Effects of ETC Service Failure and Recovery Strategies on Freeway Drivers' Satisfaction

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Abstract: In Taiwan, a distance-based electronic toll collection (ETC) system will be implemented to replace the manual collection of freeway tolls at tollbooths. For improving the service satisfaction and increasing the usage rate of the ETC, this study discusses the effects of service recovery after ETC service failure on drivers' satisfaction and usage intention. The critical incident technique (CIT) is applied to explore incidents of service failure and service recovery in relation to ETC. Statistical methods are used to discuss the intentions and preferences of drivers for service recovery via scenarios. A survey conducted using a questionnaire designed through the stated preference approach is utilized to investigate Western Taiwan freeway corridor users. The analytical results should assist the responsible managerial and operational agencies to develop better marketing strategies enhancing the usage rate of the ETC system.

Keywords: Electronic Toll Collection (ETC), Service Failure, Service Recovery, Satisfaction, Usage Intention

1. INTRODUCTION

The Taiwan Freeway Bureau will implement a fully electronic toll collection (ETC) system to replace manual collection of freeways tolls. This distance-based charging strategy should become fully operational in 2013. Distance-based charging can effectively alleviate traffic delays in metropolitan areas and solve the unfairness issue with respect to user payment. Provision of the free-flow ETC system should promote better traffic management. However, successful implementation of a distance-based charging strategy depends on the usage rate of vehicles which need to be equipped with ETC devices that enable drivers to pay tolls without stopping. According to the operating contract with the Far Eastern Electronic Toll Collection Company (FETC) responsible for the ETC service, ETC usage rate should achieve a regulative goal of 65%. However, the ETC usage rate was only 43% by June 2012, and there is still a gap between the current and the goal usage rate. To achieve the anticipated usage rate, the FETC has tried price promotion strategies to attract more ETC users, such as discounts for the on-board unit (OBU) needed for the ETC system and a 5% toll discount for ETC users. It has now decided to gradually replace the OBU equipment with free-of-charge eTags since May 2012.

Even before the ETC began to operate, there have been some studies discussing related issues such as the intention and behavior of choice, acceptance, and marketing strategies. Huang *et al.* (2005) constructed a method for stated preference analysis in efforts to understand the crucial factors impacting the behavioral intentions of drivers of passenger car

toward OBUs and concluded that the cost of the unit, the product life cycle, the frequency of freeway driving, and the driver's average income significantly affected the choice of behaviors in relation to distance-based charging. According to Lin (2006), acceptance of the ETC service scored only 2.05 on a five-point Likert scale. Social regulations, perceived behavioral control, along with user attitude compromising advantages, perceived ease to use, as well as process equity of the ETC, significantly positively influence usage intention, whereas the perceived risks such as financial risks and performance risks negatively impact this intention (Farn *et al.*, 2006). Arguments have arisen during the operation of the ETC service. Hung (2004) aimed that ETC has fallen into the invisible chasm of the innovative product market.

Wu (2007) analyzed the factors influencing the drivers who do not use the ETC system, in which the risk of ETC service failure is the major reason that more highly educated drivers on relatively longer trips choose not to use the service because they disagree the ETC as more convenient than traditional toll collection through the individual choice models. Chen (2007) indicated a significant gap between the expected and perceived service quality of ETC. However, usage and traffic volume have gradually increased due to marketing promotions since 2006. Revealed preference surveys have been carried out to explore the critical factors influencing cognition and behavior of consumers. For example, Liang (2009) developed an ETC cognitive scale to measure how cognitions of information technology characteristics and risk impacted road users' willingness to utilize the ETC service. The performance of ETC service improved based on the appropriate media spread, both new type and traditional one, along with positive public praises, has assisted in the implications of new transportation policies (Chen *et al.*, 2010). Sheng (2010) analyzed the characteristics of OBU users to explore the survival time of ETC services and the socioeconomic features of drivers preferring to use these services.

The advantages of the ETC service such as tolling efficiency, energy saving, pollution mitigation, and the integration of an electronic tooling and transportation management system (TMS) are demonstrated using real time information based on systematic data collection. However, the dispute about the ETC system has continued since February 2006 leading to driver lower acceptance rates. Reasons for this include the illegal bidding process, problem with the infrared reading system, and insufficient ETC traffic flows. Moreover, there have also been some service failures that limit consumer intentions to use ETC from the viewpoint of users, such as the lack of 24/7 counter services, lack of reliability of the tolling system that sometimes fails to charge without reason, much higher procedure fees for unpaid tolls, and insufficient notice for repaying omitted tolls (Wu, 2006). Service failures are unavoidable due to the intangibility and inseparability (Goodwin and Ross, 1992; Levesque and McDougall, 2000). A service failure occurs when customers' perceptions of service delivery do not meet customer expectations (Kelley *et al.*, 1993). Defects or dissatisfaction in any encounter during service delivery may cause a negative customer response of customers, such as negative word-of-mouth, bad feeling toward the seller or a reluctance to make a repeat purchase, all of which may potentially harm business profitability and reputation (Kelley and Davis, 1994; Johnston and Hewa, 1997). An immediate service recovery is helpful to mitigate the dissatisfaction of consumers experiencing a service failure (Kuo *et al.*, 2011), and even to increase the probability of repurchasing (Gilly, 1987). Therefore, one major issue to improve the use of the ETC service denotes an acceptable recovery after service failure. Particularly, the ETC service must meet the customer demands to keep the existing customers and attract more potential consumers based on the business perspective.

