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Understanding the Antecedents of Individuals Intention of Using Cloud Services

Shui-Lien Chen

Department of Management Sciences Management School, Tamkang University, Taiwan

June-Hong Chen*

Department of Management Sciences Management School, Tamkang University, Taiwan

Shiou Chi Chang

Department of Management Sciences Management School, Tamkang University, Taiwan

Cloud computing has become a frequent topic of discussion, garnering active interest from numerous international companies. Many studies have addressed the technical and operational concerns and the industrial applications and adoption intentions related to cloud computing. However, few studies have focused on its use at the individual level. This research integrated the technology acceptance model, the theory of planned behavior, diffusion of innovation, and security risk to develop a theoretical model that explains and predicts users' intentions to use cloud services. Data for this study were collected from 1069 users in Taiwan and were tested against the relationships through structural equation modeling.

Keywords: cloud services, technology acceptance theory, individual behavioral intention, structural equation modeling

JEL classification: M10, M31

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*Correspondence to: Department of Management Sciences Management School, Tamkang University. No. 151, Yingzhuan Road, Tamsui Dist., New Taipei City 25137, Taiwain, R.O.C. Email: cjh50215@cht.com.tw; Tel.: +886 2 2963 9283; Fax: +886 2 2963 9777.

1 Introduction

According to the official definition provided by the National Institute of Standards and Technology (Mell and Grace, 2011), "[c]loud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service-provider interaction" (Brown, 2011). The term "cloud computing" has been a buzz word in the information technology (IT) industry since 2007 and has recently received increasing attention in both computer science and information systems (Park and Ryoo, 2013; Zhang *et al*., 2014; Arpaci *et al*., 2015). Moreover, numerous industry projects have been designed and implemented, such as Amazon Elastic Compute Cloud, IBM Blue Cloud, and Microsoft Windows Azure. According to an analysis by Allied Market Research, the global personal cloud market is expected to be worth $89.9 billion by 2020, with a compound annual growth rate of 33.1% during 2015–2020 (Joshi, 2015). Morgan Stanley predicted that Microsoft cloud products (Office 365, CRM, and Azure) will compose 30% of the company's revenue by 2018, up from 11% in 2015 (rhipe Limited, 2016). Growing customer awareness is expected to promote the growth of personal cloud services in the future. Thus, cloud computing can be considered a method of delivering IT services to individuals and organizations in the form of software, platforms, and infrastructure using Internet technologies (Nedbal *et al*., 2014; Gangwar *et al*., 2015). Cloud services not only provide users with improved service but also help companies to effectively reduce costs and risks and increase scalability, flexibility, and agility (Gangwar *et al*., 2015). Through the use of cloud computing, managers or users in the same multinational corporation can synchronize their use of the same platform to more closely cooperate with each other.

A review of the literature revealed that many studies have addressed the technical and operational concerns related to cloud computing (Martens and Teuteberg, 2012; Yang and Tate, 2012), including topics such as an audit protocol for secure storage and computation in the cloud (Wei *et al*., 2014), proposal of an emotion–aware mobile cloud computing framework and a design for a partitioning solution in the 5G context (Chen *et al*., 2015), and an investigation of security problems as well as the specifications of key features (Almorsy *et al*., 2016). Numerous studies, blogs, and forums have examined the application of cloud services to industries (Rosenthal *et al*., 2010) and have evaluated service adoption intention from organizational perspectives (Nedbal *et al*., 2014). However, few studies have conducted evaluations from the perspective of individuals; for example, the factors influencing the decision to adopt cloud computing at an organizational level (Borgman *et al*., 2013), drivers of cloud computing adoption in organizations (Stieninger and Nedbal, 2014), and the benefits of the cloud for small and medium enterprises (SMEs) (Tim Aldred, 2017). Therefore, this study integrated the technology acceptance model (TAM), theory of planned behavior model (TPB), diffusion of innovation (DOI), and security risk to develop a theoretical model that explains individuals' intention of using cloud services.

