Impacts of impression changes on freeway driver intention to adopt electronic toll collection service

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ABSTRACT

This paper proposes conceptual frameworks incorporating technology acceptance model, theory of planned behavior and three additional constructs – impression changes, attitude of government, and risk to investigate the factors affecting freeway driver intention to adopt electronic toll collection service for both users and nonusers of electronic toll collection. The proposed frameworks are unique because of the incorporation of media and word-of-mouth effects to represent the impression changes, respectively. The respondents were specifically asked about their impressions of electronic toll collection related policies and strategies spread through media and word-of-mouth before and after electronic toll collection operation. Estimated results obtained from structural equations modeling validate that impression changes in both media and word-of-mouth exhibit significant direct or indirect effects on freeway driver intention to adopt electronic toll collection service. Corresponding strategies to enhance electronic toll collection adoption rate are then proposed accordingly.

1. Introduction

The first electronic toll collection (ETC) system in Taiwan was commissioned to Far Eastern Electronic Toll Collection Co. (FETC), the build-operate-transfer project contractor. The construction of ETC was completed by the end of 2005 and launched on February 10, 2006. ETC system was installed in one direction in the toll plaza along the highways and began with only two channels (one channel for passenger cars, the other for buses and trucks). Other channels in the toll plaza remained manual toll collection. Affected by ETC-related information broadcasted on media or communicated via WOM, the ETC system was not initially widely accepted among freeway drivers at the beginning of operation. Only 32,925 automobiles (about 4% of all registered vehicles in Taiwan) were equipped with an OBU as of Feb 10, 2006.[1] The ETC adoption rate of automobiles (not including trucks and buses) began at 11.16% in 2006 and reached 36.63% in July 2010. Alan (2008) indicated the low-adoption rates of ETC in some areas of US were due to a general lack of understanding about new technologies.

In addition to the lack of understanding ETC service, it was believed that the low ETC adoption rate in Taiwan in 2006 was also due to the distrust of people on this system. Prior to the operation of ETC service in 2006, the ETC-related information broadcasted was full of scandal about the government's favoring a certain company. After putting ETC service into practice, the ETC-related information broadcasted has been gradually turning to be positive because of the efforts of government's involvement. Therefore, the impact of impressions conveyed by both media and word-of-mouth (WOM) on freeway driver

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intention to adopt ETC service before and after the operation of ETC service, is significant, and the differences of these impacts between these two stages are worth to be further investigated.

According to a survey conducted by BIG research (2005), consumers consider WOM to be the most influential source of information, followed by TV advertisements. This finding highlights the importance of WOM for consumer intentions. In earlier years, WOM was mainly spread via interpersonal contact. However, the integration of the Internet into our daily lives allows WOM to be disseminated across multiple channels, including web forums, BBS and personal websites. In both these cases mentioned above, interpersonal communication channels refer to mutual interactions between two or more decision-making units. Mutual interactions provide two-way communications, thus allowing one to overcome the psychological barriers in decision making and influence or strengthen their attitude (Rogers, 2003, p. 205). On the other hand, different media, including TV, radio and websites also play an important role in the decisions made by consumers. Therefore, the success of products marketing, public or private, can greatly depend on these two channels, media and WOM.

Numerous studies using structural equation modeling (SEM) methods have been conducted on travel demand and travel behavior (e.g. Golob and Hensher, 1998; Jakobsson et al., 2000; Golob, 2003; Chen et al., 2007; Choo and Mokhtarian, 2007). There are two types of SEM models, exploratory and confirmatory (Bollen, 1989). The former one is a useful technique when there is no specified priori model. The latter, on the other hand, utilizes a model constructed in advance (i.e., the number and presumed effects of latent variables have been predetermined).

Related to our study, Chen et al. (2007) applied SEM model incorporating the technology acceptance model (TAM) and theory of planned behavior (TPB) to investigate the reasons behind the low adoption rate of ETC service in Taiwan (for ETC nonusers only). However, the effects of media and WOM, mentioned by Rogers (2003), were not incorporated into their model framework. Therefore, the framework has been modified to examine the changes in impression before and after ETC operation and the impact of media and WOM on driver intention to adopt ETC service for both ETC users and nonusers. That is, there are two types of impression changes (media and WOM) and two groups of samples (ETC users and nonusers), which results in four SEM models. The media referred to in this study includes TV, radio, websites and emails, while WOM includes public discussions on the web, email and face-to-face interaction among friends and relatives. In addition, two constructs, attitude of government and risk, are included in the causal relationships to reflect the properties of BOT projects (i.e., we suspect that the intention to adopt ETC service may correlate to these two constructs, directly or indirectly).

The structure of this paper is organized as follows. Section 2 presents the model framework proposed by this study, followed by data collection and analysis. Estimation results are included in Section 4. Concluding remarks are summarized in the final section.

2. Model framework

The proposed conceptual framework is depicted in Fig. 1. Basically, we adopt the model proposed by Chen et al. (2007), and add three important components: impression changes, attitudes of government and risk. It is, therefore, a mix of exploratory and confirmatory SEM models. Within this framework, there are four models to be estimated in this study. The first model investigates the effects of "impression changes in media" on freeway driver intention to continue using ETC service
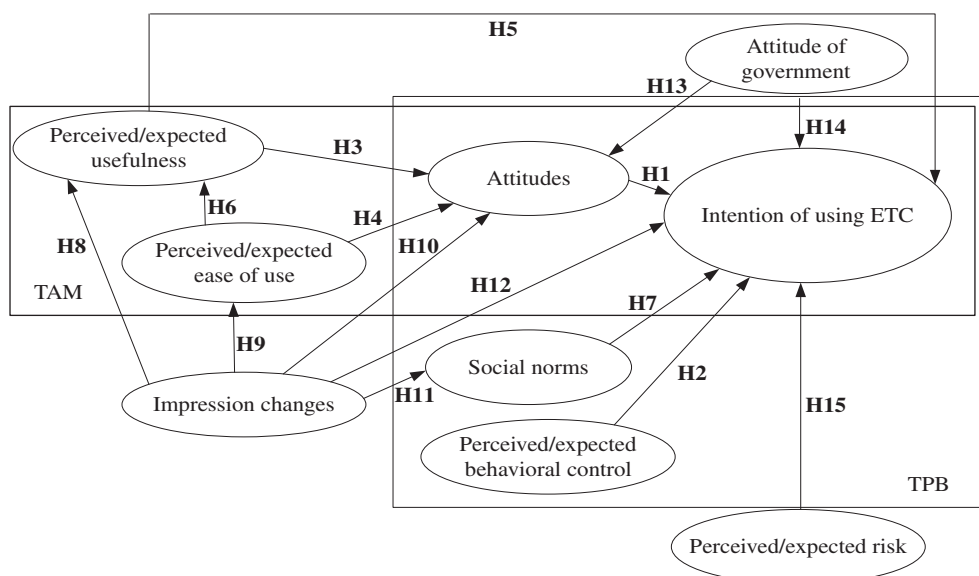