The freeway ETC service was developed as a public-private partnership (PPP) concession through a build-operate-transfer (BOT) contract involving all freeway users, and as

such has attracted societal attentions. Mass media and the word-of-mouth have magnified the failure of ETC services, leading to decreased user intention and misunderstanding of the implications of ETC strategies. Thus, service recovery measures must be taken immediately after ETC service failure occurs in order to enhance customer satisfaction and stimulate positive comments to rescue afflicted customers who may otherwise leave the program. Studies of service failure and service recovery are numerous, but there have been few specifically dealing with ETC service problems. Before the distance-based charging strategy is implemented on Taiwan freeways, attention should be paid to the potential usage rate of the ETC system and the opinion of freeway drivers about the service. Therefore, this study explores service failure and recovery strategies for the ETC to realize freeway drivers' satisfaction and usage intention. An empirical study can provide an understanding of freeway drivers' behaviors and suggest policy implications for a better service marketing strategy in order to enhance the usage rate of the ETC service. Accordingly, this study constructed a scenario framework to evaluate the performance and acceptance of proposed service recovery strategies.

2. SERVICE FAILURE AND RECOVERY

In this consumer-oriented era, enterprises must provide high quality services to satisfy customer demands and thus increase revenues. However, it costs five times more to attract new customers than to keep the existing ones (Desatinck, 1988). Keaveney (1995) noted that the financial losses incurred from losing frequent customers are much greater than for new consumers. Service failure can result from the malfunctioning of various service processes owing to intangibility, inseparability, heterogeneity and perishability. In fact, there could be a service failure anytime and anywhere during the process of service delivery (Bitner *et al.*, 1990). Service failures are characterized by duration, magnitude, and frequency (Kelley and Davis, 1994) and can occur in every encounter during service delivery because the provision and consumption of service simultaneously exist in such encounters (Goodwin and Ross, 1992). Service failures are divided into core service failures including mistakes, billing errors, and service catastrophes, as well as service encounter failures related to uncaring, impolite, unresponsive, or unknowledgeable encounters (Keaveney, 1995).

Numerous researchers have confirmed that there are two types of service failure: outcome and process. The outcome type of failure occurs when the organizations fail to satisfy customer demands or offer incomplete core services, whereas the process type of failure involves the defective delivery of a core service in which consumers perceive uncomfortable service attitudes and procedures (Parasuraman *et al.*, 1988; Hoffman *et al.*, 1995; Mour and Binter, 1995; Smith *et al.*, 1999). Parasuraman *et al.* (1985) constructed a conceptual model to measure service quality with five service gaps between customer perception and expectation. Bell and Zemke, (1987) verified that services failure occurs when customer perceptions are less than their expectations. This gap thus becomes the major considerations in service failure. The negative impact of service failure on enterprise operations are related to inferior service quality (Parasuraman *et al.* 1994), customer satisfaction, repurchase intention, (Smith and Bolton, 1998), and customer relationships (Bolton, 1998). Customers may switch to another service provider, complain to the firm about the issue, or expect a better service in the next encounter when they experience a service failure (Ko, 2007). Moreover, negative word-of-mouth triggered by service failure can expand rapidly through the internet, impacting the image of the company. Moreover, inefficient or failed service encounters increase operational

costs due to the necessity to offer service re-provision measures or compensations for consumer dissatisfaction (Tax and Brown, 1998). Dissatisfied consumers express their opinions through exiting from the services, complaining to the firm, third-party action, or negative word-of-mouth, damaging potential benefits as well as corporate image (Day and Landon Jr., 1976; Folks, 1984; Singh, 1990; Keaveney, 1995; Tax *et al.*, 1998).

However, appropriate recovery after service failure might assist an enterprise in reducing its losses and even increase customer loyalty (Gremler and Brown, 1998). Service recovery thus might become a barrier preventing consumers from switching to another service provider even if they have experienced a service failure. Barry and Terry (2008) discussed switching costs, which denote the costs to the consumer as a result of changing one service provider to another, as a measure of switching barriers. Burnham *et al.*, (2003) also adopted switching costs to investigate different aspects such as the loss of existing benefits or extra efforts incurred when accepting a new product or service. Switching barriers comprise the monetary costs, the psychological aspect of facing a new firm, and the time and effort involved in learning to use a new service or product. The likelihood of consumers engaging in some activity should diminish when the perceived costs increase. Thus, consumer intentions to switch to a new provider decrease as switching barriers increase. Previous studies have tested the relationship between switching barrier and customer loyalty, and their findings indicate that the switching barrier is an important factor in predicting customer loyalty. Huang and Hsieh (2012) evaluated consumer electronics acceptance based on innovation attributes and switching barriers, and found that the switching barrier has a significantly negatively effect on the willingness of traditional readers to use e-books. Deng *et al.* (2010) concluded that the switching barrier directly enhances customer loyalty in mobile instant message services. Consumers would change if and only if the utilities provided by new suppliers exceed the summation of that from the existing supplier and the switching barriers.