The TAM, TPB, and DOI have been widely applied as the theoretical basis in empirical studies investigating users' acceptance of various technologies (Wu *et al*., 2007; Lee *et al*., 2011; Gangwar *et al*., 2015). The TAM focuses more on technological aspects, and its strengths are its simplicity and high explanatory power (Wu *et al*., 2007; Awa *et al*., 2015). However, it does not consider the effects of individual factors in the adoption process; its constructs are narrowed to perceived usefulness (PU) and perceived ease of use (PEOU) (Wu *et al*., 2011; Awa *et al*., 2015). Hence, it must be integrated with other IT acceptance models to improve its explanatory and predictive powers. Taylor and Todd (1995) revealed that the integration of TPB with the TAM enhanced its explanatory and predictive utilities. Subjective norms (SNs) and perceived behavioral control (PBC) in the TPB complement TAM's constructs and help explain perceptions of the ease or difficulty of performing an act given resource constraints (Awa *et al*., 2015). By contrast, the DOI perspective theoretically lacks an explicit relationship with the TAM, but the TAM and DOI consist of some similar constructs and are complementary for examining information system (IS)/IT adoption (Lee *et al*., 2011). Constructs employed in the TAM are fundamentally subsets of perceived innovation characteristics; thus, integrating these two theories can result in an even stronger model (Wu and Wang, 2005). Many studies have therefore proposed integrated models primarily based on the TAM and TPB/DOI for various IS/IT settings to investigate users' technology acceptance behavior and have shown that these integrated models should achieve a higher explanatory power for technology acceptance (Chang and Tung, 2008; Lee *et al*., 2011; Wu *et al*., 2011). In addition, personal data risk and network security risk are essential observation indicators in the development of cloud computing. In recent years, IBM, Microsoft, Hewlett Packard, and Google have all merged with companies responsible for information security. This is largely because information security companies perform a vital function in the competitive arena of cloud computing (Chi *et al*., 2012).

Therefore, this paper developed an integrated model involving the TAM, TPB, DOI and security risk to predict and explain customers' behavioral intentions for adopting cloud services. The results of this empirical study may be useful for developing and testing theories related to cloud service acceptance at the individual level and for understanding strategies for designing and promoting cloud services.

2 Literature Review and Research Hypotheses

Table 1. Definition of the Variables

Constructs	Definitions of the variables
Perceived ease of use	the degree a person considers using a specific system would be free of physical and mental effort (Davis, 1989)
Perceived usefulness	the degree a person believes using a particular system would improve or enhance their job performance (Davis, 1989)
Attitude	the degree of a person's favorable or unfavorable appraisal of a specific behavior (Fishbein and Ajzen, 1975)
Subjective norm	the perceived social pressure that influences behavior decisions (Ajzen, 1991)
Perceived behavioral control	the perception of ease or difficulty in formatting the behavioral intention (Liao *et al.*, 2007)
Relative advantage	the degree to which an innovation is perceived as being more effective than its precursor (Rogers, 1983)
Compatibility	the degree to which an innovation is perceived as being consistent with existing values, needs, and the past experiences of potential adopters (Rogers, 1983)
Security risk	a potential loss due to fraud or a hacker compromising the security of an online user, such as usernames, passwords and credit card details, by masquerading as a trustworthy entity in an electronic communication (Reavley, 2005)

Figure 1 provides a pictorial description of the research framework, and Table 1 summarizes the definitions of the variables. The following section discusses the theoretical bases and development of the hypotheses.