Fig. 1. The proposed conceptual framework.

for ETC users; the second model investigates the effects of "impression changes in WOM" on freeway driver intention to continue using ETC service for ETC users; the third model investigates the effects of "impression changes in media" on freeway driver intention to accept using ETC service for ETC nonusers; the final model investigates the effects of "impression changes in WOM" on freeway driver intention to accept using ETC service for ETC nonusers. Table 1 summarizes the definitions of constructs that may be confusing between ETC users and nonusers. It should be noted that throughout the paper, the terms in both figures and tables before slash represent for ETC users, while those after slash are for ETC nonusers. For example, in Fig. 1, the term 'perceived' relates to ETC users while 'expected' relates to ETC nonusers. Meanwhile, the definition of impression changes will be elaborated upon further in Section 3.

The arrows in Fig. 1 indicate the causal relationship among factors (positive or negative relationship). The dashed rectangle represents TAM framework while the solid rectangle represents TPB framework. According to TAM, proposed by Davis (1989) and Davis et al. (1989), perceived/expected usefulness and perceived/expected ease of use affects freeway driver attitudes toward ETC adoption and will ultimately determine their intention to continue/accept using ETC service. This relates to both ETC users/nonusers.

According to TPB, freeway driver attitudes, subjective norms, and perceived/expected behavioral control are main factors affecting their intentions to continue/accept using ETC service. This relates to both ETC users/nonusers. Based on the conceptual framework proposed in Fig. 1, we postulate that diffusion of ETC related information on media and WOM affects freeway driver intention to continue/accept using ETC service. The media referred in this study includes TV, radio, websites and emails, while WOM includes public discussions on the web, email and face-to-face communications among friends and relatives.

As shown in Fig. 1, a total of 15 hypotheses are then postulated as follows:

H1: Freeway drivers' "attitudes" toward ETC service positively affects their intentions to continue/accept using ETC service for both ETC users/nonusers.

H2: Freeway drivers' "perceived/expected behavioral control" over ETC service positively affects their intentions to continue/accept using ETC service for both ETC users/nonusers.

H3: Freeway drivers' "perceived/expected usefulness" of ETC service positively affects their attitudes toward ETC service for both ETC users/nonusers.

H4: Freeway drivers' "perceived/expected ease of use" of ETC service positively affects their attitudes toward ETC service for both ETC users/nonusers.

H5: Freeway drivers' "perceived/expected usefulness" of ETC service positively affects their intentions to continue/accept using ETC service for both ETC users/nonusers.

H6: Higher "perceived/expected ease of use" of ETC service leads to higher "perceived/expected usefulness" of ETC service for both ETC users/nonusers.

H7: Higher "social norms" lead to higher intentions to continue/accept using ETC service for both ETC users/nonusers.

To further understand the changes in freeway drivers' reaction to ETC service policy and intentions to adopt ETC service before and after the operation of ETC service under the influence of information diffused by media and WOM, the following hypotheses are further postulated:

H8: Freeway drivers' "perceived/expected usefulness" of ETC service increases as changes in impression towards ETC service, diffused by media (WOM), become more positive.

H9: Freeway drivers' "perceived/expected ease of use" of ETC service increases as changes in impression towards ETC service, diffused by media (WOM), become more positive.

H10: Freeway drivers' "attitudes" toward ETC service increase as changes in impression towards ETC service, diffused by media (WOM), become more positive.

H11: Freeway drivers' "social norms" toward using ETC service increase as changes in impression towards ETC service, diffused by media (WOM), becomes more positive.

H12: Freeway drivers' "intention to continue/accept using ETC service" for users/nonusers of ETC service increases as changes in impression towards ETC service, diffused by media (WOM), become more positive.

H13: "Attitude of government" positively influences freeway drivers' "attitudes" toward ETC service.

Table 1
The definitions of constructs that may be confused between ETC users and nonusers.

Constructs	ETC users	ETC nonusers
Intention to adopt ETC service	Intention to continue using ETC service	Intention to accept using ETC service
Usefulness	Perceived usefulness	Expected usefulness
Ease of use	Perceived ease of use	Expected ease of use
Behavioral control	Perceived behavioral control	Expected behavioral control
Risk	Perceived risk	Expected risk

H14: "Attitude of government" positively influences freeway drivers' "intention to continue/accept using ETC service" for both ETC users/nonusers.

H15: Freeway drivers' "intention to continue/accept using ETC service" decreases with the increase of "perceived/expected risk" of ETC service for ETC users/nonusers.

3. Data

The purpose of this study is to understand the influences of media and WOM on the freeway driver intention to adopt ETC service before and after ETC operation. The survey was conducted face to face in rest areas along freeways for two groups of samples, ETC users and nonusers. The total samples for both groups are 159 each, with valid sample sizes of 149 and 143 for ETC users and nonusers, respectively. It should be noted that all the samples are regular travelers/commuters and the survey is a one-time RECALL survey (i.e., the before conditions were being recalled at the survey) as opposed to one before and one after.