Service recovery, a rescue process for bridging the negatively unacceptable gaps to achieve consumer expectations (Zemke and Bell, 1990), representing the strategies to improve customer dissatisfaction after experiencing service failure assists in constructing a good customer relationship, and avoiding the demonstration of disloyal behaviors to the existing firm (Fornell and Wernerfelt, 1987). Similarly, Johnston and Hewa (1997) defined service recovery as a mitigation of consumer losses to effectively retrieve the failures, and then re-build confidence in the service provider (Tax *et al.*, 1998). A widely accepted concept of service recovery refers to the strategies designed to modify the customer dissatisfaction (Harris *et al.*, 2006). Moreover, effective service recovery can have a positive impact on customer retention rates, decreasing the spread of negative word-of-mouth and improving profitability (Tax *et al.*, 1998). Reichheld and Sasser Jr. (1990) found that a reduction in customer defection rates of 5% could increase the profits of the service provider by up to 85%. Hoffman *et al.* (1995) suggested that some recovery strategies, such as the offering of restitution by managers and the compensations including free services, discounts, as well as coupons, perform better than other methods. If an operator can lower its customer defection rate from 20% down to 10%, the average life span of its relationship with a customer doubles from 5 to 10 years and, accordingly, profits continue to rise (Orilio, 2007). It is also found that in case of severe failure, consumers in western cultures possess more active and rapid recovery measures than those in eastern cultures (Lin, 2011).

In comparison to low recovery efforts, high recovery efforts are consistently evaluated highly in terms of perceived justice, which has a positive effect on customers' future behavioral intentions, regardless of the level of the relationships (Ha and Jang, 2009). Wang *et al.* (2011) indicated that the severity of the service failure, the justices of interactions and

procedures, along with perceived switching costs significantly influence customer loyalty, where interactional justice mitigates the negative impact of service failure severity on customer loyalty. Zhou *et al.* (2012) examined the differences between immediate and delayed resolution in response to consumer complaints in term of re-patronage and negative word-of-mouth intentions, resulting in that the relationship between service separation-response timing interaction and consumer response is mediated by the consumers' negative emotions. When additional compensation is offered after a service failure, the perceived equity is increased regardless of the consumer's relationship level (Kwon and Jang, 2012). In contrast to traditional service encounters involving a high contact but low technique mechanism, delivered by direct encounters between employees and customers, the implications of self-service technology (SST), e.g., automated teller machines (ATM), voice-back systems, and fax-back systems, lead to new type of SST-related failures (Pai *et al.*, 2002). Zhou *et al.* (2012) indicated that greater recovery effort increases the likelihood of staying with an SST, whereas more recovery strategies increase the likelihood of switching.

In the transportation industry, the most often adopted strategy for recovery after service failure is represented by refunding the ticket price. However, the compensation and its impact of transportation failures on the psychology of the passengers are absent in Taiwan (Chen, 2008). Wang *et al.* (2010) found that the frequency of service failures in airlines significantly and negatively affects perceived service quality and positively influences perceived failure severity, in which the invisible and unfair priority of the seat waiting list considered to be the most unacceptable type of failure. Hu *et al.* (2010) noted that delivering different information about ascription of delay responsibility significantly influences the perceived controllability of the delay and the response of railway passengers. Due to the insufficient information, the SST reservation system of the Taiwan Railway Administration has had problems with inappropriate ascription of responsibility and promises to customers (Jen *et al.*, 2007). Huang (2008) employed the technology acceptance model to analyze the SST intention to change behavior in relation to the Taiwan High Speed Railway and concluded that suitable assistance with automated ticket machines would be helpful to improve the technological readiness and the willingness of passengers to use the system.

3. RESEARCH METHODOLOGY

3.1 Critical Incident Technique

The critical incident technique (CIT) was developed by Flanagan (1954) to examine the aviation performance of pilots by helping observers to classify errors. Basically, CIT is a set of procedures used for collecting direct observations of human behavior that have critical significance and that meet methodically defined criteria. These observations are then kept track of as incidents, which are then used to solve practical problems and develop broad psychological principles. A critical incident can be described as one that makes a significant contribution—either positively or negatively—to an activity or phenomenon. Reports of critical incidents can be gathered in various ways, but typically respondents are asked to tell a story about an experience they have had.

CIT is a flexible method that usually relies on five major areas. The first is determining and reviewing the incident, followed by fact-finding, which involves collecting the details of the incident from the participants. When all of the facts are collected, the next step is to identify the issues. Afterwards a decision can be made on how to resolve the issues based on

various possible solutions. The final and most important aspect is the evaluation, which will determine if the solution that was selected will solve the root cause of the situation and will cause no further problems. Generally, CIT includes five steps: establishing the general aims, establishing plans and specifications, collecting the data, analyzing the data, and interpreting and reporting the data.

