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A Study of Satellite Navigation Fleet Management System Usage in Taiwan with Application of C-TAM-TPB Model

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Abstract: In the modern information-based society, people increasingly depend on wireless technologies to connect with others and travel in a safe, efficient manner. Telematics, a concept first developed in Europe, refers to the use of computers to receive, store and distribute information over a telecommunications system. In the automotive industry, telematics is any system providing location-based services for a vehicle over the wireless telecommunications network. In general, automotive telematics encompasses the applications of Global Positioning System (GPS) navigation, multimedia entertainment, wireless communications and automatic driving assistance systems. The purposes of this study are to test the Combined Technology Acceptance Model (TAM)-TPB model (C-TAM-TPB) and to apply these to a broad sample of Taiwan's drivers who have experienced with the usage of satellite navigation fleet management systems in order to examine the factors affecting consumers' intentions to use and adopt satellite navigation fleet management systems in Taiwan. The respective model is evaluated by conducting a questionnaire survey to explore the correlations between variables. Structural Equation Modeling (SEM) is conducted to analyze data collected from 266 users and verify the hypotheses. Overall, the results reveal that the effect of perceived ease of use, attitude, perceived behavioral control, usefulness and subjective norm influence an individual's behavioral intention.

Key words: Telematics, satellite navigation fleet management systems, C-TAM-TPB model, intentions to use

INTRODUCTION

The advantages brought by telematics are significant yet often difficult to quantify Telematics involves obtaining remote services by capturing, storing and exchanging sensor data. This data is used, for example, with embedded voice technology, which helps reduce the distractions faced by drivers, thus making the system more practical and user-friendly. Because of the added convenience of these applications for drivers, vehicle manufacturers have used telematics to help manage and improve relationships with customers (Tan, 2005). However, for automotive telematics to reach its full potential and be accepted by consumers as well as service and application providers, the privacy of users must be protected and the telematics data used in modern vehicles must be carefully secured (Duri *et al*., 2002).

Past researchers devised a number of models which aimed to explain IT by incorporating different incorporating attitudinal factors, social factors and control factors (Davis, 1989; Davis *et al*., 1989; Hartwick and Barki, 1994; Mathieson, 1991; Moore and Benbasat, 1991; Thompson *et al*., 1991). Among these models, the Technology Acceptance Model (TAM) (Davis, 1989) is perhaps the most well-known. One of the goals of models such as TAM is to develop diagnostic tools that make it possible to predict the acceptance of information systems and facilitate design changes before users ever have a chance to experience them (Davis, 1989). When empirically testing these models, however, the focus has generally been on systems that the users had experience with, such as word processing or spreadsheet software. Consequently, it is currently unclear whether models such as TAM accurately predict behavior for inexperienced users and, more importantly, whether the factors that determine IT usage are the same for both experienced and inexperienced users of a system. To address these issues, this study simply assesses the experiences of 266 users of a satellite navigation fleet management system. Using the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB) and Combined Technology Acceptance Model (TAM)-TPB model (C-TAM-TPB),

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this study incorporates social influences and behavioral controls to examine the experiences of users.

Although attitude is an important factor in predicting an individual's behavior, research on the adoption of Information Technology (IT) largely discounts the role of attitude in explaining technology acceptance behavior. In this study, we therefore give overdue focus to the role played by attitude in explaining technology acceptance behavior. Our findings provide new insights regarding predictions of technology acceptance behavior.

Theoretical background telematics: There are a wide range of telematics services that are either already in use or scheduled to be available in the near future. These include navigation and location information, applications for delivering digital information, emergency roadside assistance and pay-for-use rental and insurance, all of which require the collection of a large amount of data (demographic data, diagnostic data, statistical data, etc.).

The products and services under the banner of telematics include satellite positioning, security, surveillance, communications and entertainment and the transmission and exchange of vehicle information. With the development of Intelligent Transport Systems, the mobile service platform offered by telematics is likely to become a significant factor for automakers in developing strategic advantages and competing. In this context, it is important to give full consideration to the factors that affected users' intentions toward telematics in today's IT transportation era.

In recent years, telematics has increased in popularity around the world and many new competitors have begun entering the market and offering partial telematics services by launching GPS, navigation, auto PC and auto TV in both OE and aftermarket. The development of telematics has been restrained, however, by the incomplete telematics infrastructure. The response centers, wireless communication network, content providers and integrators are essential support services which are still in the development stage.

A vehicle's GPS navigation system includes a vehicle-based telematics system, a vehicle-based global positioning system and a control. The telematics system receives input from the driver of the vehicle and downloads directional information from an external service provider based on the input provided by the user and the geographic position of the vehicle. The directional information comprises at least two instructions, each of which is coded or associated with a respective geographic location. The control provides an output corresponding to each of the instructions in response to the vehicle's current geographic position and the instructions are provided by the control only when the current actual geographic position of the vehicle corresponds to the particular geographic location associated with the instruction.

Technology acceptance model (TAM): The importance of technology acceptance as the precursor to technology use has been studied by many researchers and practitioners (Venkatesh *et al*., 2003). The Technology Acceptance Model (TAM) is generally accepted as a valid model for predicting individual acceptance behavior across various information technologies and their users (Adams *et al*., 1992; Chin and Todd, 1995; Davis *et al*., 1989; Doll *et al*., 1998; Mathieson, 1991; Segars and Grover, 1993). TAM accounts for the relationship between internal psychological variables such as beliefs, attitudes and behavioral intention and actual system usage (Davis, 1986, 1989). According to Davis (1986), perceived usefulness and perceived ease of use are major beliefs that influence attitude toward system use and eventually lead to actual system use. TAM has earned a good reputation in this area due to its parsimony and high predictive power in explaining IT acceptance behavior across various contexts (Mathieson, 1991; Venkatesh, 2000).