The questionnaire contains three parts. The first part collects drivers' demographic data, including gender, age, education level, monthly income and car ownership. The second part explores impressions of ETC's policies and strategies, both before and after ETC operation, as conveyed through TV, radio, Internet, emails and WOM from friends and relatives. Respondents gave their impressions in a Likert scale ranging from 1 to 11 (extremely negative = 1, neutral = 6, extremely positive = 11). The final part contains eight constructs, and each construct contains several indicators. For each indicator, respondents were requested to answer their scale of agreement (extremely disagree = 1, neutral = 3, extremely agree = 5). Indicators to be measured include perceived/expected usefulness, perceived/expected ease of use, attitudes, social norms, attitude of government, perceived/expected behavioral control, perceived/expected risk, and intention to continue/accept using ETC service.

Table 2 presents the demographics of respondents for both ETC users and nonusers. As shown in the table, both ETC users and nonusers comprise of mainly male drivers (80%). In terms of age, 31–40 is the largest group accounting for 43% ETC users and 38% ETC nonusers, respectively. Both ETC users and nonusers with a college/university background constitute the largest group (51.7% and 55.2%, respectively). The monthly incomes range between NT$20,000–50,000, 51% and 44.8% for ETC users and nonusers, respectively. The majority of respondents own only one car and accounts for 73.2% ETC users and 71.3% ETC nonusers, respectively.

Table 3 presents the impression for ETC related information, before and after ETC operation, across both ETC users and nonusers after their exposure to the media and WOM. The results indicate that, across both ETC users and nonusers, the average impressions for ETC related information increase after ETC operation. This could attribute to the government's efforts since ETC is a BOT project. To capture the changes in impression (CI) before and after ETC operation, a new definition is used (as shown in Table 3, CI column). Four points were given to responses that were both positive (original scales 7–11) before and after operation of ETC; 3 points were given to responses that turned from negative (original scales 1–5) to positive; 2 points were given to responses that turned from positive to negative; 1 point was given to responses that were negative before and after operation of ETC As depicted in the table, for both ETC users and nonusers, CIs are all greater than 3 points indicating that most of respondents have positive impressions on ETC related information diffused by all communication

Table 2
Demographic breakdown of ETC users and nonusers.

	Demographics	ETC users		ETC nonusers	
		Samples	(%)	Samples	(%)
Gender	Male	116	80.0	115	80
	Female	33	20.0	28	20
Age	18–30 years old	25	16.8	45	30.5
	31–40 years old	64	43	55	38.5
	41–50 years old	30	20.1	34	24.2
	Above 51 years old	30	21.1	15	6.8
Education	Junior high school and under	9	6	1	0.7
	Senior high school	45	30.2	27	18.9
	University	77	51.7	79	55.2
	Graduate school and above	18	12.1	36	25.2
Monthly income (NT dollars)	Under 20 thousands	9	6.0	27	18.9
	20–50 thousands	76	51.0	64	44.8
	50–100 thousands	44	29.5	37	25.9
	100–200 thousands	12	8.1	9	6.3
	200–300 thousands	4	2.7	3	2.1
	Above 300 thousands	4	2.7	3	2.1
Number of cars owned	0	6	4.0	18	12.6
	1	109	73.2	109	71.3
	2	27	18.1	21	13.3
	3	7	4.7	4	2.8

Table 3
Impression of information diffused by media and WOM before and after ETC operation for ETC users and nonusers.

Types of communication channels			ETC users				ETC nonusers			
			Before	After	After–Before	CI	Before	After	After–Before	CI
Media	TV	Advertisement (Z1)	6.6	6.8	0.2	3.5	6.6	6.8	0.2[**]	3.8
		News reports (Z2)	6.3	6.6	0.3[**]	3.3	6.3	6.6	0.3[**]	3.6
		Talking shows (Z3)	5.8	6.0	0.2[*]	3.1	5.7	6.0	0.3[**]	3.6
	Radio	Advertisement(Z4)	6.3	6.5	0.2	3.5	6.3	6.5	0.2[**]	3.8
		News reports (Z5)	6.2	6.3	0.1[**]	3.5	6.2	6.3	0.1[**]	3.7
		Talking shows (Z6)	6.0	6.1	0.1	3.5	5.9	6.1	0.2[**]	3.7
	Internet	Advertisement(Z7)	6.2	6.3	0.1	3.4	6.2	6.3	0.1[**]	3.8
		News reports (Z8)	6.0	6.2	0.2	3.3	6.0	6.2	0.2[**]	3.7
WOM	Forums (Z9)		5.8	6.1	0.3[**]	3.4	5.8	6.1	0.3[**]	3.7
	E-mail (Z10)		6.0	6.1	0.1	3.5	6.0	6.2	0.2[**]	3.6
	Discussion with friends and relatives (Z11)		6.4	6.5	0.1	3.2	6.4	6.5	0.1[**]	3.8
Average impression			6.1	6.3	0.2	3.4	6.1	6.3	0.2	3.7

[*] 90% significant level.
[**] 95% significant level.

Table 4
Average score for each item.