The first essential CIT step is to define the activity to be studied and establish its aim. This involves the development of research questions and provides direction for data analysis and presentation of the findings. The aim is encapsulated in a brief, clear statement – a 'functional description' that indicates the objective of the activity and what someone engaging in the activity is expected to accomplish. Second, establishing plans and specifications involves developing a detailed and defensible plan of attack for data collection. Importantly this includes the identification of critical incidents and the recording of critical behaviors. The third step, collecting the data, involves collecting information on critical incidents that relate to the activity being studied. The preferred means for data collection are individual interviews or direct observations. Group interviews are acceptable where participant numbers are large. Written responses or questionnaires may also be used. Analyzing the data involves an inductive data analysis process that aims to classify critical incidents and identify critical behaviors. These are arranged into a series of well defined, mutually exclusive categories and sub-categories of decreasing generalizability or increasing specificity. The final step, interpreting and reporting, involves interpreting and reporting the data, in line with the intended application of the findings. CIT does not require a specific report format, but the results often include a set of critical behaviors that define the activity studied.

Kelley *et al.* (1993) utilized CIT to classify the complaint handling as well as service recovery of retailers and determined the evaluations of the recovery strategies along with the willingness to repurchase of consumers experiencing service failures. The discount, modification, and promises from managers were verified as effective strategies. Hoffman *et al.* (1995) employed CIT to explore recovery strategies for restaurants, finding that the oral apology means nothing to consumers. Chen (2010) discussed the classification of service failures and recoveries by maritime freight forwarders using CIT. According to the seven critical criteria influencing user satisfaction and loyalty, namely accuracy of ship arrival and departure times, service abilities during encounters, supply abilities in terms of shipping space, ability to provide extra shipping space, efficiency to reply to space orders, and accuracy of cargo tracking, the contracts of services assist forwarders in improving efficiency of supply chain operations. In this study, CIT is employed to determine the critical service failures and recovery strategies for the ETC system.

3.2 Data Collection

To design the ETC service failure scenarios and recoveries strategies, this study first collected information on existing failure incidents and driver complaints in relation to the ETC service from online public forums and e-news sources. A questionnaire with stated preferences was designed to gather drivers' satisfaction and usage intentions related to ETC service failure and recovery strategies. Before the questionnaire investigation was executed, a pretest was given to three experts and ten freeway drivers who often used the ETC service to ensure the adequacy and linguistic articulation of the questionnaire content. After that, the questionnaire was refined and finalized for the formal investigation. The questionnaires were distributed to the drivers of passenger vehicle using the freeways, including both users and non-users of the ETC service.

To understand the behaviors and intentions of drivers who do not pass through the tolling stations, the e-questionnaires were simultaneously available through the Internet and hard copies were distributed at eight service areas in the National Freeway system, from May to July, 2012. 640 effective samples with various trip purposes on both weekdays and holidays were received. The first part of the questionnaire investigate trip characteristics through revealed data, such as trip purpose, freeway trip frequency, average freeway trip distance, average tolls, the toll payment channels, and the experiences of failure for ETC users, or the major reasons for the unwillingness of non-ETC users. Along with the willingness to use the ETC service through a five-point Likert scale anchored from 'strongly disagree' to 'strongly agree,' three attributes such as "I prefer to pay tolls through manual toll collection," "It is important to me whether the ETC service can save me time," and "It is inconvenient to change my habits to utilize the ETC service", are employed to measure the switching barriers to drivers currently using the traditional toll collection mechanism. According to Huang (2008), the socioeconomic characteristics of the drivers significantly impact the satisfaction with ETC services. The second part of the questionnaire thus relates to gathering information about the socioeconomic features of the respondents, including residence, sex, age, education, and income, to understand the sample structure and explore the differences for classification analyses.

This study constructed three ETC service failure and recovery scenarios according to the CIT process. Respondents were asked to indicate their perceptions of each attribute on a five-point Likert scale ranging from 'strongly dissatisfy' to 'strongly satisfy'. *Scenario I* describes a failure to charge the toll attributed to ETC system breakdown while drivers pay NT$40 each time they pass through a toll plaza (NT$1 is approximately equivalent to US$0.034). In this scenario, drivers are asked to pay an extra fee (NT$50) for an overdue bill for the ETC toll. *Scenario II* refers a failure to charge the toll fee due to an insufficient sum remaining on the OBU or eTag for a driver passing through two ETC toll plazas (NT$40*2=NT$80) in a single trip. The driver is asked to pay an additional overdue fee (NT$50) twice, on for each plaza which is higher than the tolls. In *Scenario III*, the same situation is described as in the second scenario, but the driver is imposed a penalty (NT$600 per passed toll plaza) because of the lack of overdue bill notices. Each service failure corresponds to three adoptable recovery strategies. The three scenarios are compared in Table1.