TAM shares the basic premises and components outlined in Ajzen and Fishbein's Theory of Reasoned Action (Ajzen and Fishbein, 1980). However, by excluding the attitude construct from the TRA model, TAM discounts the role of attitude in explaining technology acceptance behavior. Venkatesh and his colleagues removed the construct of attitude from the Technology Acceptance Model (Venkatesh and Davis, 1996, 2000; Venkatesh *et al*., 2003), asserting that attitude plays a limited role in explaining behavioral intention or actual adoption behavior and is at best a partial mediator in the relationship between salient beliefs and the adoption behavior or intention. The extrinsic motivation and the associated instrumentality are captured by the perceived usefulness construct in TAM (Davis *et al*., 1989, 1992; Venkatesh and Davis, 2000; Venkatesh and Speier, 2000).

In recent years, the Technology Acceptance Model (TAM) has been popularly used and assessed to predict user acceptance and use based on perceived usefulness and ease of use (Davis, 1986, 1989, 1993; Davis *et al*., 1989).

TAM posits that perceived usefulness and perceived ease of use determine behavioral intention, which is in turn a significant determinant of actual system use. Perceived usefulness is ''the degree to which an

individual believes that using a particular system would enhance his/her job performance'' (Davis, 1989). Perceived ease of use refers to ''the degree to which an individual believes that using a particular system would be free of physical and mental efforts'' (Davis, 1993). According to TAM, an individual's belief determines the attitude toward using the system, which then develops the intention to use. This intention shapes the decision of actual technology usage. These causalities have been studied extensively and broadly accepted (Morris and Dillon, 1997; Suh and Han, 2002; Teo *et al*., 1999).

Combined TAM and TPB (C-TAM-TPB) model: Perceived ease of use and perceived usefulness are the two specific beliefs in TAM which determine one's behavioral intention to use a technology and are linked to subsequent behavior (Taylor and Todd, 1995a; Sheppard *et al*., 1988). According to Taylor and Todd (1995b), developing a better understanding of the relationships between the belief structures and the precursors of intention requires the decomposition of attitudinal beliefs. The decomposed model of the TPB has better explanatory power than the pure TPB and TRA models (Taylor and Todd, 1995a). In this study, satellite navigation fleet management system are a technological innovation and thus the decomposed TPB model gives a more satisfactory explanation of adoption intention, as shown in Fig. 1.

Nysveen *et al*. (2005) investigated consumers' intentions to use mobile services and found that the four overall influential factors on usage intention were motivational influences, attitudinal influences, normative pressure and perceived control. Fogelgren-Pedersen (2005) took a similar point of view, but he went on to argue that connection stability and geographic coverage were significant variables of perceived relative advantage for mobile internet. This study proposes two new variables specific to convergence services, which might also be specific to satellite navigation fleet management system: perceived quality and perceived enjoyment. The social influence of technology acceptance behavior has been widely acknowledged, yet this subject requires further analysis and quantification. Previous studies

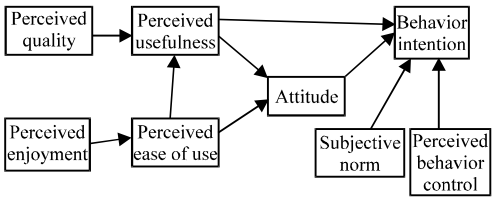

Fig. 1: Research framework of this study

tended to use Subjective Norm (SN) to analyze social influence, but these studies had mixed results. For example, the results concerning the effect of social influence on technology were inconsistent, suggesting that it had a significant influence on technology acceptance only under certain circumstances (Venkatesh and Davis, 2000).

Understanding it usage: The most commonly employed model of IT usage is TAM (Davis, 1989; Davis *et al*., 1989) and this model has received considerable empirical support (Davis, 1989; Davis *et al*., 1989; Mathieson, 1991; Taylor and Todd, 1995a). TAM holds that usage Behavior (B) is a direct function of Behavioral Intention (BI). BI is, in turn, a function of: attitude toward usage (A), which reflects favorable or unfavorable feelings toward technology usage and perceived usefulness (U), which reflects the belief that using the technology enhanced performance. Attitude is determined jointly by perceived usefulness and perceived ease of use (E). Finally, ease of use directly determines perceived usefulness. It is important to note that TAM does not include the influence on behavior of social and control factors, which previous researchers found to have a significant influence on IT usage behavior (Barclay *et al*., 1996; Compeau and Higgins, 1995; Hartwick and Barki, 1994; Mathieson, 1991; Moore and Benbasat, 1991; Taylor and Todd, 1995b; Thompson *et al*., 1991). These variables also play a key role in determining behavior in the Theory of Planned Behavior (Ajzen, 1991), in which social influences (subjective norm) are modeled as determinants of behavioral intention and perceived behavioral control is modeled as a determinant of both intention and behavior. Due to their predictive utility in IT usage research and their widespread application in the field of social psychology, Subjective Norm (SN) and Perceived Behavioral Control (PBC) were added to TAM in order to provide a more complete test of the important determinants of IT usage. Nugroho (2009) analyzed the market demand for the development of information technology and found that perceived ease of use, perceived usefulness, perceived risk and trust have the most significant effects on consumer intentions in transactions over the internet.

