

Which Factors Affect Passengers' Intention to Use the Automated Immigration Clearance System (e-Gate)?

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Abstract

This study discusses the factors that affect passengers' intent to use automated immigration clearance system (e-gate) and the corresponding causal relationship. Based on the Technology Acceptance Model, we constructed a model by considering the need for personal interaction and perceived risk, designed questionnaires by focus group discussions and observed and compared passengers' behaviour by Structural Equation Modeling and Hierarchical Regression to identify several important issues. Results indicated that (1) for experienced users, use attitude and perceived ease of use are the key factors with positive effects on use intention; (2) for inexperienced users, the need for personal interaction negatively influences use intention, and perceived usefulness has little effect on use intention; and (3) 'experience' has a significant main effect and moderator effect on the influences of personal interaction and perceived risk on use intention. These results suggest the following important implications: enhanced experience, inductive promotional strategies, positive feedback loop, provide options for immigration examination stamps, and reach a balance between control and facilitation.

Keywords: international airport, e-gate, Technology Acceptance Model, need for personal interaction, perceived risk

1. Introduction

To maintain orderly entry and exit, as well as to eliminate criminal flow, international transmission of infectious diseases, smuggling and illegal immigration, governments around the world have adopted various robust systems to screen passengers' identities in airports, seaports and border zones. For instance, in March 1998, Malaysia first introduced the biometric passport. In 1988, the U.S. Customs and Border Protection (CBP) introduced the Advanced Passenger Information System (APIS). In January 2009, CBP requested that all airlines use the ESTA (Electronic System for Travel Authorization) at check-in to screen U.S.-bound passengers from Visa Waiver Program (VWP) countries.

From March 22 to April 1, 2004, the International Civil Aviation Organisation (ICAO) held 'The 12th Session of the Facilitation Division of the ICAO' as part of the 'Convention on International Civil Aviation' in Cairo, which led to the resolution 'Standards and Recommended Practices of

Annex 9'. The convention proposed international facial identification regulations and file formats as obligatory practices for members. In the following year, according to the 'Machine Readable Travel Documents' in revised Doc 9303, the ICAO requested its 189 members to enact machine readable passports (MRP) before April 1, 2010. Moreover, non-contact chips matching ISO 14443 Type A/B are used in passports to store passport holders' basic information and biometric characteristics, which include facial images instead of sensitive personal information. In application of Self-service Technologies (SSTs) (Meuter, Ostrom, Roundtree, & Bitner, 2000) in border management mechanism, automated immigration clearance system (e-Gate) is designed to streamline the customs clearance process for enrolled passengers.

Although substantial research has been conducted on the functions, technologies and information management of e-Gate (Frontex Agency, 2007; Liu, 2011; Mironenko, 2011; Schouten & Jacobs, 2009), few studies have discussed passengers' intentions of using e-Gate and the factors affecting those intentions. Thus, based on the Technology Acceptance Model (TAM), this study constructs a model of passengers' intentions to use e-Gate using Structural Equation Modeling (SEM) and explains their attitude and behaviour toward the new technology. Based on the results of the study, suggestions were made regarding how to improve the system and encourage adoption of e-Gate in an attempt to benefit both passengers and immigration authorities.

2. Literature Review

2.1. E-Gate

Lake (2004) suggested that border management should serve the purpose of accelerating the entry of passengers and objects while preventing the entry of undesirable people and objects. Many countries have installed e-Gate to enable inspection at the border by computer automation and biometric identification techniques (Cabinet Office, 2007), such as the Global Entry Program of the U.S., the SmartGate system at Sydney Airport in Australia, the PEGASE Program at Charles de Gaulle Airport in Paris, the IRIS Program in London Heathrow Airport, Manchester Airport and Gatwick Airport in the UK, the Privium Program at Amsterdam Airport Schiphol in Nederland, the ABG Program at Frankfurt Airport in Germany and the RAPID Program at Lisbon Airport, Faro Airport and Porto Airport in Portugal (Frontex Agency, 2007).

Beginning in March 2011, the National Immigration Agency of Taiwan installed e-Gates in Kinmen Shueitou Port, Kaohsiung Airport, Taipei Songshan Airport and Taoyuan Airport. By the mid of October 2014, 1,755,001 people had registered for e-Gate and had used the system 4.98 million times for entry and exit (National Immigration Agency, 2014).

During the early stages of operation, registration was open to Taiwanese citizens with domestic household registrations aged 14 or above, who were at least 140 cm in height and were not barred from exiting Taiwan. Since September 2012, individuals meeting the following criteria have been able to use e-Gate for free, including (i) alien residents or permanent residents holding a Taiwan Resident Certificate with a multiple re-entry permit; (ii) foreign diplomats or staff members of international organisations holding a Diplomatic Identification Card issued by the Ministry of Foreign Affairs, Taiwan; (iii) overseas Chinese individuals without household registrations holding a Taiwan Resident Certificate with a multiple re-entry permit; (iv) Hong Kong and Macau residents holding an Exit & Entry Permit with multiple re-entry; and (v) Mainland Chinese residents holding an Exit & Entry Permit with multiple re-entry.

2.2. Technology Acceptance Model (TAM)

Lu, Chou, and Ling (2009) suggested that the TAM is the most common framework for research on factors affecting customers' preferences to use SSTs. TAM studies have produced rich findings

(El-Gohary, 2012; Kim, Mirusmonov, & Lee, 2010). For instance, Lee (2013) examined the factors leading to the adoption of the mobile e-book in South Korea. Ayeh, Au, and Law (2013) explained the intention to use consumer-generated media for travel planning. Lee and Lehto (2013) extended the conceptual framework of TAM and identified the determinants affecting behavioural intention (BI) to use YouTube for procedural learning. Wang, Chung, Park, McLaughlin, and Fulk (2012) found in a study on online community participation using the TAM method that 'perceived usefulness' performs better than 'perceived ease of use' in explaining actual use. Choi and Totten (2012) explored the acceptance by 817 university students in Korea and the U.S. of mobile TV. Li, Duan, Fu and Alford (2012) explained the BI to reuse e-learning systems in rural China. Huang and Martin-Taylor (2013) applied the TAM to SSTs, exploring how human resources can drive and influence the adoption of electronic human resource management (e-HRM) systems in an organisation. Oh, Jeong, and Baloglu (2013) proposed and tested a model of passengers' adoption of SSTs to explain why passengers choose SSTs over service staff.