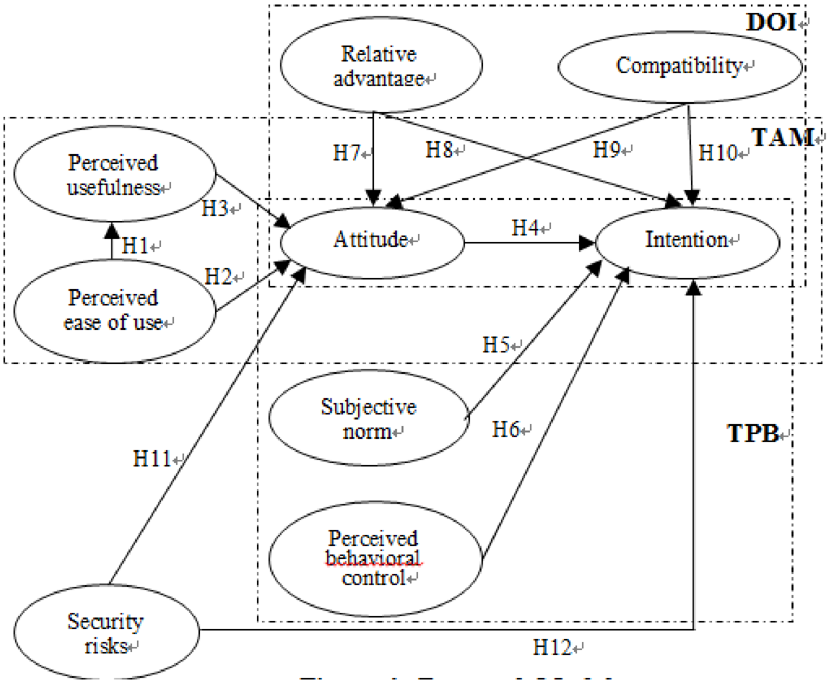

Figure 1. Research Model

2.1 Technology Acceptance Model

Davis (1986) proposed the TAM, a widely accepted model for predicting and explaining user behavior and IT usage (Stieninger *et al*., 2014; Gangwar *et al*., 2015) and for exploring cloud computing (Behrend *et al*., 2011; Opitz *et al*., 2012). The TAM is designed to explain why people adopt or dismiss various forms of IT (Eriksson *et al*., 2005; Hong *et al*., 2006). The TAM consists of PEOU, PU, attitude toward using (ATT), behavioral intention to use (BIU), and actual use. PU and PEOU are the most influential factors for new technology usage and intent and are also predictors of ATT and BIU (Wu and Wang, 2005; Wong *et al*., 2012).

PEOU refers to the degree to which a person perceives that using a specific system would be free of physical and mental effort (Davis, 1989), whereas PU is the degree to which a person believes that using a particular system would enhance their job performance (Davis, 1989). The PEOU of cloud services is an effective driver of cloud service use because users can access computing resources and IT solutions without extensive details or in-depth knowledge (CIO Magazine, 2011; Gangwar *et al*., 2015). PU is a critical indicator, because users believe that adopting cloud services can improve business efficiency, performance, and productivity (Senk, 2013; Gangwar *et al*., 2015).

If the salient belief of cloud computing users is that using cloud computing is free of effort, they will be tend to believe that its use will enhance their job performance. Davis *et al*. (1989) found that PEOU may directly influence PU, a conclusion that has been confirmed by more recent studies (Wu and Chen, 2005; Sumak *et al*., 2011). Unlike the prior indefinite argument, this paper argues that the PEOU and PU have clear and definite relationships. Therefore, this paper presents the following hypothesis:

H1: PEOU exerts a positive influence on the PU of cloud computing.

ATT is the degree to which a person provides a favorable or unfavorable appraisal of a specific behavior (Fishbein and Ajzen, 1975). Many reports have provided evidence of the impact of PU and PEOU on ATT and BIU (Sumak *et al*., 2011). ATT for cloud computing has been clearly demonstrated to be significantly affected by PEOU and PU. The higher the level of PEOU or PU, the higher the level of positive ATT for cloud computing. Therefore, this paper presents the following hypotheses:

H2: PEOU exerts a positive influence on the ATT for cloud computing.

H3: PU exerts a positive influence on the attitude toward behavior for cloud computing.