Table 1. Hypothetical service scenarios

Scenario	Service failure	Recovery strategies
Scenario I	● Failure to charge due to the ETC system ascription	A. Cancelling the extra fee
		B. Cancelling the extra fee & 10% off for the overdue toll
	● Non-immediate notice for charging failure	C. Cancelling the extra fee & receiving a compensating gift valued NT$50
Scenario II	● Non-immediate notice for charging failure	D. Keeping the extra fee NT$100
		E. Charging extra fee once per day
		F. Charging extra fee once per week
Scenario III	● Non-immediate notice for charging failure	G. Keeping the penalty NT$1,200
		H. Imposing the penalty once NT$600 per day or week
	● Non-confirmed following notice for charging failure	I. Imposing the penalty once NT$600 per day or week and promising the notice delivery address

4. EMPIRICAL RESULTS

4.1 Results of Descriptive Statistics

Table 2 lists the results of descriptive statistics. According to the socioeconomic data, male drivers (68.1%) are the major freeway users, while most drivers are aged between 25 and 54 years old (84.3%). 60% of the respondents have a college education, with the average income of between NT$ 20,000-80,000 per month (79.2%). Based on the trip characteristics, the most commonly trip purpose represents for leisure (30.3%), followed by business trips (21.9%), commuting (18.9%) and returning to one's hometown (17.0%). Notably, 60.8% of the drivers had not experienced the ETC services. Moreover, 47.4% of ETC users were satisfied with the service, whereas 14.4% of users were dissatisfied.

Table 2. Descriptive statistics

Item	Classification	Respondent (%)	Item	Classification	Respondent (%)
Sex	Male	436 (68.1)	Education	Below high school	98 (15.3)
	Female	204 (31.9)		Colleges	384 (60.0)
Age	18-24	74 (11.6)		Graduate school	158 (24.7)
	25-34	239 (37.3)	Income	< NT$20,000	77 (12.0)
	35-44	201 (31.4)		NT$ 20,000-39,999	235 (36.7)
	45-54	100 (15.6)		NT$ 40,000-59,999	199 (31.1)
	> 55	26 (4.1)		NT$ 60,000-79,999	73 (11.4)
Trip	Commute	121 (18.9)		≧ NT$ 80,000	56 (8.8)
purpose	Business	140 (21.9)	ETC	Non-users	389 (60.8)
	Hometown return	109 (17.0)	experience	< 1 year	75 (11.7)
	Visiting	60 (9.4)		1-3 years	113 (17.7)
	Leisure	194 (30.3)		4-5 years	32 (5.0)
	Other	16 (2.5)		> 5 years	31 (4.8)

Additionally, this study utilizes a multiple responses to identify the major reasons why drivers are unwilling to use the ETC service. Rare usage of the freeway becomes the most crucial reason (46%), while 130 respondents (33.4%) are unwilling to pay for electronic toll equipment, i.e., OBU or eTag. 22.4% of respondents noted the inconvenience of the value storing procedure, followed by the risk of ETC service failure (20.6%). Moreover, 60 drivers (15.4%) disagree with the efficiency of ETC service. Some minor reasons included habitual use of hardcopy prepaid tickets, unacceptability of the illegal bidding process by the FETC, not liking the appearance of the device, spatial occupancy, and taking public vehicles. From the perspective of ETC users, the most unacceptable type of failure refers to the addition of an extra fee in excess of the unpaid tolls (32.3%), followed by having to pay a processing fee for value storage in convenience stores (28.7%). 66 respondents (26.3%) expressed dissatisfaction with failure to charge attributed to ETC system breakdown while still having a sufficient sum remaining in the OBU or eTag. Other perceived failures were the inability to check the sum remaining in the toll payment equipment without spatial-temporal limitation (21.1%), lack of 24/7 counter services (13.1%), non-immediate notice for failure to charge through a short message service (11.6%), and unreliable delivery of notification letters (9.6%).

4.2 Differential Analysis of Customer Satisfaction

4.2.2 ANOVA for service recovery

One-way analysis of variance (ANOVA) was adopted to examine differences in driver satisfaction for different service recovery strategies. The analytical results reveal that all F-values for all three scenarios have a significance level of p=0.05, indicating that the three different recovery strategies (A, B, and C for *Scenario I*, see the last column in Table 1) significantly impact the customer satisfaction in all scenarios. Moreover, this study utilized Scheffe post hoc test to compare paired recovery strategies. Table 3 lists the analytical results of the Scheffe post hoc test, in which the significant differences exist between the paired recovery strategies in the same scenario except the difference between the compensations of a 10% discount (strategy B) or by a gift valued at NT$50 (strategy C) in *Scenario I*.