MATERIALS AND METHOD

Research model: This study uses the C-TAM-TPB model as the theoretical base and utilizes previous studies' results (Hu *et al*., 1999; Lin and Lu, 2000; Mathieson *et al*., 2001; Moon and Kim, 2001; Chen *et al*., 2002) by combining other factors in order to understand

the adoption of perceived behavior and behavior intention. The present study uses eight constructs: perceived usefulness, perceived ease of use, perceived behavior control, perceived quality, perceived enjoyment, attitude, subjective norm and behavior intention. Fig. 1 shows the relationships between the constructs in the proposed model. The proposed model incorporates two new constructs, perceived quality and perceived enjoyment, which may significantly influence the existing variables of TAM and C-TAM-TPB to explore the special characteristics of satellite navigation fleet management system usage in Taiwan. The specific elements of the model and related hypotheses are further detailed in the research hypotheses section. The authors carefully considered any indication that competing models are comparable to the model presented in Fig. 1 and this is applied to further analysis in the PLS estimation.

Research hypothesis: In the following, we develop the corresponding hypotheses. The TAM is based on two distinct but interrelated beliefs, perceived usefulness and perceived ease of use, to predict the acceptance of computer technology by end-users. Studies have found perceived usefulness to have the strongest influence among the two TAM variables (Davis, 1989; Igbaria *et al*., 1996). According to TAM (Davis *et al*., 1989), perceived usefulness is defined in this study as "the degree to which an individual believes that using the services will contribute to reaching a particular objective". In accordance with the previous literature regarding information system usefulness (Davis, 1989; Taylor and Todd, 1995a), this study proposes that increased usefulness has a positive association with one's attitude towards usage. The concept of perceived usefulness is multi-dimensional and related to the issues of working speed, work efficiency and effectiveness, making work easier and other practical considerations. A system with high perceived usefulness is one that is viewed by users as offering a positive "use-performance" relationship. This variable directly influences the actual use of particular information technologies (Davis, 1989; King and He, 2006). Perceived usefulness and perceived ease of use are the basis for predicting end user acceptance of computer technology. Previous studies have shown perceived usefulness to have the strongest influence (Davis *et al*., 1989; Igbaria *et al*., 1996). In the present study, the definition of perceived usefulness is "the degree to which a person believes that using a particular system would enhance his or her job performance (Davis, 1989)." This study adopts this definition and also highlights the aspect of "capable of being used advantageously."

- **H1:** Perceived usefulness has a direct, positive effect on attitude

Several authors have mentioned that while ease of use influences perceived usefulness, the opposite is not true. Therefore, a system that is easier to use can be more useful (Davis *et al*., 1989; Igbaria *et al*., 1996; Venkatesh *et al*., 2003; Avlonitis and Panagopoulos, 2005). According to Mathieson (1991), a great amount of variance in usefulness can be explained by ease of use. The effort saved by tourists as a result of increased ease of use can be re-directed elsewhere, thus allowing for more work to be done with the same effort (Davis *et al*., 1992). Ease of use deals with a more fundamental type of use characteristic. It involves the bare functional characteristics of satellite navigation fleet management system with regard to the service complexity, the speed of learning to use the service and the integration of the service in satellite navigation fleet management system. Models measuring the acceptance of services acknowledge the effect of ease of use on attitude (Davis, 1989). According to previous studies' results, perceived ease of use explains when the users think the operational system is simple to use as well as when the complexities of a system make it difficult for users to use. Moreover, ease of use refers to the users thinking it is more difficult to use a new technology, which affects the behavior intention of adopting this new technology (Davis *et al*., 1989; Taylor and Todd, 1995b). We propose H2 as follows:

- **H2:** Perceived ease of use has a direct, positive effect on attitude

The Theory of Reasoned Action (TRA) was developed by Fishbein and Ajzen (1975, 1980). This theory, which was derived from previous research, started out as the theory of attitude and later led to the study of attitude and behavior. The TRA was created in large part due to the perceived shortcomings of previous research, in which there were weak correlations between attitude measures and performance of behaviors (Hale *et al*., 2002). The TRA's key application concerns the prediction of behavioral intention, which includes predictions of attitude and predictions of behavior. Separating behavioral intention from behavior makes it possible to account for limiting factors on attitudinal influence (Fishbein and Ajzen, 1980). Behavioral Intention (BI), Attitude (A) and Subjective Norm (SN) are the three components of TRA. According to TRA, a person's behavioral intention depends on the person's attitude about the behavior and subjective norms (BI = A+SN). If