TAM is an extension based on the Theory of Reasoned Action (TRA) and explains and predicts users' behaviour (Chen, Gillenson, & Sherrell, 2002). Fishbein and Ajzen (1975) proposed TRA, and suggested that to predict a person's specific behaviour, it should first recognise their BI. Their behaviour is the selection made based on existing information after rational thinking.

There are two basic assumptions of TRA: most people's behavioural performance is controlled by individual will and is rational behaviour. BI is the immediate determining factor of individuals' adoption of actual behaviour. Two factors of individuals' BI are attitudes toward behaviour and the subjective norm to adopt such behaviour. The factors indirectly influence behaviour by BI. Upon this assumption, TRA suggests that BI is the factor of actual behaviour, whereas BI is influenced by attitudes toward the behaviour and subjective norms. Based on TRA, TAM suggests that the use of attitude and BI will be influenced by the 'perceived ease of use' and 'perceived usefulness' and BI will influence actual system use. When users have higher 'perceived usefulness', it will more positively and directly influence 'use intention' and 'use attitude'. When all systems are equal, users will choose the method that is the easiest to use. Regarding TRA, Fishbein and Ajzen (1975) suggested that attitude consists of beliefs regarding the consequences of performing a behaviour and is multiplied by their evaluation of these consequences. BI measures a person's relative strength of intention to perform a given behaviour. In this study, attitude (use attitude) refers to a passenger's positive or negative comments on a specific practice or behaviour and is influenced by individual beliefs and outcomes of the behaviour. BI (use intention) represents a passenger's intention to use e-Gate.

In TAM, Davis' original model explained 'perceived usefulness' as the degree to which a person believes that using a particular system would enhance their job performance and defined 'perceived ease of use' as the degree to which a person believes that using a particular system would reduce effort. This study defines 'perceived usefulness' as a passenger's perception of the efficiency enhancement offered by e-Gate and defines 'perceived ease of use' as a passenger's perception of the ease of using e-Gate.

In addition, as different technology systems will influence users by other external factors, external variables are included to probe into users' acceptance of new technology. However, Davis (1989) did not specifically define external variables and emphasised the selection of proper external variables based on different fields and characteristics. Since the proposal of TAM by Davis, with theoretical characteristics and simplicity, many fields have adopted TAM to develop great amount of empirical research. Some scholars recognized the insufficiency of original TAM. Therefore, after supplement of literatures, Venkatesh and Davis (2000) introduced an extension of the TAM, called TAM 2. The main statement of TAM2 is that two processes will influence perceived usefulness: social influence processes and cognitive instrumental processes. Venkatesh and Bala (2008) then supplemented TAM and TAM 2 which did not include anchor and adjustment, two possible

external variables on perceived usefulness, in the model and proposed TAM 3. However, this study focused on factors of passengers' selection for e-Gate or service personnel regarding the need for personal interaction and perceived risk to use e-Gate. After comparing the situations to use TAM, TAM2 and TAM3, this study treated original TAM as the base of research framework and included 'the need for personal interaction' and 'perceived risk' as external variables.

2.3. Need for Personal Interaction

The idea of adopting new SSTs is definitely innovative to many organisations. However, people do not possess entirely positive attitudes towards them (Parasuraman & Grewal, 2000). Without obvious benefits to themselves, people may be reluctant to use SSTs unless there are no other alternatives available (Chang & Yang, 2008). People are driven not only by personal factors (Zhu, Nakata, Sivakumar, & Grewal, 2007) but also by situational factors (Oyedele & Simpson, 2007). The actual use of SST is positively influenced in a crowded environment (Machleit, Eroglu, & Mantel, 2000) and in situations in which customers know what is expected from them (Lee & Allaway, 2002). Dabholkar (1996) found that the need for interaction with a service employee has a negative effect on the expected quality of the technology-based self-service option. Wang and Namen (2004) suggested that airlines encourage passengers to use self-service kiosks by reducing interactions between customers and service employees to ease consumer dependence on employee contact. According to Lu *et al.* (2009), on-site customer service has negatively influences inexperienced passengers' intentions to use SSTs. This study defines the need for personal interaction as a passenger's intention to choose the personnel-in-contact counter for immigration inspection in the customs clearance process during entry/exit.

2.4. Perceived Risk

Bauer (1960) defined 'perceived risk' as "consumer behaviour inherently involves risk as any action taken by the consumer will lead to consequences which cannot be predicted by certainty and some of these consequences can be unpleasant". Bauer (1960) discussed numerous examples of behaviour in which consumers' perceptions of risk were likely to be important determinants of the outcomes and emphasised that he was only concerned with subjective (perceived) risk and not 'real-world' (objective) risk. Thus, perceived risk has two components: uncertainty (the likelihood of unfavourable outcomes) and consequences (the importance of a loss). In consumer behaviour research, studies often treat perceived risk as a multidimensional construct (Crespo, del Bosque, & de los Salmones Sanchez, 2009), which includes financial, performance, social, physical, psychological, time/convenience, privacy, source, etc. (Chang & Tseng, 2013). Because e-Gate is related to personal privacy, when passengers adopt products or services that they have never used, they will consciously or unconsciously perceive the risk. This study defines perceived risk as a passenger's perception of loss or trouble caused by using e-Gate.

3. Conceptual Framework and Questionnaires Construction

3.1. Theoretical Background and Hypothesis Formulation

Based on the TAM framework (Davis, 1989) and related literature (Chen & Tseng, 2012; Dabholkar, 1996; Dabholkar & Bagozzi, 2002; Davis, 1993; Lee, Xiong, & Hu, 2012; Lu *et al.*, 2009; Pavlou, Liang, & Xue, 2007; Venkatesh, Thong, & Xu, 2012; Wang & Namen, 2004), the following hypotheses are proposed in this study.

