

# Predicting electronic toll collection service adoption: An integration of the technology acceptance model and the theory of planned behavior

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## Abstract

In order to reduce the number of vehicles stuck in congestion, especially for stop-and-go traffic at toll plazas, the establishment of electronic toll collection (ETC) systems has been a hot issue and dominant trend in many countries. Taiwan has joined the crowd, adding an ETC system to its toll roads in early 2006. However, despite the potential benefits for motorists, the utilization rate has been lower than expected during the introductory stage. The objective of this study is to advance our understanding on the critical antecedents of motorists' intention of ETC service adoption by integrating both technology acceptance model (TAM) and theory of planned behavior (TPB) perspectives. Through empirical data collection and analysis from highway motorists who had not installed on-board units (OBU) for ETC service in Taiwan, we found that system attributes, perceived usefulness and perceived ease of use, indeed, positively engender motorists' attitudes towards ETC service adoption. Moreover, results also reveal that attitude, subjective norm and perceived behavioral control positively influence the intention of ETC system adoption. Implications for practitioners and researchers, and suggestions for future research are also addressed in this study.

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*Keywords:* Electronic toll collection; Intelligent transportation systems; Technology acceptance model; Theory of planned behavior

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## 1. Introduction

Faced with annually increasing demand for travel and transport of goods, transportation systems are reaching the limits of their existing capacity. Heavy highway congestion has become one of most serious urban problems for many countries worldwide. As congestion and service disruptions in highways continue to escalate, especially for stop-and-go traffic at toll plazas, government officials are beginning to realize that traditional transportation strategies are no longer effective. Faster, more convenient, and information

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technology-related solutions must be implemented in order to meet the demand for expansion of current highway systems. Consequently, the establishment of electronic toll collection (ETC) systems has been a hot issue and dominant trend in many countries.

ETC is part of an intelligent transportation system and it is also a fairly mature technology that allows for electronic payment of highway tolls by using vehicle-to-roadside communication technologies (e.g., microwave, infrared communication, or GPS technology). Motorists purchase on-board units (OBUs) that electronically identify vehicles as they pass through a toll plaza without stopping or even slowing down, with tolls automatically charged to or debited from “smartcards” inserted in their OBUs. The removable credit-card-sized electronic purse contains stored value which can be periodically replenished when the balance is low (Decorla-Souza and Kane, 1992). ETC not only eliminates the traffic queue at tollbooths and improves safety for the motoring public, but is also coupled with potential impacts on personal travel behavior, commercial vehicle operations, and greater electronic commerce opportunities in particular (Golob and Regan, 2001).

In Taiwan, Far Eastern Electronic Toll Collection Co. (FETC), the build-operate-transfer project contractor, was commissioned by the Taiwan Area National Freeway Bureau to install the nation’s first ETC system in 22 toll plazas along two North-South highways, which carry 5–6 million vehicles per year. After being tested in a variety of conditions, the construction of ETC was completed by end 2005 and launched on February 10, 2006. Furthermore, government officials announced that a satellite-based vehicle positioning system (VPS) would be implemented in 2008, with the entire system being operational by July 2010. Taiwan authorities envision that all manual tolls will eventually be replaced.

However, during the initial stage of the first three months – and despite potential benefits for motorists, large-scale TV commercials, and diverse promotion activities for the ETC system – the utilization rate of large vehicles (e.g., tourist coaches, trucks, container vehicles) was only around 20%. Furthermore, the utilization rate of ETC lanes among small vehicles (e.g., private cars) was only about 6.5% by May 6, 2006, showing that the individual use of ETC service has been lower than expected (<http://www.fetc.net.tw>, 2006).

The objective of our study is to uncover the important factors affecting the intention of ETC service adoption. Although the application of ETC service is still in an early stage and why motorists choose (or do not choose) ETC is far from being completely understood, comprehending the determinants of ETC service adoption would help our government officials better deploy and manage their information technology resources and enhance overall effectiveness. Moreover, the initial adoption of an e-service is also one of the crucial driving forces to further influence continued use of the service (Kwon and Zmud, 1987). In order to provide a solid theoretical basis for examining the important antecedents for ETC service adoption, this paper integrates two important streams of literature under the nomological structure of the theory of reasoned action (TRA): (1) the technology acceptance model (TAM) (Davis, 1989; Davis et al., 1989), and the theory of planned behavior (TPB) (Ajzen, 1991).

In TAM, behavioral intention is determined by attitude towards usage as well as by the direct and indirect effects of two system features: perceived usefulness and perceived ease of use (Davis, 1989, 1993). The value of TAM in technology-driven contexts has been consistently important and widely accepted (Bernadette, 1996; Venkatesh and Davis, 2000). However, as Rogers (1995) argued, diffusion of innovative technology is highly related to communication channels, individuals, organizational members, and social system in addition to the technology itself. As with most information systems, ETC service adoption could only be partially explained by TAM since both human and social factors should also be incorporated and considered simultaneously. Likewise, together with TAM, TPB was selected to provide a necessary theoretical premise for the research model examined in this study.

TPB is a well-researched model which is widely used in predicting and explaining human behavior across a variety of settings while also considering the roles of individual and social systems in the process (Ajzen, 1991). TPB identifies three attitudinal antecedents of behavioral intention. Two reflect the perceived desirability of performing the behavior: attitude toward outcomes of the behavior and subjective norm. The third, perceived behavioral control, reflects perceptions that the behavior is personally controllable (Ajzen, 1987, 1991). As the focus of this study is on the ETC service adoption setting, which is considered as an instance of the acceptance of innovative technology intertwined with social systems and personal characteristics, the integration of TAM and TPB for our research framework should be in a more comprehensive manner to examine the intention and acceptance of ETC service.

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