Table 3. One-way ANOVA results

Recovery scenarios and strategies*			Mean difference	*p*-value	95% confidence	
	(x)	(y)	(x-y)		upper	lower
Scenario I	A	B	-0.341	0.000	-0.50	-0.18
	A	C	-0.445	0.000	-0.60	-0.29
	B	C	-0.105	0.270	-0.26	0.05
Scenario II	D	E	-0.402	0.000	-0.57	-0.23
	D	F	-0.891	0.000	-1.06	-0.72
	E	F	-0.489	0.000	-0.66	-0.32
Scenario III	G	H	-0.303	0.000	-0.45	-0.15
	G	I	-0.795	0.000	-0.94	-0.65
	H	I	-0.492	0.000	-0.64	-0.34

* *The letters A, B, C … I denote the recovery strategies in the last column of Table 1.*

4.2.2 Sample classification based on trip and socioeconomic characteristics

Based on the ANOVA results for sample classification, driver satisfaction under *Scenario I* is revealed to be indifferent at the 0.05 significance level, except for driving distance, area of residence, age, and income. The results of Scheffe post hoc test indicate that the differences between all paired classifications are insignificant. Driver satisfaction for most characteristic classifications under *Scenario II* achieves a significance level of p=0.05 except for driving distance, while insignificant differences exist for tolling mechanism under *Scenario III*. Table 4 shows a significant difference level of p=0.05.

According to Table 4, frequent freeway users tend to utilize the ETC service for their trips. This is consistent with the results obtained in previous studies (e.g., Sheng, 2010). Drivers making hometown return trips are relatively more willing to utilize ETC services because of prior efficiencies related to having to drive during peak hours and relatively longer trip distance. Similar to Chen *et al.* (2010), the analytical results from this study reveal that residents in the northern area of Taiwan show greater willingness to employ the ETC system and contribute the most usage of electronic equipments. The major reason for the differences based on area of residence denotes the distinct road use practices, meaning fewer drivers in central and southern Taiwan use the freeway to commute, particularly for a trip that requires passing through a tolling plaza. Moreover, drivers with higher education or income tend to use ETC service to reduce the waiting time for passing through the tolling plazas, to decrease the tolls by taking advantage of the specific ETC discount, and to improve air and noise pollutions. Younger drivers aged between 18 and 24 are comparatively unwilling to use ETC

services for their freeway trips. This is consistent with the findings of Wu (2006). Notably, drivers paying by the traditional mechanism, including cash and hardcopy prepaid tickets expressed greater preference to use the ETC service than did existing ETC users who might experience service failures of the ETC system.

Table 4. Significance results for paired-compared sample classifications

Characteristics	*Scenario II*			*Scenario III*		
	Classification		Difference	Classification		Difference
	Based	Compared	(*p*-value)	Based	Compared	(*p*-value)
Trip						
Frequency	Per month	Per day	-0.279 (0.048)	Per 2-3 days	Per week	0.247 (0.049)
		Per 2-3 days	-0.342 (0.011)		Per month	0.285 (0.018)
		Per 2 weeks	-0.373 (0.009)		--	
Purpose	Hometown	Visiting	0.367 (0.017)	Hometown	Commuting	0.245 (0.036)
		Leisure	0.375 (0.000)		Leisure	0.271 (0.003)
	Business	Leisure	0.249 (0.021)		--	
Distance	--	--		30-100 km	100-200 km	-0.176 (0.019)
Mechanism	Traditional toll	ETC	0.141 (0.006)	--	--	
Socioeconomic factors						
Area of residence	North	Central	0.304 (0.000)	North	South	0.198 (0.001)
		South	0.333 (0.000)		--	
Sex	--	--		Male	Female	-0.106 (0.019)
Age	18-24	25-34	-0.490 (0.000)	18-24	25-34	-0.431 (0.000)
		35-44	-0.514 (0.000)		35-44	-0.438 (0.000)
		45-54	-0.339 (0.024)		45-54	-0.472 (0.000)
Education	Below high school	College	-0.237 (0.003)	Below high school	Graduate	-0.242 (0.002)
		Graduate	-0.415 (0.000)		--	
	College	Graduate	-0.178 (0.009)		--	
Income	< 20k	60-80k	-0.372 (0.008)	--	--	
	20-40k	40-60k	-0.338 (0.000)	--	--	
		60-80k	-0.479 (0.000)	--	--	

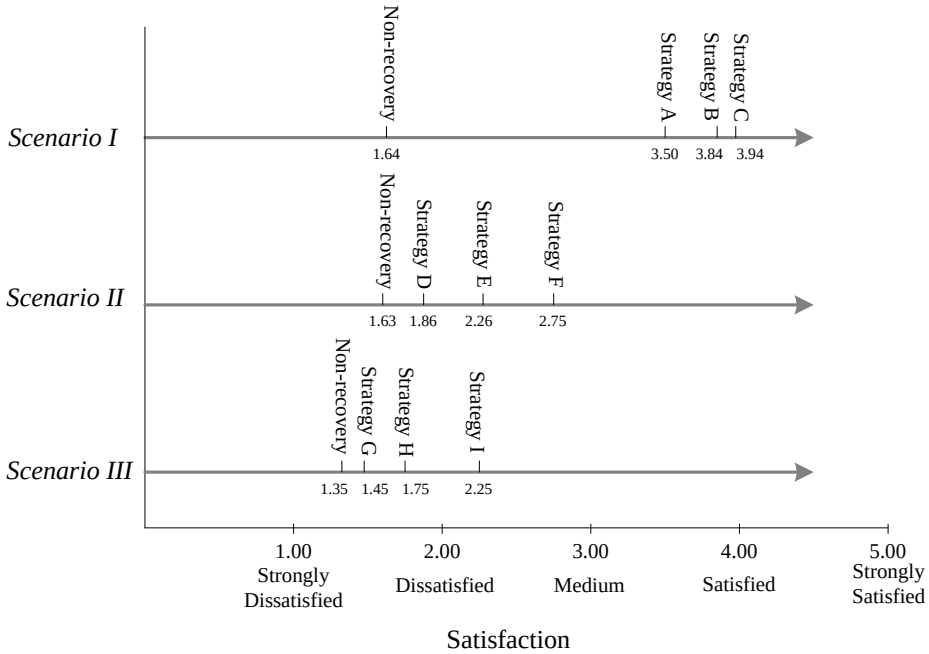
4.3 Impact of Service Recovery on Customer Satisfaction