Surprenant and Solomon (1987) suggested that in a visible service process, interaction and communication between service personnel and customers are part of overall service quality. They defined the need for personal interaction as an important item for the construction of a service quality evaluation model. According to Dabholkar (1992), the need for interaction with a service

employee has a negative effect on attitudes towards using a new computerised self-service option. Gelderman, Ghijssen, and van Diemen (2011) indicated that a high need for personal interaction may lead to decreased interest in learning how SSTs work and a reduced motivation to try those technologies. Thus, this study infers that the need for personal interaction has a significantly negative effect on perceived usefulness, perceived ease of use and use intention.

H1: Need for personal interaction has a negative effect on perceived usefulness.

H2: Need for personal interaction has a negative effect on perceived ease of use.

H3: Need for personal interaction has a negative effect on use intention.

Based on TAM-related literature (Chen & Tseng, 2012; Edmunds, Thorpe, & Conole, 2012; Lee *et al.*, 2012; Lu *et al.*, 2009; Venkatesh, 2000; Venkatesh *et al.*, 2012), this study infers that perceived ease of use significantly and positively influences perceived usefulness; perceived usefulness and perceived ease of use significantly and positively influence use attitude; and attitude significantly and positively influences use intention.

H4: Perceived ease of use has a positive effect on perceived usefulness.

H5: Perceived usefulness has a positive effect on use attitude.

H6: Perceived ease of use has a positive effect on use attitude.

H7: Use attitude has a positive effect on use intention.

In research on electronic shopping for custom apparel, Kang and Kim (2012) suggested that perceived risk significantly influences behavioural intention. In research on Malaysians' intentions to use mobile banking, Cheah, Teo, Sim, and Oon (2011) found a negative correlation between perceived risk and use intention. Yang, Tseng, and Cheng (2010) studied airlines' web check-in systems and suggested that passengers' perceived risk of using SSTs has a negative effect on use intention. This study infers that perceived risk has a significantly negative effect on use intention.

H8: Perceived risk has a negative effect on use intention.

As discussed above, there are six factors (need for personal interaction, perceived usefulness, perceived ease of use, perceived risk, use attitude and use intention) in the proposed research model. The eight hypothesised relationships (H1 to H8) and their directions are summarised in Figure 1.

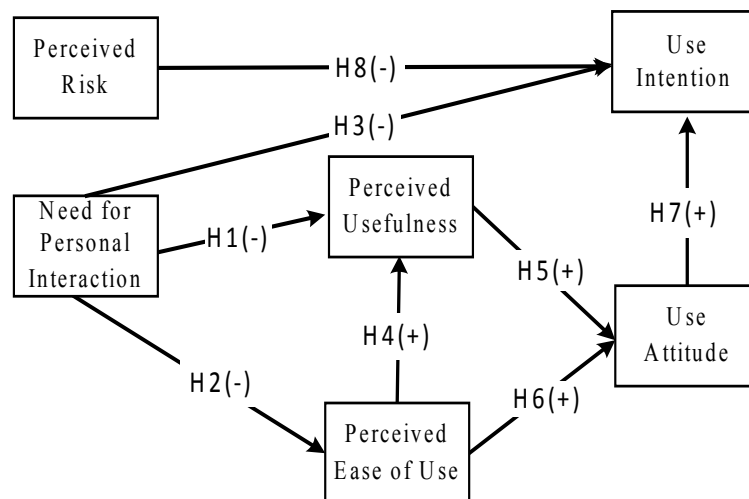


Figure 1. A proposed research model

3.2. Focus Group Discussions

To precisely recognise the core value of the issue and indicate possible management problems and potential service errors in passengers' customs clearance process during entry/exit, this study designed questionnaires by focus group discussions (FGDs) (Sutton & Arnold, 2013) based on the structure of Figure 1.

According to the literature cited in section 2.2, this study designed interview guidelines regarding use attitude, use intention, perceived usefulness and perceived ease of use, as well as operational definitions and possible causal relationships between the required factors for personal interaction and perceived risk, cited in section 2.3, according to the usage situations of e-Gate. By FGDs, this study invited immigration officers who have worked for at least 10 years in Kaohsiung Airport or Taoyuan Airport, tour leaders and travel bloggers to participate in discussions. In Kaohsiung and Taoyuan, we held FGDs and invited respectively five participants to join in the discussion.

The discussion was divided into three stages. First, according to interview guidelines, the researcher controlled the discussion and made sure that participants understood the use characteristics of e-Gate. Participants were invited to describe their episodes about e-Gates or interpersonal services in their past experience, assistance with passengers or personal experience upon six factors. If the participants could not find an appropriate factor to assign the episodes, they were allowed to form a new factor. However, In Kaohsiung and Taoyuan, no new factors were suggested for any episodes by those participants in two FGDs.

In each FGDs, the researcher made no critical comments, avoided leading their answers, and only expressed sympathy to encourage participants' opinions. Furthermore, a question-and-answer session was arranged, during which all of the participants were invited to contribute to the discussion. Two rounds of discussions lasted for two hours and were recorded. The recordings were transcribed, and after careful reading, specific concepts were established. The researcher then generalised and clustered the characteristics of specific concepts. Concepts with a high degree of homogeneity were clustered. The characteristics of the clusters were named by simple terms. Based on the previous procedure, 28 observed variables were obtained, as shown in Table 1.

3.3. Data Collection

Face-to-face interviews were conducted in the immigration hall of Taoyuan Airport in early February 2013. The respondents were selected following the concept of equal interval sampling. Only the target subjects acquainted with the e-Gate system in Taiwan's airports were invited to complete the questionnaire.

Based on the construct measurements (see Table 1), the respondents were asked to indicate their responses to each observed variable via a seven-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Because full-information estimation methods require a suitable sample size to obtain meaningful parameter estimates, as suggested by Stevens (1996), 15 respondents are needed for each observed variable; thus 420 respondents are needed for 28 variables to obtain better results. Considering the possibility of invalid samples, 450 questionnaires were distributed in this study. A total of 437 valid questionnaires were retrieved, including those of 16 foreigners who had used e-Gate in Taiwan and 43 foreigners who had never used e-Gate in Taiwan but were aware of the service. To avoid any bias caused by the relatively low response rate among passengers, only questionnaires completed by passengers from households registered in Taiwan were considered. After this elimination, 378 acceptable questionnaires remained.