2.2 Theory of Planned Behavior

Ajzen (1985) developed the TPB model, which links attitudes and behavior. Moreover, Pelling and White (2009) identified that behavior is determined by intentions. TPB identifies three determinants that influence individual behavior: an individual's attitude toward behavior, SNs, and PBC (Ajzen, 1991; Taylor and Hunsinger, 2011; Cheon *et al*., 2012). Ajzen (2002) reported that a person who has a positive attitude, SNs, high PBC, and intention to perform a behavior should succeed in implementing the behavior. Attitude toward behavior is defined as an assessment of one's beliefs regarding the consequences of the specific behavior and the desirability of these consequences (Ajzen, 1985; Stantchev *et al*., 2014). Those who believe that performing a given behavior will lead to positive outcomes will hold a favorable attitude toward performing the behavior; for example, when individuals form positive (or negative) attitudes toward cloud computing, they tend to have higher (or lower) intentions toward using it (Arpaci *et al*., 2015). Similar studies have provided empirical evidence for other cases of IT acceptance (Hong *et al*., 2006; Lee, 2010).

SNs are the perceived social pressures that influence behavioral decisions (Ajzen, 1991) and are understood to be an individual's perception of whether other individuals believe that the specific behavior is appropriate (Shin, 2013). Several studies have posited that SNs significantly and positively affect usage intention and are a determinant in the adoption and utilization of new technologies (Wong *et al*., 2012). Therefore, individuals are more likely to use cloud services if their friends are already users.

PBC is the perception of ease or difficulty in formatting behavioral intention (Liao *et al*., 2007). In the TPB, behavior control is represented as a continuum of behaviors, ranging from those that are effortlessly performed to those that require considerable effort and resources (Ajzen, 2002). Numerous empirical studies have indicated a relationship between PBC and intention (Shih and Fang, 2004). PBC is associated with beliefs about the presence of control factors that may advance or obstruct the performance of a behavior (Liao *et al*., 2007). Thus, the more fundamental cloud computing skills that users possess, the more likely they are to have the behavioral intention to engage in cloud computing. Therefore, this paper presents the following hypotheses:

H4: ATT exerts a positive influence on behavioral intention toward cloud computing.
H5: SNs exert a positive influence on behavioral intention toward cloud computing.
H6: PBC exerts a positive influence on behavioral intention toward cloud computing.

2.3 Diffusion of Innovation

Rogers' (1983) DOI theory delineates the technology innovation adoption process from broad social psychological and sociological perspectives (Oliver and Goerke, 2008). Rogers described that five characteristics influence the diffusion and acceptance of innovations: relative advantage, compatibility, complexity, trialability, and observability (Stieninger *et al*., 2014). These characteristics are referred to as the perceived characteristics of innovations (PCIs) and affect a person's choice to use innovative technology (Moore and Benbasat, 1991; Zhu and He, 2002).

Moore and Benbasat (1991) expanded Rogers' (1983) five perceptual factors to eight, namely relative advantage, image, compatibility, ease of use, visibility, demonstrability of results, trialability, and voluntariness of use. They argued that PCIs are realities perceived and determined by end users. The DOI is among the major theories that have attempted to explore factors affecting individuals' adoption of innovative technology. To obtain an accurate understanding of it, several factors of innovation must be considered simultaneously, and their relationships must be evaluated (Tornatzky and Klein, 1982). Studies have consistently shown that the following innovation factors have the most significant relationships with innovation adoption: compatibility, relative advantage, and complexity, all of which originate from the DOI (Tornatzky and Klein, 1982; Stieninger *et al*., 2014). These factors are perceived attributes of innovations that help to explain the adoption of innovative technologies. Therefore, two representative factors, relative advantage and compatibility, were considered to be relevant in the context of this research. Thus, the variables of voluntariness, image, demonstrability of results, visibility, and trialability were not discussed in this research.