Constructs (users/non-users)	Indicators	Items	ETC users	ETC nonusers	t-test
Perceived/expected usefulness	A1	Faster passing through the toll collection station through the use of the ETC lane	4.2	3.9	−4.51[**]
	A2	Smoother highway driving through the use of the ETC lane	4.1	3.7	−5.11[**]
	A3	Ease of toll payment through the use of the ETC lane	4.2	3.8	−4.67[**]
	A4	Faster arrival at destination or more controllable driving time through the use of the ETC lane	4.0	3.4	−5.29[**]
Perceived/expected ease of use	B1	I think topping up the ETC's paying card is easy	–	3.2	–
	B2	I think operating the OBU is easy	3.3	3.3	−5.63[**]
	B3	I think topping up the ETC's paying card is convenient	3.7	–	–
	B4	Overall, using the ETC is easy	4.1	–	–
Attitude of government	C1	The bidding process of ETC held by government is open, fair, and right	–	2.7	–
	C2	The government promotion of the OBU for the ETC is proactive	–	3.2	–
	C3	Overall, the government has tried hard to promote the ETC policy	3.1	3.1	−3.07[**]
Attitudes	D1	I think that I would like to use the ETC	4.1	3.3	−9.72[**]
	D2	I think that the use of the ETC is correct	4.1	3.1	−8.11[**]
	D3	I think that using the ETC would be a good experience	3.9	3.4	−7.87[**]
	D4	I think that the ETC policy is a good strategy	4.1	3.1	−6.17[**]
Social norms	E1	I know important people in my life who think that I should equip the OBU to use the ETC	3.8	2.9	−9.05[**]
Perceived/expected behavioral control	F1	I am able to understand the information related to ETC systems and service	3.7	–	–
	F2	I am able to pay the charges related to the OBU of ETC	–	3.4	–
Perceived/expected risk	G1	Overall, I think that equipping the OBU to use ETC creates a loss (either in money or in time)	2.4	3.0	5.47[**]
	G2	Generally speaking, it is risky and dangerous to offer my personal information to an enterprise	–	3.4	–
	G3	The usage of the ETC system might invade my personal privacy (e.g.: tracking or monitoring driving	–	3.3	–
Intention to adopt ETC service	H1	I am going to retain/equip the OBU and use the ETC system	4.0	2.6	−13.34[**]
	H2	I am going to recommend my friends and relatives to equip the OBU and use the ETC system	3.7	2.6	−10.06[**]

[**] 95% significant level.

channels after ETC operation. It should be noted that Z1–Z6 are items relating to "traditional media" and Z7–Z10 relate to "the Internet". Additionally, Z9–Z11 are defined as items relating to "WOM". According to Duan et al. (2008), Z9–Z10 are classified as items related to "online WOM"[2] and Z11 relates to "interpersonal WOM".

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[2] Duan et al. (2008) propose that online word-of-mouth includes product reviews, discussion boards, chat rooms, blogs, wikis, and other discussions.

Other than the first construct (impression changes) presented in the previous table, eight constructs are summarized in Table 4.[3] The results show that the average scores of ETC users' perceived effectiveness is higher than ETC nonusers' expected effectiveness (for all four indicators). Similar results apply to "attitudes", "social norms", "behavioral control" and "intention". As for "ease to use", "attitude of government" and "risk", there exist different significant indicators for ETC users and nonusers.

4. Results

Several tests are performed to investigate the reliability and validity of the proposed models. Section 4.1 presents the results of these tests. Section 4.2 develops the relationship among constructs to validate the hypotheses postulated in Section 2.

4.1. Reliability and validity tests

4.1.1. Reliability

In this paper, the model reliability was measured using Cronbach's α. Reliability is a measure of consistency of test results, where higher reliability indicates higher stability and consistency. According to Fornell and Larcker (1981), composite reliability should be above 0.6. Tables A1 and A3 (in Appendix A) present the results of reliability of each dimension. All the constructs have a Cronbach's α above 0.6, indicating a high reliability of the indicators and constructs.

4.1.2. Convergent validity

Convergent validity is used to evaluate the factor loadings of measurement variables on a latent variable and test that all factor loadings are statistically significant. As shown in Tables A1 and A3 (in Appendix A), all factor loadings are above 0.5 and statistically significant. The results comply with the standard suggested by Hair et al. (1998). Furthermore, the convergent validity of the constructs is tested by an average variance extracted (AVE) method. AVE is a measure of the amount of variance in a latent variable explained by the measurement variables. Higher AVEs indicate higher convergent validity and discriminant validity of latent variables. Fornell and Larcker (1981) suggest that AVE should be greater than 0.5 for convergent validity. As shown in Tables A1 and A3, AVE is greater than 0.5 in most constructs, indicating that the indicators and constructs in our scale are developed with convergent validity for both ETC users and nonusers.

4.1.3. Discriminant validity

Evidence of discriminant validity occurs when the square root of the AVE for each variable exceeds the correlation between variables in pair (Fornell and Larcker, 1981). If the correlation between a pair of variables is greater than the AVE for any of the variables, we can infer that the measurement items for one variable may also be used to measure the other (Anderson and Gerbing, 1998). According to Anderson and Gerbing (1998), discriminant validity is confirmed if the minimum AVE among all constructs is greater than the square of the maximum value in the correlation matrix. Tables A2 and A4 (in Appendix A) show the correlation coefficients among constructs for ETC users and nonusers. The results show that the validity is significant.

4.2. Estimated model with impression changes in media

The estimated results of the model with impression changes in media are reported in Table 5. In terms of the model's goodness of fit, χ^2/df is very small indicating the proposed model is statistically satisfactory. RMSEA is below 0.08, and CFI is higher than 0.9, indicating that the data fit is adequate. Nevertheless, GFI is only 0.8, which is slightly lower than the threshold value of 0.9. The paths among different constructs are illustrated in Fig. 2, based on the estimated results. One of the differences between this model and Chen et al.'s (2007) lies in the inclusion of impression changes in media. The influence of media impression changes on the intention to continue/accept using ETC service is direct for ETC nonusers, whilst being indirect for ETC users. For both ETC users and nonusers, media impression changes would positively affect the perceived/expected ease of use of ETC service (H9), the attitude toward ETC service (H10), and the social norms toward using ETC service (H11). There are three paths of influence beginning with media impression changes and ending with the intention to continue/accept using ETC service for ETC users/nonusers. The first path starts from media impression changes → perceived/expected ease of use → perceived/expected usefulness → attitude toward ETC service → intention to continue/accept using ETC service (H9 × H6 × H3 × H1). The second path starts from media impression changes → attitudes toward ETC service → intention to continue/accept using ETC service (H10 × H1). The final one is from media impression changes → social norms toward using ETC service → intention to continue/accept using ETC service (H11 × H7). Whilst the direct influence of media impression changes is significant for ETC nonusers, this is not the case for ETC users. In sum, the increase of positive media impressions on ETC service has direct and indirect influences on freeway driver intention to continue/accept using ETC service.

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[3] It shall be noted that in order to use the two-sample t-test, it must be assumed that the two samples come from the same population, i.e., with the same variance. The equality of variances assumption can be verified with the F test, or the more robust Levene's test can be used.

Table 5
Path coefficients of the model with impression changes in media.