Table 1. Construct measurement

Item number	Observed variables
V01	Personnel-in-contact services can satisfy my needs
V02	Selection of service according to the situation at the time
V03	Procedure of the personnel contact service is simpler
V04	Personnel-in-contact service is necessary
V05	Improvement of the crowd during rush hour in the airport
V06	The system is convenient and efficient
V07	The system reduces the amount of time required
V08	Independent accomplishment of the customs clearance process
V09	It is easy to register for e-Gate
V10	Clear operating guidelines
V11	It is easy to operate e-Gate
V12	It does not take much time to learn to use e-Gate
V13	Consideration of human factors
V14	It is a problem to be unfamiliar with the use environment
V15	Once the system breaks down, it will be a problem
V16	Possible cognitive difference between departure and destination immigration inspection, resulting in an extra communication cost
V17	Use of e-Gate is not as expected
V18	e-Gate is a system with a positive value
V19	It is a good idea for the government to implement e-Gate
V20	I enjoy using e-Gate for customs clearance
V21	It is a smart choice to use e-Gate
V22	Generally speaking, I have good comments about e-Gate
V23	I will recommend e-Gate to others
V24	It will try to understand e-Gate
V25	I will frequently use e-Gate
V26	I will continue to use e-Gate over other choices in the future
V27	I will register for e-Gate
V28	When personal confidential information is illegally collected, used and exposed, it will be a problem

4. Methodology

4.1. Demographic and Travel Profiles

The collected data were analysed for descriptive statistics according to social and economic characteristics and travel characteristics. One hundred sixty-nine subjects have used e-Gate (44.7%), whereas 209 have not (55.3%). The sample consists of 47.1% males and 52.9% females. Most of them are 31-40 years old (36.8%), with the next two largest group being composed of subjects aged 21-30 years (27.2%) and 41-50 years (16.4%) respectively. Most of them have graduated from universities (53.2%) and work in the service industry (19.8%), followed by those employed in the commerce (15.3%) and information industries (13.2%). Most of the subjects have an annual income of 24,001-32,000 USD (28.6%), followed by those earning 16,001-24,000 USD (25.7%). The most common travel destination is Hong-Kong/Macao/China (44%), followed by Northeast Asia (22%) and Southeast Asia (16%), whereas a few individuals were travelling to the U.S./Canada (3%) or Europe (6%). Travel purposes include work or business (39.4%), sightseeing (35.2%) and visiting friends (11.9%). The most common annual frequency of outbound travel is 6-10 times (32.8%), followed by 3-5 times (25.9%) and 1-2 times (22%). Most subjects travel in economy class (91%).

To ensure a flexible system, the facial characteristics of e-Gate applicants are collected (obligatory item). If the applicant agrees, the National Immigration Agency records fingerprints (supportive item) for cross-comparison. Among 169 experienced users of e-Gate, 151 were willing to provide fingerprints (89.3%).

4.2. Exploratory Factor Analysis (EFA)

Before EFA, this study conducted item discrimination analysis to examine whether the critical ratio (CR value) of the 28 variables is greater than 3 and whether all of the variables had corrected-item total correlation coefficients greater than 0.3 (Pallant, 2010). After calculation, with the exception of V28, the remaining 27 variables were reserved.

Principal component analysis with Varimax rotation was used to extract factors from the 378 questionnaires consisting of 27 reserved variables. The inclusion of an observed variable in a factor was based on the factor loadings, eigenvalues and the percentage of variance explained. First, the factor loadings equal to or greater than 0.5 were included in a factor. Second, the factors with eigenvalues equal to or greater than 1 were considered significant. Finally, the results of the factor analysis explained at least 60% of the total variance (Child, 1990; Saadé, He, & Kira, 2007). The initial result suggested a six-factor structure, with eigenvalues of 31.63, 6.10, 4.05, 3.11, 1.78 and 1.40 and extraction sums of squared loadings of 56.49%, 10.90%, 7.22%, 5.55%, 3.17% and 2.50%. The six factors, and their corresponding variables, are as follows: need for personal interaction (V01 to V04), perceived usefulness (V05 to V08), perceived ease of use (V09 to V13), perceived risk (V14 to V17), use attitude (V18 to V22) and use intention (V23 to V27).

The extracted factors accounted for 89.90% of the total variance. The result of Bartlett's test of sphericity was significant ($p < 0.001$) and the Kaiser-Meyer-Olkin (KMO) overall measure of sampling adequacy was 0.964, well above the recommended level. The internal consistency for the whole scale was measured by Cronbach's coefficient, yielding a value of 0.858. The coefficients for each factor were 0.939, 0.812, 0.938, 0.957, 0.828 and 0.769, respectively. The results showed adequate internal consistency for the construct measurement. Pearson correlation analysis was conducted on the six factors, and there was significant correlation among the factors. The correlation coefficients were 0.364-0.672. Thus, the factors had acceptable discriminant validity (Kline, 2011).

4.3. Confirmatory Factor Analysis (CFA)

At this stage, CFA was performed using the maximum likelihood method of estimation (ML) to examine whether the construct measurement has reasonable construct validity and reliability and to further identify the causal relationships among the six latent constructs to determine whether the data fit the complete structural model.

To observe and compare passengers' behaviour, this study conducted CFA with the underlying data using AMOS Version 7.0 (Arbuckle, 2006), comparing experienced users and inexperienced users. According to Jöreskog and Sörbom (1989), the quality of CFA should be evaluated by the overall model fit and the internal model fit.

4.3.1. Overall Model Fit

To evaluate the overall model fit, an absolute fit measure (the normed Chi-square χ^2/df ratio, RMSEA, GFI, AGFI), an incremental fit measure (NFI, NNFI, CFI, IFI, RFI, TLI) and a parsimonious fit measure (PGFI, PNFI, PCFI) were used to determine whether a covariance structural model fits the research hypotheses.