a person has an intention to perform a particular behavior, then it is considered likely that the person will do it. Behavioral intention is a measure of the relative strength of a person's intention to perform a behavior. Attitude, on the other hand, it refers to the beliefs about the consequences of performing a behavior, multiplied by a person's valuation of these consequences. Subjective norm can be seen as a combination of perceived expectations from relevant individuals or groups along with intentions to comply with these expectations. In other words, subjective norm refers to one's view of whether close friends or family members think that this behavior should be performed (Fishbein and Ajzen, 1975). Therefore, a person's volitional (voluntary) behavior can be predicted by that person's attitude toward the behavior as well as how that person thinks other people will view the behavior. A person's behavioral intention is thus formed by a combination of attitude and subjective norms. According to Fishbein and Ajzen (1975), the attitudes and norms are not weighted equally in predicting behavior. These factors have very different effects on behavioral intention among different people or in different situations. To account for this, a weight is associated with each of these factors in the predictive formula of the theory. For example, for a person who cares little about what others think, subjective norms carries minimal weight in predicting behavior (Miller, 2005). Miller (2005) defines attitude as "the sum of beliefs about a particular behavior weighted by evaluations of these beliefs". Subjective norms are defined as "the influence of people in one's social environment on his/her behavioral intentions; the beliefs of people, weighted by the importance one attributes to each of their opinions, [which] influenced one's behavioral intention". Behavioral intention is defined as "a function of both attitudes toward a behavior and subjective norms toward that behavior, which has been found to predict actual behavior." Thus, the theory of planned behavior (Ajzen, 1985) is a better predictor of intention than the theory of reasoned action (Ajzen and Fishbein, 1980) and Behavioral Intention (BI) is a stronger predictor of behavior than Behavioral Expectation (BE). The results also suggest that attitude-toward-the-act (Aact), Subjective Norm (SN) and Perceived Behavioral Control (PBC) are better predictors of BI than of BE and that development of a behavioral plan moderates the Aact-BI-B relationships. Thus, we propose H3 as follows:

- **H3:** Attitude has a direct, positive effect on behavior intention

Ease of use is a very important factor in the acceptance of an information system (Davis *et al*., 1989). Perceived ease of use refers to users' beliefs of the degree of difficulty involved in using a system. Users perceive a difficult system as less useful and they are therefore more likely to abandon it (Davis, 1989). Previous research has provided evidence of the significant effects of perceived ease of use on users' intention to use directly or indirectly through perceived usefulness and attitude towards using (Venkatech and Bala, 2008; Wixom and Todd, 2005; Moon and Kim, 2001; Venkatesh and Morris, 2000). Other studies found ease of use to be a crucial factor for the adoption of online banking services (Gounaris and Koritos, 2008; Amin, 2007; Rigopoulos and Askounis, 2007). Previous studies have indicated that while ease of use influences perceived usefulness, the opposite is not true. Therefore, a system that is easier to use could be more useful (Davis *et al*., 1989; Igbaria *et al*., 1996; Venkatesh *et al*., 2003; Avlonitis and Panagopoulos, 2005). Thus, we propose H4 as follows:

- **H4:** Perceived ease of use has a direct, positive effect on perceived usefulness

According to a previous study by Taylor and Todd (1995a) which examined the role of prior experience on IT usage, there are substantial differences in the relative influence of the determinants of IT usage based on experience. Compeau and Higgins (1995) have found that computer self-efficacy influences expectations about the future outcomes of computer use, such as job performance and personal accomplishment. In the context of IT use especially, perceived usefulness directly effects behavioral intention (Davis *et al*., 1989). Thus, we propose H5 as follows:

- **H5:** Perceived usefulness has a direct, positive effect on behavior intention

Social norm refers to the degree to which users believe that others will approve of their behavior (Hsu and Lu, 2007). Subjective norm is a similar concept involving referent identification and norm compliance (Hsu and Lu, 2004). Referent identification refers to individuals adopting the opinions of people who are important to them, such as friends, peers, coworkers, relatives and classmates (Ahuja and Thatcher, 2005; Brown and Venkatesh, 2005). Norm compliance refers to individuals performing a particular activity in accordance with the expectations of others in order to either strengthen relationships or avoid rejection. The research model used in this study is based on previous studies on subjective norm and proposes a positive relationship between subjective norm and intention. This is confirmed by empirical studies and

theoretical models such as the Theory of Reasoned Action and the Theory of Planned Behavior (Lucas and Spitler, 2000; Venkatesh *et al*., 2000). For example, users have a strong desire to use satellite navigation fleet management system because they seek to gain acceptance from the external reference group and have already assimilated to the norms of the group.

According to the Theory of Planned Behavior, human behavior is guided by three basic beliefs: beliefs about the likely consequences of a behavior and the evaluations of these consequences (behavioral beliefs), beliefs about others' normative expectations and motivation to comply with these expectations (normative beliefs) and beliefs about the presence of factors that facilitate or impede performance of the behavior and the perceived power of these factors (control beliefs). In their respective aggregates, behavioral beliefs result in a favorable or unfavorable attitude toward the behavior; normative beliefs give rise to perceived social pressure or subjective norm; and control beliefs lead to perceived behavioral control. The combination of attitude toward the behavior, subjective norm and perception of behavioral control leads to the formation of a behavioral intention. In general, the more favorable the attitude and subjective norm and the greater the perceived control, the stronger the person's intention to perform the behavior in question. Social influence is the degree of an individual's belief that important others believe he or she should use the new system. In C-TAM-TPB, subjective norm represents social influence as a direct determinant of behavioral intention. Thompson *et al*. (1991) use the term "social norms" in defining their construct and they acknowledge its similarity to subjective norm within TRA. While these constructs have different labels, each of them contains an explicit or implicit notion that individuals' behavior is influenced by how they believed others view them as a result of having adopted a behavior. People's perception that most people who are important to them think they should or should not perform the behavior in question is the definition of subjective norm (Ajzen, 1991; Davis *et al*., 1989; Fishbein and Azjen, 1975; Mathieson, 1991; Taylor and Todd, 1995b). Behavioral intention has been established as a good predictor of both self-reported and actual usage (Szajna, 1996; Agarwal and Prasad, 1999). Thus, intention serves as a replacement for behavior, which means behavioral intention is affected by both attitude and subjective norms. Thus, we propose H6 as follows:

- **H6:** Subject norm has a direct, positive effect on behavior intention

Ajzen (1985, 1991) first introduces the original of control beliefs concepts which discussed the internal notion of individual "self-efficacy" (Bandura, 1977) and to external resource constraints between these two constructs. Self-efficacy and perceived ability are related. According to Compeau and Higgins (1991) higher levels of self-efficacy result in increased levels of behavioral intention and IT usage. In regards to IT usage, there are two dimensions for control beliefs: on e relating to resource factors (e.g., time and money) and the other relating to technology compatibility issues that have a constraining effect on usage. All other factors being equal, behavioral intention and IT usage are expected to decline when less time and money are available and as technical compatibility decreases. The absence of facilitating resources essentially represents obstacles to usage and inhibits the formation of intention and usage; however, the presence of facilitating resources may not necessarily encourage usage. Thus, we propose H7 as follows:

- **H7:** Perceived behavior control has a direct, positive effect on behavior intention

DeLone and McLean (1992) developed a taxonomy of the success of Information Systems (IS) in order to provide order to the criterion measures utilized in IS assessment. They synthesized a taxonomy system based on the six factors quality, information quality, information use, user satisfaction, individual impact and organization impact of IS success from a review of 180 articles. They went on to assert the interdependence of the taxonomic categories, including those of the effectiveness-influence level. A user's positive attitude towards a particular information system (IS) has an influence on his/her intention to use this IS (Davis, 1989). A website is considered as a kind of IS and a web user's positive attitude towards a particular website is therefore expected to affect his/her willingness to continuously use that website. According to the results of prior empirical studies, web users' intentions to revisit a website are significantly influenced by their positive attitude towards the website (Lin and Lu, 2000). DeLone and McLean (1992) first proposed the notion of information quality and argued that it is a significant construct for building successful information systems. Information quality was further developed as a determinant of system quality by Lin and Lu (2000), who indicate that information quality variables are good predictors of perceived ease of use and perceived usefulness. Thus, we propose H8 as follows:

- **H8:** Perceived quality has a direct, positive effect on perceived usefulness

Much empirical evidence exists concerning the importance of enjoyment or intrinsic motivation applied to

the TAM model (Venkatech and Bala, 2008). The enjoyment or intrinsic motivation results from the experience itself; a technical system is perceived by users as more enjoyable when they have a feeling of control over it (Monsuwe *et al*., 2004). A study by Davis *et al*. (1992) found that perceived enjoyment is significantly related to perceived ease of use. Conducting research on the intention to use information systems, Van der Heijden (2004) added perceived enjoyment to the TAM model. Van der Heijden (2003) extended the original TAM by adding the construct of perceived enjoyment. Van der Heijden (2004) further researched the internet from utilitarian and hedonic purpose frameworks and found that perceived enjoyment as a hedonic purpose strongly influences web use for entertainment purposes. A study by Mangin *et al*. (2012) found that the control latent variable has a significant effect on the TAM model's latent variables of ease of use and attitude towards use, while innovation has a sole effect on intention to use. In addition, the latent variable of enjoyment has a significant impact on ease of use, attitude towards use and intention to use. Thus, we propose H9 as follows:

- **H9:** Perceived enjoyment has a direct, positive effect on perceived ease of use

Instruments: In this study, during the pre-test stage from May 10th to 31st, 2010, there were 47 valid questionnaires. After two weeks, the formal questionnaires were mailed with pre-paid postage so the drivers could return them via mail. At the fourth week after the formal questionnaires had been mailed out, the drivers were called via telephone to remind them of the importance of filling out and sending back the questionnaires. At the end, a total of 325 questionnaires were received; however, 59 questionnaires were invalid. Therefore, only 266 questionnaires were considered as the valid sample for this study. The return rate of questionnaires was 81.85%.

RESULTS AND DISCUSSION

In this study, 266 responses were valid. Among all the valid responses for this study, males make up the majority (198, 74.4%). The majority of subjects are between the ages of 31 and 40 (89, 33.5%). Concerning highest education level, the majority of respondents list high school degree (137, 51.5%). For data analysis, the method of Structural Equation Modeling (SEM) with Partial Least Squares (PLS) is adopted to verify the research assumptions due to its minimal requirement of sample size, residual distribution and because of its exploratory suitability (Chin, 1998).

Smart PLS (Ringle *et al*., 2005) is utilized as the data analysis tool because of its ability to show the relationship between the manifest variables and latent variables. Generally speaking, PLS is the most accepted variance-based SEM approach (Chin *et al*., 2003) and because it is prediction-oriented, it avoids inadmissible solutions and factor indeterminacy, thus providing a better explanation when explaining a complex relationship (Fornell and Bookstein, 1982). In other words, PLS is a causal modeling technique that is suitable for developmental models with expected complex variable relationships. This technique provides a way to test multiple dependencies within a data set and it is also more robust against model assumption violations than covariance based causal modeling methods (such as LISREL). In addition, PLS tests the strength of latent variable relationships and it can thus be used to test this study's proposed hypotheses (Lohmoller, 1989).