Hypotheses	Paths	ETC users	ETC nonusers
H1	Attitudes → Intention	0.339 (3.106)**	0.326 (3.749)**
H2	Perceived/expected behavioral control → Intention	0.117 (2.151)**	0.133 (2.421)**
H3	Perceived/expected usefulness → Attitudes	0.495 (5.352)**	0.891 (8.711)**
H4	Perceived/expected ease of use → Attitudes	0.259 (3.427)**	–
H6	Perceived/expected ease of use → Perceived/expected usefulness	0.565 (8.2)**	0.511 (4.406)**
H7	Social norms → Intention	0.237 (3.811)**	0.209 (3.089)**
H9	Media impression changes → Perceived/expected ease of use	0.396 (2.471)**	0.345 (4.051)**
H10	Media impression changes → Attitudes	0.26 (3.177)**	0.237 (3.379)**
H11	Media impression changes → Social norms	0.396 (2.93)**	0.29 (3.078)**
H12	Media impression changes → Intention	–	0.243 (3.078)**
H15	Risk → Intention	−0.13 (2.97)**	−0.339 (−2.564)**
Goodness of fit	χ^2/df	1.666	1.152
	RMSEA	0.067	0.033
	CFI	0.945	0.985
	GFI	0.825	0.877

Note: values in parentheses are *t*-values; *df* = degree of freedom.
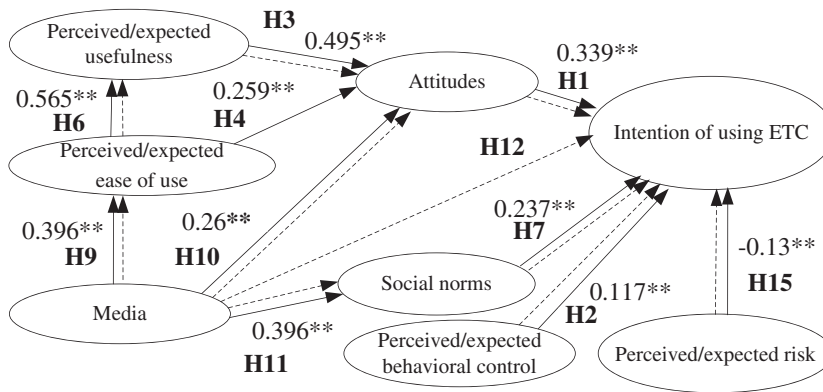** 95% significant level.

Fig. 2. Estimation results of the model incorporating media impression changes (*Note*: solid lines are for ETC users, and dash lines are for ETC nonusers. Only path coefficients of ETC users are presented.).

The other difference between this model and Chen et al. (2007) is the consideration of social norms. The estimation results in this study suggest that freeway drivers have a stronger intention to continue/accept using ETC service when people important to them consider ETC service as necessary (H7). On the other hand, we also discovered a significant correlation between perceived/expected behavioral control and intention to continue/accept using ETC service (H2). In other words, freeway drivers have more intention to continue/accept using ETC service if they are able to pay the charges related to ETC service and to understand the information related to the ETC systems and service. A negative relationship between perceived/expected risks and intention to continue/accept using ETC service (H15) was also validated. This relationship suggests that freeway drivers have a lower intention to continue/accept using ETC service if they perceive/expect a higher risk of using it. The effect of perceived ease of use on intention is mediated through attitudes for ETC users (H4 → H1), whilst this does not hold true for ETC nonusers.

The following paths are not insignificantly tested in Fig. 2 – the path between media impression changes and perceived/expected usefulness (H8), the path between perceived/expected usefulness and intention to continue/accept using ETC service (H5), the path between the attitude of government and attitudes toward ETC service (H13) and the path between the attitude of government and intention to continue/accept using ETC service (H14). It is surprising that in both figures the influence of attitude of government on the intention to continue/accept using ETC service is not significantly tested for both ETC users and nonusers. This is probably a result of the government's inability to cater to the demands of the general public for reduced ETC service related costs. However, this inference should be examined further.

It is also interesting to note that the relationship between media impression changes and perceived/expected usefulness of ETC service is not significant. A plausible explanation is that freeway drivers have the impression that they need to slow when passing through ETC channels. Such impressions could explain why perceived/expected usefulness of ETC service does

not significantly affect freeway driver intention to adopt ETC service. This is another distinguishing point separating this study from Chen et al. (2007).

4.3. Estimated model with impression changes in WOM

To further investigate the effects of changes in impression through WOM before and after the ETC operation on the intention to continue/accept using ETC service for ETC users and nonusers, the construct of the impression changes in media in Fig. 2 is replaced by the impression changes in WOM. These estimated results are presented in Table 6. As shown in Table 6, impression changes in WOM have a positive influence on ETC nonusers' intention to accept using ETC service (H12). This finding reveals that for ETC service nonusers, positive WOM increases their intentions to accept using ETC service. In addition, for both ETC users and nonusers, impression changes in WOM positively influence both the perceived/expected ease of use of ETC service (H9) and the social norms toward ETC service (H11). However, impression changes in WOM only positively influence attitudes of ETC users, but not those of ETC nonusers.

Impression changes in WOM also indirectly affect freeway driver intention to continue/accept using ETC service through three paths. The first path is from impression changes in WOM → perceived/expected ease of use → perceived/expected usefulness → attitude toward ETC service → intention to continue/accept using ETC service (H9 × H6 × H3 × H1). The second path is from impression changes in WOM → perceived/expected ease of use → attitudes toward ETC service → intention to continue/accept using ETC service (H9 × H4 × H1). The final one is from impression changes in WOM → social norms → intention to continue/accept using ETC service (H11 × H7). As per the aforementioned findings, we can infer that the increase of positive impression changes in WOM about ETC service can directly and indirectly influence freeway driver intention to adopt ETC service. The estimation results are illustrated in Fig. 3.