In SEM, chi squared is not a useful fit index for most researchers because it is affected by sample size, complex models with many parameters and the distribution of variables (Tanaka, 1993). In practice, the χ^2/df ratio has been recommended as a better measure of goodness of fit than

the χ^2 value (Min, 2012). Regarding absolute fit measure indices, the χ^2 statistics of experienced and inexperienced users are 442.954 and 482.746, with 316 degrees of freedom (*df*). Thus, two groups have χ^2/df ratios of 1.402 and 1.528, which are less than the cutoff point of 3 suggested by Bagozzi and Yi (1989). Furthermore, the RMSEA of experienced and inexperienced users are 0.049 and 0.050, less than 0.05. The GFI of the two groups are 0.845 and 0.865 (≥ 0.80 is considered acceptable); the AGFI are 0.814 and 0.838 (≥ 0.80 is considered acceptable).

Regarding incremental fit measure indices, the NFI of experienced users and inexperienced users are 0.892 and 0.936; the NNFI are 0.963 and 0.974; CFI are 0.966 and 0.977; the IFI are 0.967 and 0.977; the RFI are 0.881 and 0.929; and the TLI are 0.963 and 0.974. Except for experienced users' NFI and RFI values, which are slightly lower than the marginal acceptance level of 0.9, the rest of these values fit well with the empirical data.

Regarding the parsimonious fit measure indices, experienced users' and inexperienced users' PGFI are 0.706 and 0.723 (≥ 0.50 is considered acceptable); the PNFI are 0.803 and 0.843 (≥ 0.50 is considered acceptable); and the PCFI are 0.870 and 0.879 (≥ 0.50 is considered acceptable), suggesting that the model has reached a parsimonious level (Min, 2012).

Based on the abovementioned results, except for a few indices that are slightly lower than the general criteria, most of the model-fit indices exceeded the common acceptance levels suggested by previous research (Arbuckle, 2006; Bagozzi & Yi, 1989; Chang & Yang, 2008; Jöreskog & Sörbom, 1989; Min, 2012), suggesting that the hypothesised model fits the empirical data well.

4.3.2. *Internal Model Fit*

The internal model fit was evaluated by examining internal consistency, convergent validity and discriminant validity.

The internal consistency of the constructs was evaluated in terms of composite reliability, as defined by Fornell and Larcker (1981). Previous literature suggests assessing internal consistency based on a composite reliability (CR) level of 0.6 (Anderson & Gerbing, 1988; Bagozzi & Yi, 1989). Convergent validity indicates the degree to which multiple variables measuring the same construct agree. Convergent validity is adequate when constructs have an average variance extracted (AVE) of at least 0.5 (Fornell & Larcker, 1981). Discriminant validity is the degree to which variables differentiate between constructs. Each variable should correlate to a greater degree with other variables of the same construct than with the variables of other constructs. Specifically, t-values associated with each of the factor loadings suggest that each variable is significantly loaded on the appropriate construct. In other words, when the absolute value of the t-value of each variable is above 1.96, the p-value should be lower than 0.05, suggesting that the variables have discriminatory power (Anderson & Gerbing, 1988).

Table 2 lists the standardised factor loadings (SFL), t-values, squared multiple correlation (SMC), CR and AVE values for the variables. These values are necessary to assess the measurement model fits of this study.

For experienced users, the SFL values were 0.786-0.915 and the CR values of the six constructs were 0.891-0.943, greater than the suggested criterion of 0.6. AVE values were 0.671-0.805, and the SMC values ranged from 0.618-0.837, greater than the suggested criterion of 0.5. These results supported the reliability of the six constructs. The absolute values of the t-values of the variables were 11.409-19.059 and were statistically significant ($|t\text{-value}| > 1.96, p < 0.05$).

For inexperienced users, the SFL values of the variables were 0.736-0.893. The CR values of six constructs were 0.942-0.969, and the AVE values were 0.764-0.863. The SMC values of the variables were 0.736-0.893, meeting the suggested criterion. In addition, the absolute values of the t-values of the variables were 16.659-25.489 and were significant.

Based on the abovementioned results, the loadings in the model were significant for experienced and inexperienced users, and the indicators loaded well on their respective constructs.

Table 2. Measurement model results

Construct	Item number	SFL		t-Value ^a		SMC		CR ^b		AVE ^c	
		Experienced users	Inexperienced users	Experienced users	Inexperienced users	Experienced users	Inexperienced users	Experienced users	Inexperienced users	Experienced users	Inexperienced users
Need for Personal Interaction	V01	0.823	0.926	--	--	0.678	0.857	0.904	0.951	0.701	0.830
	V02	0.823	0.895	12.254*	21.597*	0.678	0.802				
	V03	0.870	0.942	13.202*	25.268*	0.758	0.888				
	V04	0.833	0.880	12.451*	20.553*	0.693	0.774				
Perceived Usefulness	V05	0.817	0.925	--	--	0.667	0.856	0.891	0.957	0.671	0.848
	V06	0.810	0.941	11.743*	25.399*	0.656	0.885				
	V07	0.792	0.918	11.409*	23.423*	0.628	0.843				
	V08	0.856	0.900	12.614*	22.030*	0.734	0.810				
Perceived Ease of Use	V09	0.821	0.865	--	--	0.679	0.749	0.930	0.942	0.728	0.764
	V10	0.848	0.872	13.212*	17.202*	0.719	0.761				
	V11	0.846	0.915	13.156*	18.951*	0.715	0.838				
	V12	0.896	0.858	14.362*	16.659*	0.802	0.736				
	V13	0.852	0.859	13.296*	16.701*	0.725	0.738				
Perceived Risk	V14	0.915	0.925	--	--	0.837	0.855	0.943	0.958	0.805	0.850
	V15	0.863	0.944	16.778*	25.489*	0.744	0.891				
	V16	0.902	0.926	18.735*	23.962*	0.814	0.858				
	V17	0.908	0.891	19.059*	21.326*	0.825	0.794				
Use Attitude	V18	0.865	0.894	--	--	0.748	0.800	0.917	0.959	0.688	0.824
	V19	0.863	0.909	14.854*	20.661*	0.745	0.826				
	V20	0.789	0.885	12.710*	19.353*	0.622	0.783				
	V21	0.786	0.925	12.636*	21.661*	0.618	0.856				
	V22	0.840	0.924	14.143*	21.575*	0.705	0.854				
Use Intention	V23	0.845	0.915	--	--	0.714	0.837	0.932	0.969	0.731	0.863
	V24	0.884	0.930	14.980*	23.841*	0.782	0.865				
	V25	0.861	0.913	14.294*	22.512*	0.741	0.834				
	V26	0.838	0.945	13.657*	25.128*	0.702	0.893				
	V27	0.847	0.941	13.910*	24.764*	0.717	0.886				

Notes: a. “*”: significant at $p < 0.05$, $|t\text{-value}| > 1.96$; b. Construct reliability (CR) = (sum of standardised loadings)² / ((sum of standardised loadings)² + sum of indicator measurement error); c. Average variance extracted (AVE) = (sum of squared standardised loadings) / (sum of squared standardised loadings + sum of indicator measurement error).