Relative advantage (RA) is "the degree to which an innovation is perceived as being more effective than its precursor" and compatibility is "the degree to which an innovation is perceived as being consistent with existing values, needs, and the past experiences of potential adopters" (Rogers, 1983). Although relative advantage and usefulness were considered similar constructs in a previous study (Venkatesh *et al*., 2003), relative advantage explicitly compares innovative technology and its existing substitutes, although this comparison is not an integral part of PU (Shin, 2010). An innovation tends to be accepted when it accords with individuals' existing job responsibilities, needs, and value systems (Tan and Eze, 2008). Stieninger and Nedbal (2014) revealed that cloud computing solutions provide several advantages including relieving the load of the network infrastructure, removal of the need for hardware maintenance, partial operation of infrastructure, flexibility, simple administration, collaboration opportunities, potential cost savings, and increased automation. Because cloud computing can be considered an innovation owing to its newness relative to other modes of Internet services, relative advantage, which is an indicator of how well an innovation fits a potential adopter's values and needs compared with traditional methods, was included in this research. Rogers (1983) suggested that the perceived relative advantage and compatibility of an innovation are positively related to its potential for adoption. Individual users prefer consistency with existing technology usage experiences and expect greater effectiveness. Armbrust *et al*. (2010) posited that process and data compatibility are the current biggest challenges for this factor. If cloud computing is perceived to have greater relative advantage and compatibility (COMP), it is likely to be adopted more quickly. Therefore, the following hypotheses are presented:

H7: Relative advantage exerts a positive influence on ATT for cloud computing.

H8: Relative advantage exerts a positive influence on behavioral intention for cloud computing.

H9: COMP exerts a positive influence on ATT for cloud computing.

H10: COMP exerts a positive influence on behavioral intention for cloud computing.

2.4 Security Risk

Security is relevant to the model developed in this study, because there is a perception of risk involved in transmitting sensitive information when cloud services are used. Security risk (SR) is defined as potential loss due to fraud or as a hacker compromising the security of an online user by stealing information such as usernames, passwords, and credit card details by masquerading as a trustworthy entity in an electronic communication (Reavley, 2005). Many users believe that they are vulnerable to identity theft while using online banking services (Littler and Melanthiou, 2006). Gartner identified seven cloud computing security risks: privileged user access, regulatory compliance, data location, data segregation, recovery, investigative support, and log-term viability (Brodkin, 2008).

In normal cloud computing, threats and attacks on accounts can be made through networks, data transactions, or unauthorized access using false or defective authentication. Numerous studies on security risks have found that the greatest challenge to virtual service is assuring customers that privacy protection, confidentiality, and security will be maintained (Casaló *et al.*, 2011). The perception of a low level of security may affect users' attitudes towards using cloud services. Users with a low tolerance for technological risks may delay their use of these services. Therefore, the following hypotheses are presented:

H11: Security risks exert a negative influence on the ATT for cloud computing.
H12: Security risks exert a negative influence on the behavioral intention toward cloud computing.

3 Research Methodology

3.1 Measures

Construct measures described in the literature were collected to form the basis of the original scale items in this research. All constructs were measured with multi-item scales that had been validated to fit the current research. The scale items for PU, PEOU, and ATT were adapted from Davis (1989); each dimension included three items. The three scale items each for SN and PBC were adapted from Taylor and Todd (1995a, 1995b). RA in this study was measured using a seven-item scale and COMP using a four-item scale, both adapted from Rogers (1983). SR and behavioral intention (CBI) were measured using three-item scales developed by Stone and Grønhaug (1993) and Bhattacherjee (2001), respectively.

These scales demonstrated strong reliability and validity and were modified to provide an adequate measurement standard for determining new technology adoption. A conventional 7-point Likert scale was used throughout, with 1 denoting strong disagreement and 7 denoting strong agreement.

3.2 Data Collection

This research discussed users' responses to a questionnaire related to the intention to use cloud services. The sample members shown in Table 2 are composed of professional users (i.e., those in IT occupations) and normal users (i.e., those in non-IT occupations such as traditional industry, trade, real estate, and medicine). Cloud services are used over the Internet; therefore, network users were targeted and investigated through an online questionnaire.