The model results for this study are shown in Table 1. Measurements were evaluated for reliability and validity. Based on the data in Table 1, most of the latent variable reliabilities are high (above 0.81), with the two lowest Cronbach's alpha values being 0.74 for behavior intention and 0.76 for perceived behavior which indicates that all measurement models have satisfactory values for Cronbach's α (>0.7). Convergent validity is shown by the data in Table 1, where the composite reliability is between 0.846 and 0.928, which is higher than 0.7 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). In this study, the Average Variance Extracted (AVE) is between 0.585 and 0.664, which meets the satisfying discriminant validity value that is higher than 0.5 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). No item is loaded more strongly on another construct than on its own construct, therefore confirming discriminant validity on the item level. Furthermore, for all constructs, the AVE is higher than the squared correlations to all other constructs, which suggests a high degree of discriminant validity on the construct level (Fornell and Larcker, 1981).

The significant models were judged on strong outer loadings, which means at least greater than 0.60 and ideally greater than 0.70 (Chin, 1998). Convergent validity is assessed using the Composite Reliability (CR) measure proposed by Fornell and Larcker (1981) and the 0.70 threshold proposed by Nunnally (1978) is used in this assessment. Most of the latent variable reliabilities are high (above 0.81), with the two lowest Cronbach's alpha values being 0.74 for behavior intention and 0.76 for perceived behavior, indicating that all measurement models have satisfactory values for Cronbach's α (>0.7). Composite reliability was, as shown in Table 1, the composite reliability is between 0.846 and 0.928 which is

Table 1: PLS quality criteria, AVE, composite reliability (CR) and Alpha

Construct variable	AVE	CR	R^2	Cronbach's alpha
Perceived usefulness	0.649248	0.928292	0.878580	0.909818
Perceived ease of use	0.655763	0.919404	0.603079	0.894486
Attitude	0.642116	0.914015	0.830719	0.885717
Behavior intention	0.655781	0.850862	0.783464	0.739747
Subjective norm	0.638816	0.876002		0.813546
Perceived behavior control	0.585654	0.846394		0.758153
Perceived quality	0.664362	0.907718		0.871604
Perceived enjoyment	0.663794	0.887355		0.830330

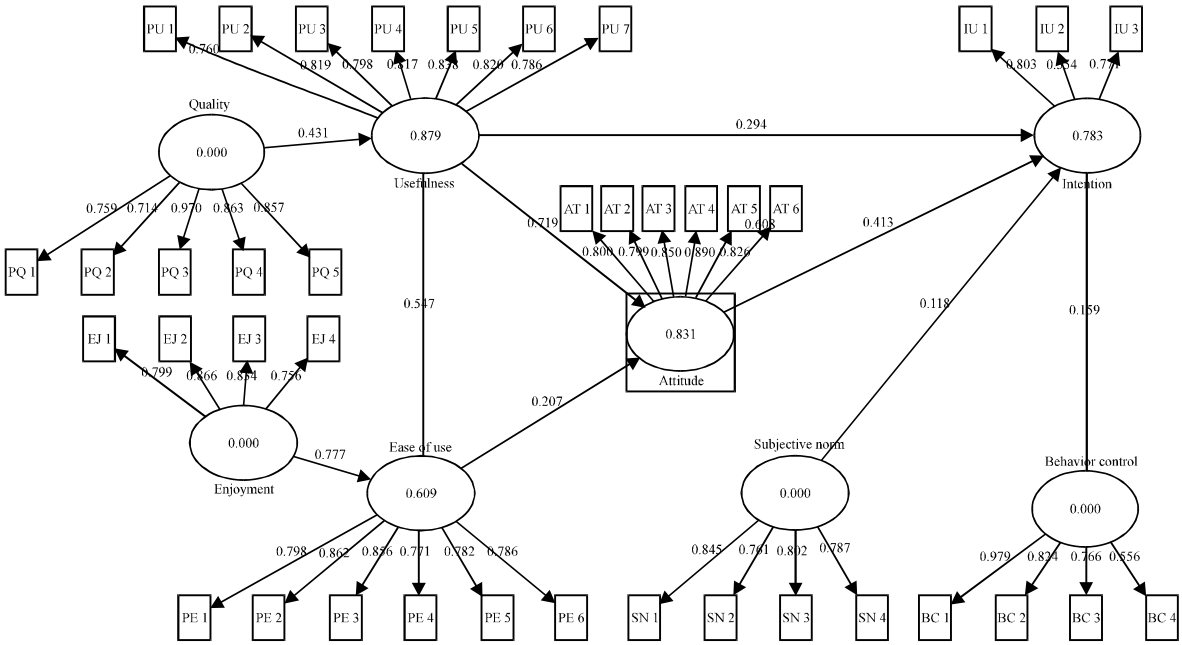

Fig. 2: SEM R^2 values and path coefficients

higher than 0.7 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). In this study, the Average Variance Extracted (AVE) is between 0.585 and 0.664 which meets the satisfying discriminant validity value that is higher than 0.5 (Bagozzi and Yi, 1988; Fornell and Larcker, 1981). No item is loaded more strongly on another construct than on its own construct, therefore confirming discriminant validity on the item level. Furthermore, for all constructs, the AVE is higher than the squared correlations to all other constructs, which suggests a high degree of discriminant validity on the construct level (Fornell and Larcker, 1981). All R^2 values indicate reasonably solid explanations and good overall fit based on the 0.33 moderate R^2 value criteria used by Chin (1998). According to Table 1 and Fig. 2, "perceived usefulness" is found to have an R^2 of 0.878580, "attitude" is found to have an R^2 of 0.830719, "behavior intention" is found to have an R^2 of 0.783464 and "perceived ease of use" is found have an R^2 of 0.603079 The R^2 values suggest solid explanations and good overall fit based on the 0.33 moderate R^2 value criteria used by Chin (1998). The PLS results support the proposed hypotheses and indicate a good fit between the model and data.