Regarding the discriminant validity, Hair Jr., Black, Babin, and Anderson (2009) suggested that a multi-trait/multi-method matrix should be used for validation purposes. The square root of AVE for each construct in the validity diagonal (i.e., the highlighted regions) should be consistent with the highest value in the matrix and higher than the correlation coefficients in the column and row of the same latent construct (Fornell & Larcker 1981). As shown in Table 3 (experienced users) and Table 4 (inexperienced users), the correlation between any two constructs was less than the square root of the AVE of the items measuring the constructs, indicating that the two group measurement model adequately discriminates between the constructs.

Table 3. Multi-trait/multi-method matrix (experienced users)

	Need for Personal Interaction	Perceived Usefulness	Perceived Ease of Use	Perceived Risk	Use Attitude	Use Intention
Need for Personal Interaction	0.701					
Perceived Usefulness	0.144	0.671				
Perceived Ease of Use	0.095	0.228	0.728			
Perceived Risk	0.062	0.047	0.149	0.805		
Use Attitude	0.180	0.305	0.269	0.100	0.688	
Use Intention	0.183	0.221	0.309	0.142	0.629	0.731

Notes: Bolded values on the diagonal represent AVE, whereas the other values are the correlation coefficients squared.

Table 4. Multi-trait/multi-method matrix (inexperienced users)

	Need for Personal Interaction	Perceived Usefulness	Perceived Ease of Use	Perceived Risk	Use Attitude	Use Intention
Need for Personal Interaction	0.830					
Perceived Usefulness	0.415	0.848				
Perceived Ease of Use	0.300	0.536	0.764			
Perceived Risk	0.368	0.224	0.134	0.850		
Use Attitude	0.408	0.500	0.429	0.338	0.824	
Use Intention	0.542	0.415	0.309	0.473	0.608	0.863

Notes: Bolded values on the diagonal represent AVE, whereas the other values are the correlation coefficients squared.

Based on the validation results of the overall model and the internal model fit discussed above, this study is predominantly confirmatory because it determines the extent to which the two groups' proposed models are consistent with the empirical data.

4.4. Verification of Research Hypotheses

The research hypotheses were verified by the path coefficient (β) determined by SEM through AMOS Version 7.0. The path analysis of the research model for the two groups is shown in Figure 2 and Figure 3. The results of the hypothesis verification based on the model fit are shown in Table 5.

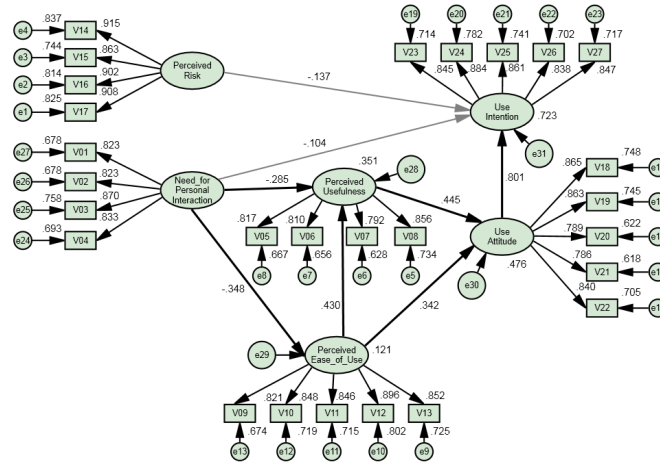


Figure 2. The result of the path analysis of the research model (experienced users)

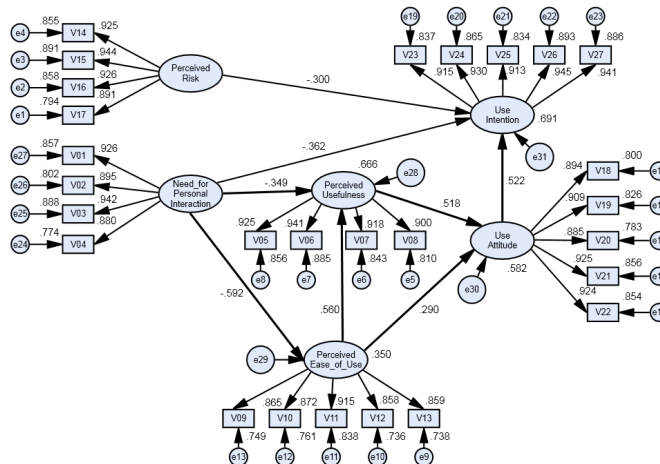


Figure 3. The result of the path analysis of the research model (inexperienced users)

Table 5. The results for the research hypotheses after analysing the overall model

	Hypothesis	Path	Path coefficient (β)	Standard error	CR value (t-value)	p-Value	Results
Experienced users	H1	Need for Personal Interaction-> Perceived Usefulness	-0.285	0.060	-3.544	***	Accepted
	H2	Need for Personal Interaction-> Perceived Ease of Use	-0.348	0.059	-4.164	***	Accepted
	H3	Need for Personal Interaction-> Use Intention	-0.104	0.042	-1.888	0.059	Rejected
	H4	Perceived Ease of Use->Perceived Usefulness	0.430	0.084	5.184	***	Accepted
	H5	Perceived Usefulness->Use Attitude	0.445	0.082	5.268	***	Accepted
	H6	Perceived Ease of Use->Use Attitude	0.342	0.079	4.244	***	Accepted
	H7	Use Attitude-> Use Intention	0.801	0.079	10.845	***	Accepted
	H8	Perceived Risk-> Use Intention	-0.137	0.035	-2.690	0.007	Rejected
Inexperienced users	H1	Need for Personal Interaction-> Perceived Usefulness	-0.349	0.038	-5.954	***	Accepted
	H2	Need for Personal Interaction-> Perceived Ease of Use	-0.592	0.039	-8.949	***	Accepted
	H3	Need for Personal Interaction-> Use Intention	-0.362	0.047	-6.872	***	Accepted
	H4	Perceived Ease of Use->Perceived Usefulness	0.560	0.071	8.885	***	Accepted
	H5	Perceived Usefulness->Use Attitude	0.518	0.093	6.174	***	Accepted
	H6	Perceived Ease of Use->Use Attitude	0.290	0.104	3.493	***	Accepted
	H7	Use Attitude-> Use Intention	0.522	0.068	9.413	***	Accepted
	H8	Perceived Risk-> Use Intention	-0.300	0.036	-6.821	***	Accepted