The dummy variable regression model is utilized to estimate the parameters because the service recovery strategies are class variables, t. Three dummy variables referring to service recovery strategies for each scenario (i.e., D_A, D_B, and D_C for *Scenario I*, D_D, D_E, and D_F for *Scenario II*, along with D_G, D_H, and D_I for *Scenario III*) are used for analysis of the impact of service recovery strategies on driver satisfaction. The results of the dummy variable regression model are listed in Table 5. F-values in all three scenarios achieve the significance level of p=0.05, indicating that driver satisfaction is significantly dependent on dummy variables in all scenarios. Based on the positive Beta values, the service recovery strategies are seen to possess a significantly direct and positive influence on driver satisfaction. The results imply that the post-recovery satisfaction levels are greater than before adoption of the recovery strategy. Moreover, driver satisfaction increases when the provider improves the recovery strategy.

Table 5. Estimation of dummy regression indicating driver satisfaction and service recovery

Model		Non-standardized coefficient		Standardized	*t*-value	*p*-value
		Coefficient	Standard deviation	Beta		
Scenario I	Constant	1.64	0.04		37.328	0.000
	D_A	1.86	0.06	0.56	29.943	0.000
	D_B	2.20	0.06	0.66	35.428	0.000
	D_C	2.30	0.06	0.69	37.114	0.000
Scenario II	Constant	1.63	0.05		35.469	0.000
	D_D	0.23	0.06	0.08	3.487	0.000
	D_E	0.63	0.06	0.22	9.667	0.000
	D_F	1.12	0.06	0.39	17.193	0.000
Scenario III	Constant	1.35	0.04		33.534	0.000
	D_G	0.10	0.06	0.04	1.843	0.065
	D_H	0.41	0.06	0.16	7.180	0.000
	D_I	0.90	0.06	0.36	15.845	0.000

The post-recovery satisfaction levels for each strategy are illustrated in Figure 1. Compared to the other scenarios, the level of satisfaction is less with *Scenario III*, where charging much more fees and penalties leads to inferior satisfaction (1.35) before adoption of the recovery strategies. In both *Scenario II* and *III*, drivers attribute the responsibility of charging failures to an insufficient sum remaining in their electronic tolling device. However, Figure 1 indicates that the customer satisfaction ratings in those two scenarios are located between 1.45 and 2.75, below the medium level of 3.0, even when recovery strategies were employed. This verifies that if extra processing fees and penalties were not cancelled, the improvement of recovery is slight because drivers consider the additional charging is inappropriate. On the other hand, there is a significant improvement in driver satisfactions in *Scenario I* if the service provider cancels the extra fee as part of service recovery. In fact, other strategies, like offering 10% off the overdue toll or a gift valued at NT$50 assist in a gradual increase of satisfaction.



Note: Details of strategies A, B, C … I are indicated in the last column of Table 1.

Figure 1. Driver satisfaction for recovery strategies

4.4 Drivers' Willingness to Use ETC

This study adopts K-means clustering to discuss the market segments of drivers' willingness to utilize eTags for distance-based charging on the freeways. The switching barrier and post-recovery satisfaction are employed as the clustering variables to divide drivers into four clusters, as shown in Figure 2. The switching barrier is calculated based on the average score for the three measures mentioned in Section 3.2. The Pearson's chi-squared achieves 594.78 where p=0.000 and the degree of freedom is 12. In addition, 32.2% of respondents belonging to cluster 2, 31.2% are in cluster 1, while clusters 3 and 4 have 23.4% and 13.2%, respectively.