The testing of the structural model involves making estimates of the path coefficients, which indicate the positive or negative relationships between the dependent and independent constructs as well as the strength of these relationships and the R^2 value, which represents the degree of variance of the dependent constructs explained by the independent constructs. Combining the path coefficients (arbitrary value and statistical significance) and R^2 provides an indication of how well the model is performing. R^2 gives an indication of the model's predictive power and the path coefficients should be significant and directionally consistent with the hypotheses. Figure 2 indicates that the R^2 refers to the fraction of variance that can be explained by a model. As more PLS factors are added, R^2 will always increase because it measures the strength of the least-squares fit. In this study, an R^2 of 0.879 means that the model accounts for 87.9% of the variance in the

observed activities for perceived usefulness. Moreover, the R^2 of perceived ease of use is 0.603079, which means the model accounts for 60.3% of the variance in the observed activities for perceived ease of use. In addition, 0.830719 is the R^2 for attitude, which means the model accounts for 83.1% of variance in the observed activities for attitude. An R^2 of 0.783464 of behavior intention means that the model accounts for 78.3% of the variance in the observed activities for behavior intention. As more PLS factors are incorporated into the fit, the value gets closer and closer to 1 (i.e., 100%).

As shown in Fig. 2, the whole model accounts for 78.3% of the variance in the construct of behavior intention. The factors of perceived usefulness, perceived ease of use and attitude contribute significantly to the observed explanatory power of behavior intention. Specifically, 83.1% of the variances observed in attitude can be accounted for by the combination of perceived usefulness and perceived ease and perceived usefulness contributes slightly more to attitude than perceived ease of use, with the path coefficients of 0.719 and 0.207, respectively. The significant path coefficients are shown in Fig. 2. All proposed hypotheses are supported.

Convergent validity exists when each of the measurement items loads with a significant t-value on its latent construct. The p-value of this t-value should typically be significant, at least at the 0.05 alpha protection levels. This study calculates the t-test statistic to test our hypothesis; the results are shown in Fig. 3. Adopting Chin (1998)'s recommendation, a bootstrapping procedure is used to access the statistical significance of each path coefficient using t-tests. T-values are computed from a series of PLS evaluations made against several partitions of the data set. In this study, all the T-values in Fig. 3 achieve the minimum requirement of greater than or equal to 1.96. Therefore, the positive correlations between the constructs suggest that significant effects can be expected between them.

In Table 2, the PLS estimation is carried out in an exploratory manner and includes all possible relations; these are subsequently removed based on the hierarchical principle (i.e., the elimination of one relation at a time, always taking the relation with the worst significance level, after which the model is re-estimated). This procedure is conducted until all of the relations are significant and at the minimum 0.05 level. In the PLS estimation, missing values are removed on a case-wide basis.

Consequently, evaluation of the core concepts has convergent validity and reliability. For each factor, the square root of AVE is obviously larger than its correlation coefficients with other factors, in addition to slightly lower than the value of CA. Thus, the scales have good discriminate validity (Fornell and Larcker, 1981). The model goodness of fit is evaluated on the R^2. Every index reaches ideal value, revealing good fitness in the structural model. This