Table 2. Demographics (Number of Subjects = 1069)

Gender	**Freq.**	**%**	**Internet Tool**	**Freq.**	**%**
Male	593	55.5	PC	704	65.9
Female	476	44.5	NB	351	32.8
Age	**Freq.**	**%**	Mobile device	14	1.3
<=18	14	1.3	**Internet Hours /Day**	**Freq.**	**%**
19-22	98	9.2	1	32	3
23-29	364	34.1	2	100	9.3
30-45	520	48.6	3	187	17.5
46-59	71	6.6	4	112	10.5
> = 60	2	0.2	5	149	13.9
Education	**Freq.**	**%**	6	97	9.1
< =junior high school	8	0.8	7	28	2.6
senior high school	115	10.8	8	117	10.9
College/university	773	72.3	9	15	1.4
Master	165	15.4	10	85	7.9
Doctor	8	0.7	11	3	0.3
Occupation	**Freq.**	**%**	12	66	6.2
Information technology	253	23.7	13	6	0.6
Traditional industry	196	18.3	14	6	0.6
Finance	74	6.9	15	21	2
Trade	29	2.7	16	10	0.9
Real estate Industry	17	1.6	17	1	0.1
Medicine	72	6.7	18	7	0.7
Livelihood service	102	9.5	19	0	0
Media/ publication	12	1.1	20	14	1.3
Education/ Government	87	8.1	21	1	0.1
Wholesale / Retail	32	3	22	0	0
In job-waiting	95	8.9	23	1	0.1
Student	100	9.4	24	11	1

To enhance content validity and reliability, the questionnaire was first pretested with a convenience sample of 50 individuals, who were not included in the main survey, to identify deficiencies in the questionnaire design. After the main content was revised, the questionnaire was deployed by a professional marketing company, 104 Survey Company, which owns and maintains an exhaustive professional Taiwanese survey database. Sample members who were willing to participate clicked on the URL. A total of 1,069 valid and complete questionnaires were collected as the data for the final analysis.

The respondents included more men than women, with the majority aged 23–45 years. Approximately 88.4% of respondents held a university degree or higher. Most respondents worked in the IT sector (23.7%) and traditional industry (18.3%), with an even distribution of respondents in other occupations. Approximately 65.9% of participants reported using personal computers as their primary tool for Internet access. Finally, most respondents spent less than 10 hours using the Internet each day. Detailed descriptive statistics related to the respondents' profiles are shown in Table 2.

4 Data Analysis and Results

4.1 Statistics Related to Measurement Accuracy Analysis

In this study, SPSS PASW Statistics 18.0 and AMOS 17.0 were used to examine the results if confirmatory factor analysis (CFA) and test the significance of each hypothesis. CFA determined the accuracy of the scales through several indices, illustrating the model's fit. Subsequently, scale reliability was dichotomized into two measures, namely Cronbach's α and composite reliabilities (CR), and validity was dichotomized into two measures, namely convergent validity and discriminant validity, for examination.

The CFA model had a comparative fit index (CFI) of 0.93, an incremental fit index (IFI) of 0.93, a normed fit index (NFI) of 0.92, a Tucker–Lewis index (TLI) of 0.92, an adjusted goodness of fit index (AGFI) of 0.84, and a root mean square error of approximation (RMSEA) of 0.07, suggesting adequate model fit (Bagozzi & Yi, 1988; Hair *et al.*, 2010), except for the goodness of fit index (GFI), which was 0.87. All Cronbach's α and CR values, ranging from 0.87 to 0.93, exceeded the minimum threshold of 0.7 (Komiak and Benbasat, 2006), indicating an acceptable level of reliability (Table 3).