4.4. Discussions: effects of impression changes

To compare the effects of impression changes, as a result of exposure to the media and WOM, on the intentions to continue/accept using ETC service of ETC users and nonusers, five effects (one direct and four indirect) are summarized in Tables 5 and 6, respectively. The effects of the models with media and WOM are further compared in Table 7. As noted from Table 7, for ETC users, neither exposure to media or WOM, has a direct impact on their intentions to adopt ETC service. However, all indirect effects, except indirect (1), indicate that changes in impression tend to be influenced more by media than by WOM (indirect (2), (3) and (4)). Furthermore, the results indicate that the intention to adopt ETC service for ETC users, is influenced more by the impression created as a result of media rather than through WOM. In contrast, for ETC nonusers, impression changes in WOM have a stronger influence on intention to adopt ETC service than those in media. In terms of indirect effects, changes in impression as a result of the media are stronger than those influenced by WOM (indirect (1), and (4)).

It is interesting to note that the total effects (direct effect + indirect effects) of impression changes in both media and WOM on ETC nonusers are much higher than those on ETC users, suggesting that ETC nonusers are more likely to be affected by their impression changes than ETC users, especially for those from WOM. Therefore, in order to encourage ETC nonusers to accept using ETC service, the government and FETC should propose effective marketing strategies to increase impression changes of freeway drivers (especially for ETC nonusers) through formal media and informal media (WOM). Since the majority of freeway drivers are male and young (under 40 years old) with a high education level (as shown in Table 2), it is an effective marketing strategy to hire popular writers of blogs and miniblogs (e.g. facebook, twitter, plurk, . . .) to frequently post their good experiences with using ETC.

Table 6
Path coefficients of the model with the impression changes in WOM.

Hypotheses	Paths	ETC users	ETC nonusers
H1	Attitudes → Intention	0.399 (5.559)**	0.275 (2.935)**
H2	Perceived/Expected behavioral control → Intention	0.107 (2.123)**	0.145 (2.215)**
H3	Perceived/expected usefulness → Attitudes	0.815 (6.856)**	0.742 (7.581)**
H4	Perceived/expected ease of use → Attitudes	0.164 (2.041)**	0.252 (2.302)**
H6	Perceived/expected ease of use → Perceived/expected usefulness	0.447 (6.924)**	0.528 (4.23)**
H7	Social norms → Intention	0.177 (3.083)**	0.167 (2.105)**
H9	Impression changes in WOM → Perceived/expected ease of use	0.381 (2.89)**	0.21 (2.272)**
H10	Impression changes in WOM → Attitudes	0.178 (2.321)**	–
H11	Impression changes in WOM → Social norms	0.379 (3.678)**	0.284 (2.656)**
H12	Impression changes in WOM → Intention	–	0.39 (4.17)**
H15	Risk → Intention	−0.131 (−3.104)**	−0.532 (−3.243)**
Goodness of fit	χ^2/df	1.691	1.047
	RMSEA	0.068	0.018
	CFI	0.951	0.996
	GFI	0.873	0.909

Note: values in parentheses are *t*-values; *df* = degree of freedom.
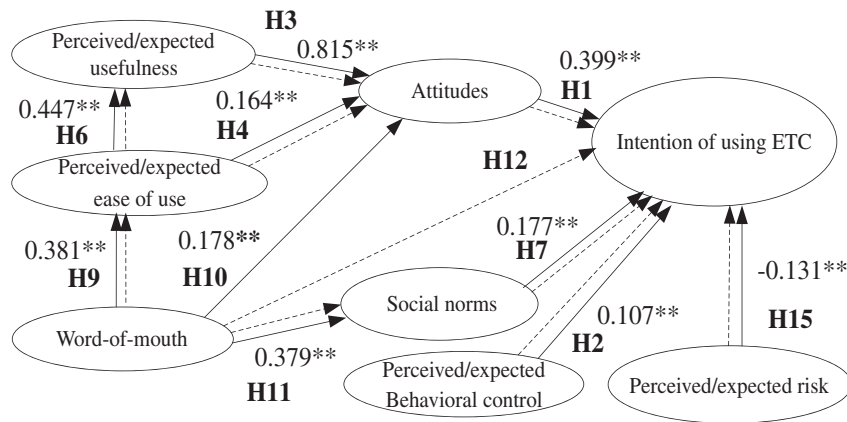** 95% significant level.

Fig. 3. Estimation results of the model incorporating impression changes in WOM (*Note*: solid lines are for ETC users, and dash lines are for ETC nonusers. Only path coefficients of ETC users are presented.).

Table 7
Effects of impression changes in media and WOM on the intention to adopt ETC service.

Effects	Paths	ETC users		ETC nonusers	
		Media	WOM	Media	WOM
Direct	H12	–	–	0.243	0.39
Indirect (1)	H9 × H6 × H3 × H1	0.03754	0.05538	0.05120	0.02262
Indirect (2)	H10 × H1	0.08814	0.07102	0.07726	–
Indirect (3)	H9 × H4 × H1	0.03476	0.02493	–	0.01455
Indirect (4)	H11 × H7	0.09385	0.06708	0.06061	0.04742
Total		0.25429	0.21841	0.43207	0.47459

5. Concluding remarks

In this paper, Chen et al.'s (2007) model was extended by including two dimensions, namely media and WOM, to investigate how impression changes, before and after ETC's operation, affect freeway driver intention to continue/accept using ETC service. This was examined for both ETC users and nonusers, separately. The estimated results show that, for ETC nonusers, impression changes either in media or WOM have a positive and direct effect on freeway driver intention to adopt ETC service, while this does not hold true for ETC users. Even so, for both ETC users and nonusers, impression changes either in media or WOM still indirectly affect intentions to adopt ETC service mediated by perceived/expected ease of use, perceived/expected usefulness and attitudes. In other words, if promoters can change the impressions about their innovation through the media or WOM, they can directly or indirectly influence potential users' intentions to adopt the innovation.

In both models with impression changes in media and WOM, attitudes, social norms and perceived behavioral control have direct effects on the intentions to adopt ETC service. Perceived/expected ease of use affects perceived/expected usefulness, which further affects freeway drivers' attitudes towards ETC service and thus their intentions to adopt ETC service.