Notes: *p < 0.05, **p < 0.01, ***p < 0.001

For experienced users, H3 (need for personal interaction-> use intention) ($\beta=-0.104$, $p=0.059$) and H8 (perceived risk-> use intention) ($\beta=-0.137$, $p=0.007$) are rejected, whereas the test indicates significant effects for H1, H2, H4, H5, H6 and H7. Path relations are in the positive or negative direction, in agreement with the previous assumption. The explanatory power of the overall model is 72%.

For inexperienced users, the test indicates significant effects of H1-H8. Path relations are in the positive or negative direction, in agreement with the previous assumption. The explanatory power of the overall model is 69%.

4.5. Explanatory Effects of Constructs on Use Intention

Bollen (1989) stated that direct effects are defined as the influences of one variable on another that are not mediated by any third variable, whereas indirect effects refer to the values that are mediated by at least one other variable. The combination of these two effects results in the total effect, which is a more relevant way of interpreting results because it demonstrates all the changes of a dependent variable as single-unit changes in an independent variable (Song, Lee, Kang, & Boo, 2012). According to Figure 2 and Figure 3, perceived risk and use attitude directly influence use intention and perceived usefulness and perceived ease of use indirectly influence use intention through use attitude. The need for personal interaction not only directly affects use intention but also indirectly affects use intention mediated by perceived usefulness, perceived ease of use and use attitude.

According to the overall effect in Table 6, for experienced users, use attitude is the most powerful construct, with a total impact of 0.801, suggesting that the group's attitude toward e-Gate is the key to those individuals' acceptance of SSTs. Regarding the explanatory effect, the second most important is the perceived ease of use (0.427). Thus, this group values the simplicity of using the system. In addition, perceived risk exhibits the lowest explanatory effect (-0.137). H8 (perceived risk-> use intention) does not exhibit a significant effect.

For inexperienced users, the need for personal interaction is the most powerful factor, with a total impact of -0.636. Perceived usefulness is the least powerful construct with a total impact of 0.271. Thus, in the customs clearance process, this group depends on personnel-in-contact services and does not necessarily agree that e-Gate is an effective system.

Table 6. Decomposition of effects with standardised values

	Construct	Direct effect	Indirect effect	Overall effect
Experienced users	Need for Personal Interaction	-0.104	-0.250	-0.354
	Perceived Usefulness	--	0.356***	0.356***
	Perceived Ease of Use	--	0.427***	0.427***
	Perceived Risk	-0.137	--	-0.137
	Use Attitude	0.801***	--	0.801***
Inexperienced users	Need for Personal Interaction	-0.362***	-0.274*	-0.636*
	Perceived Usefulness	--	0.271***	0.271***
	Perceived Ease of Use	--	0.303***	0.303***
	Perceived Risk	-0.300***	--	-0.300***
	Use Attitude	0.522***	--	0.522***

Notes: *p < 0.05, **p < 0.01, ***p < 0.001

4.6. Examinations of Moderator Effects on Use Intention

Among the 16 hypotheses for the two groups, only H3 and H8 for experienced users are not supported, whereas the others exhibit significant effects. The directions of the path relations match the initial assumptions. Hierarchical regression is used to further determine whether 'having the experience of using e-Gate (i.e., experience)' has a significant moderator effect on H3 and H8.

First, this study treats 'experience' as a dummy variable; respondents who have experienced

e-Gate are denoted as 1, and those who have not experienced e-Gate are denoted as 0.

According to Table 7, the results of Model C show that the need for personal interaction ($\beta=-0.780$, $t\text{-value}=-16.710$) negatively and significantly influences use intention. Experience ($\beta=0.341$, $t\text{-value}=3.570$) significantly and positively influences use intention. In other words, the dummy variable of experience shows that compared to inexperienced users, experienced users have higher use intention. Based on Model C, the interaction effect between need for personal interaction and experience ($\beta=0.479$, $t=5.170$) significantly and positively influences use intention. Thus, experience has significantly main and moderator effects in the relationship between need for personal interaction and use intention.

Likewise, the results of Model C show that perceived risk ($\beta=-0.750$, $t\text{-value}=-14.790$) negatively and significantly influences use intention. Experience ($\beta=0.342$, $t\text{-value}=3.610$) significantly and positively influences use intention. In other words, according to the dummy variable 'experience', compared to inexperienced users, experienced users have higher use intention. According to Model C, the interaction effect between perceived risk and 'experience' ($\beta=0.451$, $t=5.010$) significantly and positively influences use intention. Thus, experience has significantly main and moderator effects in the relationship between perceived risk and use intention.

Table 7. Examination of the moderator effect of 'experience' on user intention

	Independent variable	Model A		Model B		Model C	
		Standardised coefficients (β)	T-value	Standardised coefficients (β)	T-value	Standardised coefficients (β)	T-value
Need for personal interaction	Need for personal interaction	-.668	-17.410*	-.640	-16.280*	-.780	-16.710*
	experience			.113	2.860*	.341	3.570*
	Need for personal interaction * experience					.479	5.170*
	F-value	303.160*		158.580*		121.900*	
	R ²	.446		.458		.494	
Perceived risk	Perceived risk	-.627	-15.600*	-.599	-14.230*	-.750	-14.790*
	Experience			.087	2.060*	.342	3.610*
	Perceived risk * experience					.451	5.010*
	F-value	243.006*		124.650*		96.810*	
	R ²	.393		.399		.437	

Notes: *p < 0.05

5. Conclusions and Implications

5.1. Conclusions

- (1) Generally, regardless whether respondents have experienced e-Gate, both the need for personal interaction and perceived risk have significantly negative influences on use intention. This finding supports H3 and H8. However, if 'experience' is treated as a dummy variable for hierarchical regression, it is found that (i) experienced users have higher use intention than

inexperienced ones, regardless of the need for personal interaction or perceived risk; (ii) experience has a significant main effect and moderator effect on the influences of personal interaction and perceived risk on use intention.