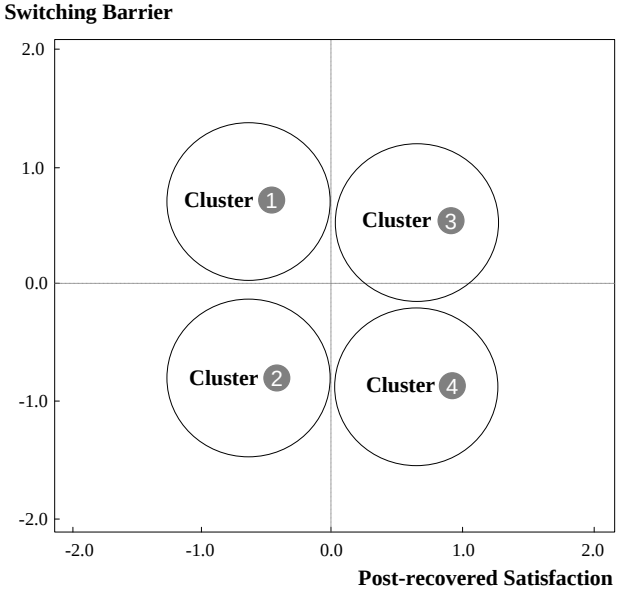


Figure 2. Clusters determined by post-recovery satisfaction and switching barriers

According to cluster cross analysis and willingness to use ETC services, drivers in cluster 1 (with higher switching barriers and relative dissatisfaction) would like to pay tolls though a non-ETC system, with 57.8% of drivers strongly disagreeing with and 35.5% of drivers disagreeing with willingness to utilize ETC services. In contrast, 53.3% and 24.9% of respondents who strongly agree with willingness to use ETC services are located in clusters 2 and 4, respectively, where the switching barrier is relatively lower. In fact, 70.6% of drivers in cluster 2 and 80.5% of respondents in cluster 4 would prefer to utilize the ETC service. The results reveal that the ETC service provider should pay attention to eliminating the switching barrier to increase usage. Notably, there exist insignificant differences of willingness to use ETC services between those who are relatively satisfied with service recovery strategies (i.e., clusters 3 and 4) and those dissatisfied with these strategies in clusters 1 and 2. This might result from the below medium level of satisfaction in *Scenarios II* and *III*, and is consistent with the findings of Hu *et al.* (2010).

5. CONCLUSIONS

To understand the post-recovery satisfaction of drivers experiencing ETC service failures, this

study investigates 640 effective responses from users of western freeway corridors. Scenario analysis is designed based on the critical incident technique as well as stated preference questionnaires. Based on the perspective of ETC users, the most unacceptable type of failure is related to extra fees in excess of unpaid tolls (32.3%), followed by processing fees for value storing at the convenience stores (28.7%). 66 respondents (26.3%) expressed dissatisfaction due to the failure to charge attributed to ETC system breakdown when they had a sufficient sum remaining on their OBU or eTag, while 21.1% of drivers were unhappy with the inability to check on the remaining sum in their tolling devices without spatial-temporal limitation (21.1%). On the other hand, rare usage of the freeway was the most crucial reason (46%) for non-ETC user, while 130 respondents (33.4%) were unwilling to pay for the electronic toll equipments, i.e., OBU or eTag. In addition, 22.4% of respondents cited the inconvenience of value storing, followed by the risk of ETC service failures (20.6%). Moreover, 60 drivers (15.4%) disagree with the efficiency of the ETC service.

Moreover, the results of one-way ANOVA reveal that all different recovery strategies significantly impact the customer satisfaction in all scenarios, with the significant difference between the paired recovery strategies in the same scenario. The exception is for the difference between being offered a 10% discount (strategy B) and a gift valued at NT$50 (strategy C) in *Scenario I*. Driver satisfactions for most characteristic classifications under *Scenario II* achieve the significance level of p=0.05 except for driving distance, while insignificant differences existed in tolling mechanism under *Scenario III*. According to the dummy variable regression model, the much more fees and penalties charged in *Scenario III* before adopting recovery strategies than in the other scenarios led to the inferior level of satisfaction (1.35). Drivers attributed the responsibility for the failure to charge due to an insufficient sum remaining in their electronic tolling equipments in both *Scenario II* and *III*. However, Figure 1 indicates that all customer satisfactions ratings in those two scenarios were located between 1.45 and 2.75, even if recovery strategies were employed. This verifies that if extra processing fees and penalties were not cancelled, the improvement of recovery is slight because drivers consider the additional charging is inappropriate. In contrast, driver satisfactions improved significantly in *Scenario I* after the service provider sought to recover from the failure by cancelling the extra fee. In fact, other strategies, like offering 10% off the overdue toll or a gift valued at NT$50 assisted in gradually increases in satisfaction.

According to the cross analyses of clusters and willingness to use the ETC service, the drivers in cluster 1, with a higher switching barrier and relative dissatisfaction, would like to pay tolls though a non-ETC system, in which 57.8% of drivers strongly disagree with and 35.5% of drivers disagree with the willingness to utilized ETC services, respectively. The results reveal that the ETC service provider should pay attention to eliminating switching barriers in order to increase the usage and by improving ETC service failures to enhance the positive evaluation of freeway drivers. This study contributes to ETC operators and responsible authorities on ways to improve ETC services. Although the FETC drastically changed its policy so that drivers can freely apply for the reactive eTag as a substitute for the costly active OBU, the usage of ETC services has improved only insignificantly. The perceptions of eTag users might differ from the previous OBU users. Further research is thus recommended to discuss service failures as well as recovery strategies after a wide application of eTags, and to analyze the impact of the eTag on the willingness to use ETC services along with word-of-mouth.

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