For ETC users, impression changes in either media or WOM do not have a direct effect on their intention to retain ETC service. However, the intention to adopt ETC service is influenced more by impression changes in media than in WOM. In contrast, for ETC nonusers, impression changes in WOM have a stronger direct effect on intention to adopt ETC service than those in media do, but impression changes in WOM has weaker indirect effects as compared to those in media.

The results of this study confirm that the conceptual framework integrating TAM, TPB, media and WOM can provide in-depth insights in investigating factors affecting freeway driver intention to adopt ETC service. This integration provides a more complete explanation and also helps clarify the importance of changes in impression, as a result of the media and WOM, for government and FETC to develop new marking strategies. As suggested by the empirical findings, if the government can simultaneously influence the media and WOM to increase positive comments about ETC service, it can significantly enhance people's intentions to adopt ETC service and increase its likelihood of success. To name a few, the government can stress, via different channels of media and WOM, on the positive effects of using ETC service, such as improvement of air pollution and reduction of travel time.

Empirical findings also indicate that the relationship between the attitude of government and intention to adopt ETC service is not significantly supported. A plausible explanation is that respondents did not have a clear understanding of ETC service program and its propaganda, so their intentions were not significantly affected.

Furthermore, the effect of perceived/expected risks on intention to adopt ETC service is significantly negative, indicating that drivers are less likely to adopt ETC service if they perceived/expected a high level of risk. Although government's

attitude does not directly influence freeway drivers' attitudes and intentions to adopt ETC service, there are still actions that government can take to promote ETC service.

Impression changes as a result of the media or WOM on ETC service adoption can significantly enhance freeway driver intention to adopt ETC service. If government can make use of various media (formal and informal) to convey positive information about ETC service, they can enhance freeway drivers' impressions about this policy and thus increase their intentions to adopt ETC service. Since our results indicate the majority of freeway drivers were male and young with a high education level, hiring popular writers of blogs and miniblogs (e.g. facebook, twitter, plurk, ...) to frequently post their good experiences with using ETC might be a good way to promote ETC service.

Some directions for future studies and limitation of this study are as follows. First, the proposed framework can be applied to other intelligent transportation and information communication technologies, such as Telematics, GPS, and smartcard. Second but not least, it is worthwhile to incorporate different impression changes (media and WOM) and driver groups (ETC users and nonusers) into an integrated conceptual framework through moderation effect analyses. Third, since the survey was a one-time recall survey, the credibility of information before ETC's operation could be influenced to some extend and the interpretations of results should bear that in mind.

Acknowledgments

Appendix A. Appendix

Tables A1–A4.

Table A1
Estimated results of the CFA model with impression changes in media (ETC users/non-users).

Constructs	Items	Regression coefficients	Factor loadings	t-values	AVE	Cronbach's α
Perceived/expected usefulness	A1	1/1	0.81/0.96	–	0.68/0.61	0.90/0.88
	A2	1.11/0.96	0.88/0.79	12.42[**]/12.23[**]		
	A3	1.09/0.80	0.83/0.69	11.72[**]/9.95[**]		
	A4	1.11/0.82	0.78/0.67	10.80[**]/8.96[**]		
Perceived/expected ease of use	B1	–/0.97	–/0.78	–/6.58[**]	0.67/0.57	0.84/0.73
	B2	1/1	0.92/0.74	–		
	B3	0.98/–	0.76/–	11.66[**]/–		
	B4	0.74/–	0.76/–	10.24[**]/–		
Attitude of government	C1	–/1	–/0.56	–/–	–/0.65	–/0.88
	C2	–/1.24	–/73	–/5.78[**]		
	C3	1/1.37	1/0.80	–/5.5[**]		
Attitudes	D1	1/1	0.89/0.86	–	0.76/0.65	0.94/0.88
	D2	1.01/0.98	0.89/0.86	15.94[**]/14.62[**]		
	D3	1.20/0.92	0.90/0.86	16.67[**]/15.14[**]		
	D4	1.03/0.74	0.81/0.63	13.19[**]/9.03[**]		
Subjective norms	E1	1/1	1/1	–	–	–
Perceived/expected behavioral control	F1	1/1	1/1	–	–	–
Perceived/expected risk	G1	1/1	1/0.51	–	–/0.52	–/0.75
	G2	–/1.30	–/0.80	–/6.06[**]		
	G3	–/1.56	–/0.82	–/5.71[**]		
Impression changes in media	Z7	1/0.76	0.573/0.60	–/7.98[**]	0.56/0.50	0.94/0.92
	Z3	1.62/1.27	0.87/0.82	7.39[**]/10.51[**]		
	Z2	1.65/0.97	0.89/0.82	7.50[**]/8.22[**]		
	Z1	0.996/0.96	0.66/0.77	6.30[**]/9.92[**]		
	Z5	1.71/1.01	0.80/0.78	6.84[**]/13.76[**]		
	Z6	1.58/1.045	0.79/0.79	7.19[**]/10.31[**]		
	Z7	1.01/0.76	0.63/0.60	6.06[**]/7.98[**]		
	Z8	1.34/0.73	0.74/0.55	13.10[**]/6.5[**]		
	Z9	1.41/0.88	0.77/0.65	9.00[**]/7.70[**]		
	Z10	1.42/0.76	0.71/0.61	6.55[**]/7.3[**]		
Intention to adopt ETC service	H1	1/1	0.74/0.86	–	0.61/0.78	0.79/0.89
	H2	1.12/1.07	0.81/0.90	9.81[**]/12.87[**]		

[**] 5% significance level.

Table A2
Correlation coefficients among constructs incorporating impression changes in media (ETC users /non-users).