- (2) For experienced users, H3 and H8 do not have significant effects. Regarding the need for personal interaction (H3), this group does not have strong feelings toward the necessity for personal interaction. Regarding perceived risk (H8), according to section 4.1, among 169 experienced users, 151 subjects voluntarily provided fingerprint records (89.3%), indicating that most users agree with and trust the use of personal biometrics by the National Immigration Agency. Thus, perceived risk does not significantly influence their intention to use e-Gate. In addition, use attitude and perceived ease of use are the key factors with positive effects on use intention.
- (3) Inexperienced users are not willing to actively apply for e-Gate, and they prefer personnel-in-contact services. Their need for personal interaction influences their perceptions of the usefulness and ease of use of e-Gate and indirectly influences their use attitude. Moreover, the need for personal interaction has the most powerful effect, and perceived usefulness has the lowest explanatory effect. Thus, this group is highly reliant on personnel-in-contact services, and it is not easy for these individuals to change their habits.
- (4) For the two groups, although perceived usefulness influences use intention, this effect is not as significant as the effects of use attitude and perceived ease of use on use intention. Thus, passengers pay more attention to the evaluation and ease of use of e-Gate than to the benefit that the e-Gate system provides for customs clearance efficiency.

5.2. Implications

Based on the results, the following issues were identified and suggestions proposed to help authorities improve their security programs and systems.

- (1) According to section 4.6, interaction between the need for personal interaction (or perceived risk) and experience significantly and positively influences use intention. Thus, enhanced experience is the key factor to successfully implement e-Gate. It is suggested that authorities can increase the value of new computerised self-service options by word-of-mouth and strategic incentives to encourage passengers to experience the system.
- (2) Inductive promotion strategy: Research by Oh *et al.* (2013) on tourists' adoption of SSTs at resort hotels indicated that the desire for interaction with service staff serves as a countervailing construct against technology-related perceptions and subsequent technology-adoption decisions. According to Table 6, inexperienced users depend to a significant degree on personnel-in-contact services, and they lack the active motive and incentive to use this e-Gate unless no other alternatives are available. Chang and Yang (2008) suggested using Skinner's positive reinforcement (e.g., incentive programs) and negative reinforcement (e.g., increasing perceived service complexity if alternative means are used) to encourage passengers to change their habits.
- (3) System reliability: Although perceived risk negatively influences the use intentions of both groups, the effect on experienced users is insignificant. Thus, this group recognises the advantages and disadvantages of e-Gate, and they intend to use it. Inexperienced users' avoidance of risk is inevitable as they have never experienced the e-Gate system. Yang (2007) suggested that the enhancement of the reliability of the system and meeting customers' needs would enhance passengers' use intentions. Dabholkar and Bagozzi (2002) emphasised that reliable service delivery creates trust. Thus, passengers accept SSTs. Compared to inspection by personnel, which takes 5-6 minutes on average, e-Gate only requires 12 seconds for passengers to pass customs clearance. However, Lin (2011) argued that the system should be improved.

For instance, exposure to sun, plastic surgery and heavy makeup can result in incorrect assessment. Thus, authorities should improve the identification technique and the precision of the system to reduce passengers' perceived risk.

- (4) Positive feedback loop: Many studies have suggested that satisfaction will influence customers' decision to continuously use a product or service (Anderson & Mittal, 2000; Bolton, Kannan, & Bramlett, 2000). According to Table 5, use attitude positively influences the use intentions of both groups. In other words, passengers' comments on e-Gate will influence their use of the system or their intention to use the system. The authorities should develop convenient complaint channels and relevant solutions to create a positive feedback loop for service delivery.
- (5) Balance between control and facilitation: To strengthen cross-comparison, France, Germany, Italy and Luxembourg save both facial and fingerprint identification data for e-passports issued after 2007. Following the issuance of the Household Registration Act, e-passports issued in Taiwan only include facial characteristics and fingerprints if the passport holder agrees. According to section 4.1, 89.3% of experienced users voluntarily accept fingerprinting. However, in the future, human rights, privacy protection and ethical regulations require careful policy in this area. Protective measures should be put in place in organisations and programs to maintain balance among personal privacy, administration efficiency and public security.
- (6) Option for immigration examination stamps: Currently, e-Gated does not offer immigration examination stamps. For the two groups, regarding V16 (possible cognitive difference between departure and destination immigration inspection, resulting in an extra communication cost) underlying the construct of perceived risk, the total average value is 3.78, which is lower than the median value of 4 on a seven-point Likert scale. It is suggested that authorities can consider allowing e-Gate passengers to clear immigration and obtain immigration examination stamps in passports through self-service machines. This practice will not only avoid the question regarding international passengers' extra communication cost but also satisfy some passengers' interest in the collection of passport stamps as travel souvenirs or for other reasons.

6. Concluding Remarks

Biometric identification technology can be used to automate the inspection of low-risk passengers. Authorities can then focus their resources on identifying and scrutinizing high-risk passengers, thus simplifying border management of human flow and improving the efficiency of border management and customs clearance.

Application of SSTs to border management is still at the initial stages (Nieh, 2013). In March 2011, the National Immigration Agency liberalized Taiwanese people's applications for the e-Gate system. Beginning in September 2012, foreigners who frequently visit Taiwan were also allowed to apply for use. Thus, this investigation is only an empirical study of a mainstream group of e-Gate users, Taiwanese people. The samples collected for this study only represent part of the whole target population. The primary framework proposed by this study can serve as a reference for future researchers of technology readiness and can lead to the acceptance e-Gate by passengers with different demographic variables.

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