., 2003). The reason can be even if biofuels have some features that are suitable for consumers' demands, it is not means they can implied that using biofuels is easy. Consumers have no confuse to find that biofuels have advantages better than traditional products, such as protect environment, low switching cost, reduce the vehicle's engine wear , but these advantages can make it to be ease of use.

Generally, in term of insignificant paths, there are some unbiased reasons causing the inconsistency with previous researches. Firstly, we used data drawn from the survey utilized the web-based and mailed, this research cannot approach to consumers who do not surf the web usually. Secondly, the majority of respondents are from 18-25 years old (38.7%), while biofuels' target consumers may be expected from 26-35 years old. Further researches can use demographic variables as control variables to explain these effects under different demographic contexts.

As prior research demonstrated, we find that the TAM appeared to provide researchers a theoretically sound and parsimonious model which can be used to predict the new technology, in this case is biofuels. A notable finding of this result is that, overall, the TAM holds true for biofuels in Vietnam. It is obvious that PU, PEOU have positive relationship with attitude of biofuel, whereas attitude significantly influenced intention to use it. For this reason, there is potential for application and development of biofuels in Vietnam. Thus, it is necessary that the government should help consumers confirm or increase their perception positively through biofuels.

Although this research makes a remarkable contribution to the literature, we have some remaining issues. Firstly, the measurements used in this study were derived primarily from prior research and were, in general, reflective of the constructs studied. They may have shortcomings that should be addressed in further research. Secondly, because of the time limit, we used variables elimination method for insignificant effects. Further researches should solve it by increasing the number of observations or analyzing the indirect affects to keep the original proposed model. Thirdly, this study just focused on direct effect, ignored the role of mediating variable. Therefore, future studies measuring and including the indirect influence could bridge this knowledge gap.

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