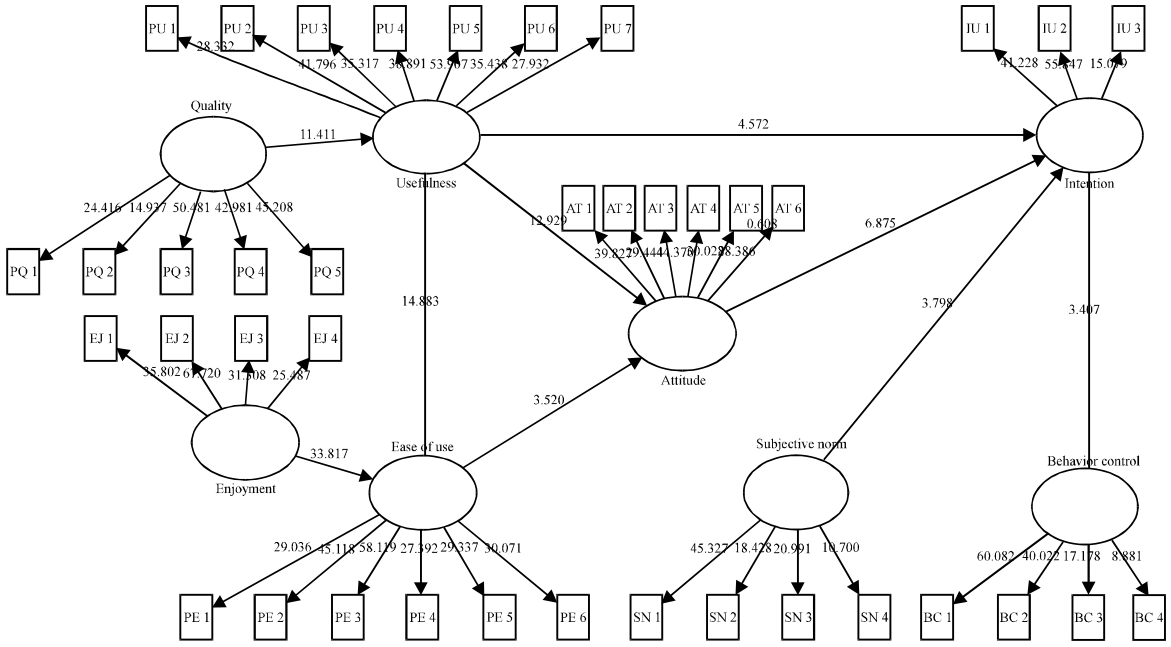

Fig. 3: SEM t-value

Table 2: Path coefficients and their significance

Hypothesis/Path	Path coefficient by PLS	T-value	Supported or Not
H1: Perceived usefulness -> Attitude	0.719363***	12.928656	Yes
H2: Perceived ease of use -> Attitude	0.207141***	15.045090	Yes
H3: Attitude -> Behavior intention	0.412694***	6.875291	Yes
H4: Perceived ease of use -> Perceived usefulness	0.546773***	14.882960	Yes
H5: Perceived usefulness -> Behavior intention	0.294193***	11.354059	Yes
H6: Subjective norm-> Behavior intention	0.117918***	3.798191	Yes
H7: Perceived behavior control-> Behavior intention	0.159342***	3.407098	Yes
H8: Perceived quality -> Perceived usefulness	0.430816***	11.411400	Yes
H9: Perceived enjoyment -> Perceived ease of use	0.776581***	33.816698	Yes

*p<0.05, **p<0.01, ***p<0.001

means that there is good fitness of samples and model in this study. All the hypotheses are supported (Fig. 2, 3, Table 2).

CONCLUSION

In recent years, drivers have been searching for ways to efficiently and effectively find freeway and road direction. Traditional methods of finding the directions, such as looking at a certain city's or county's map or buying a whole booklet of maps of an entire region, had certain restrictions and limitations and practitioners and researchers in this field must thus consider the advantages of GPS in promoting satellite navigation fleet management systems. Overall, satellite navigation fleet management systems offer the public IT transportation convenience so that everyone is able to enjoy a high quality of life with advanced technology.

The results of the present study show that perceived quality and perceived enjoyment are the two most important factors in satellite navigation fleet management system. Perceived quality is an effective predictor of users' attitudes and intentions to use satellite navigation fleet management system. This means that users' needs for satellite navigation fleet management system are more closely related to perceived quality (i.e., products, trust in the medium and trust in the information, support and convenience) than perceived ease of use (e.g., interaction with the devices and ease of use). The need for effective functionalities and a wider scope of satellite navigation fleet management system services in Taiwan should be important issues of concern for users. The promotion and presentation of satellite navigation fleet management system services to potential users should reflect the attitudinal factors in the model (i.e., perceived usefulness). Users are most concerned with their ability to reduce the time spent paying tolls. For example, adopting satellite navigation fleet management system provides greater convenience to users. In this study, the model is sufficiently predictive and explains the behavioral intention of satellite navigation fleet management system. The structural model provides a good fit to the data and most path coefficients in the model are found to be statistically significant.

Because users have become increasingly sophisticated and selective when using and adopting new technologies, they are especially sensitive to the perceived quality and they seek specific usefulness and novel enjoyment. For discretionary use, customers want a technology that targets their specific interests, rather than one which gives them general options. While using satellite navigation fleet management system, the perceived quality indicates a sense of synchronicity and continuity with significant people, things, activities and social norms. When using convergence technologies, users want to feel as if they are emotionally and virtually connected with the world, its resources and its people.

In addition, satellite navigation fleet management system users take advantage of improved traffic flow, intelligent transportation and superior quality of life. In conclusion, given the constantly changing nature of satellite navigation fleet management system technologies, this study leads to a better understanding of the user factors of satellite navigation fleet management system in this new field of convergence and sheds light on the implications for the development of effective applications. The findings of this study provide a good basis for industry to develop a service evaluation framework to determine the adoption potential of new services.

RECOMMENDATIONS

One of the major limitations of the study was that the sampling only came from Taiwan's logistics trucking service's drivers with usage experience of satellite navigation fleet management systems, so the results may not be applicable to other industries also dealing with satellite navigation fleet management systems. It is suggested that future studies can be targeted at different industries so as to further examine the correlations among those variables. In addition, this is a quantitative study. Future research can include a qualitative method which

observes and records users' satisfaction and future intention to use after experiencing the satellite navigation fleet management system. By doing so, a clearer picture of this topic can be drawn with more complete results.

This study contributes to that process by providing a comprehensive user C-TAM-TPB model of satellite navigation fleet management system. The results can make logistics trucking service marketers aware of the factors they consider in attracting customers by using satellite navigation fleet management system. This study also contributes to theory building by considering satellite navigation fleet management system acceptance in the logistics trucking service context. Moreover, it successfully develops and tests an extensive model of the experienced drivers' adaptation by including the external factors of usage of satellite navigation fleet management system experience. The results support all the hypotheses. The findings suggest that frequent drivers have more positive attitudes in using satellite navigation fleet management system and have a higher intention to use them on trips. That is, frequent drivers have stronger satellite navigation fleet management system usage needs for trips. This implies that logistics trucking service marketers should consider using satellite navigation fleet management system services as one of the key elements in attracting frequent drivers. Overall, utilizing satellite navigation fleet management system services results in reduced time in looking for directions, improved traffic flow, more intelligent transportation and superior quality of life.

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