	RISK	AG	MD	BC	EOU	U	SN	ATT	INT
RISK	**1**								
AG	0	**1**							
MD	0	0	**1**						
BC	0/−0.133	0	0	**1**					
EOU	0	0	0.25/0.29	0	**1**				
U	0	0	0.18/0.21	0	0.71/0.36	**1**			
SN	0	0	0.27/0.26	0/0.22	0.07/0.07	0.05/0.05	**1**		
ATT	0	0.07/−0.06	0.36/0.36	0/0.23	0.70/0.31	0.79/0.59	0.10/0.46	**1**	
INT	−0.21/−0.32	−0.09/0.16	0.31/0.37	0.19/0.29	0.51/−0.03	0.57/0.25	0.29/0.46	0.72/0.43	**1**

Note: RISK: Perceived/expected risk, MD: Impression changes in media, EOU: Perceived/expected ease of use, U: Perceived/expected usefulness, BC: Perceived/expected behavioral control, AG: Attitude of government, SN: Subjective norms, ATT: Attitudes, INT: Intention to adopt ETC service.

Table A3
Estimated results of the CFA model with impression changes in WOM (ETC users/non-users).

Constructs	Items	Regression coefficients	Factor loadings	*t*-values	AVE	Cronbach's α
Perceived/expected usefulness	A1	1/1	0.806/0.929	–	0.67/0.64	0.90/0.88
	A2	1.118/0.986	0.876/0.808	12.371[**]/12.605[**]		
	A3	1.039/0.883	0.812/0.754	10.864[**]/11.469[**]		
	A4	1.134/0.859	0.78/0.689	10.735[**]/9.622[**]		
Perceived/expected ease of use	B1	–/0.944	–/0.772	–/6.041[**]	0.65/0.60	0.84/0.73
	B2	1	0.961/0.777	–		
	B3	0.918/–	0.737/–	9.907[**]/–		
	B4	0.648/–	0.701/–	8.593[**]/–		
Attitudes	C1	0.839/1	0.889/0.881	16.781[**]/–	0.77/0.70	0.94/0.88
	C2	0.844/0.96	0.893/0.882	16.786[**]/14.386[**]		
	C3	1/0.935	0.902/0.886	–/14.897[**]		
	C4	0.857/0.755	0.814/0.688	13.61[**]/9.476[**]		
Attitude of government	E1	–/1	–/0.65	–	–/0.52	–/0.76
	E2	–/1.038	–/0.748	–/6.769[**]		
	E3	1/1.077	1/0.75	–/6.845[**]		
Subjective norms	Q1	1/1	1/1	–	–	–
Perceived/expected behavioral control	F2/ F3	1/1	1/1	–	–	–
Perceived/expected risk	G1	1/1	1/1	–	–/0.52	–/0.75
	G2	–/1.388	–/0.79	–/5.84[**]		
	G3	–/1.572	–/0.811	–/0.569[**]		
Impression changes in WOM	Z11	0.552/1.204	0.5/0.783	5.716[**]/7.307[**]	0.54/0.59	0.75/0.79
	Z10	1.398/1.1	0.931/0.822	7.125[**]/8.062[**]		
	Z9	1/1	0.721/0.689	–/–		
Intention to adopt ETC service	K1	1/1	0.743/0.89	–/–	0.60/0.87	0.79/0.89
	K2	1.117/1.12	0.81/0.975	9.675[**]/11.569[**]		

[**] 5% significance level.

Table A4
Correlation coefficients among constructs incorporating impression changes in WOM (ETC service users/non-users).

	AG	RISK	WOM	BC	EOU	U	SN	ATT	INT
AG	**1**								
RISK	0	**1**							
WOM	0	0	**1**						
BC	0	0	0	**1**					
EOU	0	0	0.24/0.31	0	**1**				
U	0	0	0.16/0.19	0	0.66/0.43	**1**			
SN	0	0	0.30/0.27	0/0.22	0.37/0.45	0.50/0.50	**1**		
ATT	0.086/–	0	0.30/0.25	0/0.15	0.65/0.53	0.8/0.73	0.44/0.63	**1**	
INT	−0.05/–	−0.22/−0.39	0.25/0.48	0.17/0.22	0.49/0.35	0.62/0.41	0.49/0.51	0.73/0.51	**1**

Note: RISK: Perceived/expected risk, MD: Impression changes in media, EOU: Perceived/expected ease of use, U: Perceived/expected usefulness, BC: Perceived/expected behavioral control, AG: Attitude of government, SN: Subjective norms, ATT: Attitudes, INT: Intention to adopt ETC service.

References

Alan, D.S., 2008. Customer relationship management considerations and electronic toll collection as sustainable technology. International Journal of Sustainable Economy 1 (1), 17–42.

Anderson, J.C., Gerbing, D.W., 1998. Structural equation modeling in practice: a review and recommended two-step approach. Psychological Bulletin 103 (3), 411–423.

BIG research, 2005. Worth of mouth most influential, other media vary by demos and product categories.

Bollen, K.A., 1989. Structural Equations with Latent Variables. John Wiley & Sons, New York.

Chen, C.-D., Fan, Y.-W., Farn, C.-K., 2007. Predicting electronic toll collection service adoption: an integration of the technology acceptance model and the theory of planned behavior. Transportation Research: Part C 15 (5), 300–311.

Choo, S., Mokhtarian, P.L., 2007. Telecommunications and travel demand and supply aggregate structural equation models for the US. Transportation Research Part A 41 (1), 4–18.

Davis, F.D., 1989. Perceived usefulness, perceived ease of use and user acceptance of information technology. MIS Quarterly 13 (3), 319–340.

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.

Duan, W., Gu, B., Whinston, A.B., 2008. The dynamics of online word-of-mouth and product sales—an empirical investigation of the movie industry. Journal of Retailing 84 (2), 233–242.

Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research 18 (3), 39–50.

Golob, T.F., 2003. Structural equation modeling for travel behavior research. Transportation Research Part B 37 (1), 1–25.

Golob, T.F., Hensher, D.A., 1998. Greenhouse gas emissions and Australian commuters' attitudes and behavior concerning abatement policies and personal involvement. Transportation Research Part D 3 (1), 1–18.

Hair Jr., J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 1998. Multivariate Data Analysis. Prentice-Hall, Englewood Cliffs, NJ.

Jakobsson, C., Fujii, S., Garling, T., 2000. Determinants of private car users' acceptance of road pricing. Transport Policy 7, 135–158.

Rogers, E.M., 2003. Diffusion of innovations, fifth ed. Free Press, New York.