Table 3. Analysis of Measurement Accuracy

Constructs	Measures	Factor loading	Cronbach's α	*CR*
PEOU	Learning to operate the cloud computing system is easy for me	0.85***	0.93	0.93
	It is easy for me to become skillful at using the cloud computing system	0.94***		
	Overall, the cloud computing system is easy to use	0.93***		
PU	Using cloud computing can improve one's job performance	0.80***	0.87	0.88
	Using cloud computing can increase one's job effectiveness	0.87***		
	I find cloud computing to be useful to me	0.84***		
SR	The thought of purchasing a personal computer within the next 12 months for use at home makes me feel psychologically uncomfortable	0.79***	0.91	0.91
	The thought of purchasing a personal computer within the next 12 months for use at home gives me a feeling of unwanted anxiety	0.92***		
	The thought of purchasing a personal computer within the next 12 months for use at home causes me to experience unnecessary tension	0.92***		
SN	People important to me support my use of cloud computing	0.79***	0.87	0.87
	People whose opinions I value prefer that I should use cloud computing	0.88***		
	People whose opinions I value prefer that I should use cloud computing	0.83***		
PBC	Using cloud computing system was entirely within my control	0.78***	0.88	0.88
	I had the resources, knowledge, and ability to use cloud computing	0.87***		
	I would be able to use the cloud computing system well for learning process	0.87***		
RA	Using a PWS improves the quality of work I do	0.72***	0.93	0.93
	Using a PWS makes it easier to do my job	0.74***		
	Using a PWS improves my job performance	0.76***		
	Overall, I find using a PWS to be advantageous in my job	0.81***		
	Using a PWS enhances my effectiveness on the job	0.86***		
	Using a PWS gives me greater control over my work	0.87***		
	Using a PWS increases my productivity	0.85***		
COMP	Using a PWS is compatible with all aspects of my work	0.85***	0.92	0.92
	Using a PWS is completely compatible with my current situation	0.87***		
	I think that using a PWS fits well with the way I like to wrok	0.83***		
	Using a PWS fits into my work style	0.87***		
ATT	Using cloud computing is a good idea	0.81***	0.88	0.88
	I like using cloud computing	0.87***		
	It is desirable to use cloud computing	0.84***		
CBI	I will use the cloud computing system on a regular basis in the future	0.90**	0.90	0.91
	I will frequently use the cloud computing system in the future	0.91***		
	I will strongly recommend that others use it	0.82***		

*** *P*<0.001; ** *P*<0.01; * *P*<0.05

In addition, it was necessary to test the common method variance (CMV), which refers to the amount of fictitious covariance existing among variables, because this study collected data from a single source through self-reporting scales. The most widely used technique, one-factor testing, was employed (Mossholder *et al.*, 1998; O'Connor and Morrison, 2001; Podsakoff *et al.*, 2003). CFAs were used as a complex method to compare the fit of a single-factor model to the fit of a nine-factor model. The one-factor model yielded χ^2 = 12712.02 with 464 degrees of freedom. This model provided a significantly worse fit to the data ($p < 0.001$) than the nine-factor measurement model with χ^2 = 2404.8 and df = 428. Thus, a significant difference was observed between the two models. Therefore, the results showed that the null hypothesis is rejected, suggesting that this study is free of the CMV problem.

Convergent validity measures the extent to which the items actually represent the latent variable, and these measures were tested in this study by calculating the average variance extracted (AVE). An AVE value of 0.50 and higher indicated a sufficient degree of convergent validity (Hair *et al*., 2011). Discriminant validity measures the degree to which various constructs differ from one another, and these measures were assessed by determining the chi-square difference and comparing AVEs with the squared correlations. Support for discriminant validity is provided if the difference in chi-square values is sufficiently large (>3.84) and statistically significant ($p < 0.05$) (Hightower *et al.*, 2002). The AVE value for each construct should be higher than the squared correlation between constructs (Fornelland Larcker, 1981).

Table 4. Correlation, AVE and Chi-Square Difference Results

Constructs	**Mean**	**S.D.**	**PU**	**PEOU**	**SR**	**ATT**	**SN**	**COMP**	**PBC**	**RA**	**CBI**
PU	4.78	1.23	**0.70**	15.85	195.11	23.69	79.34	117.76	67.02	62.35	67.85
PEOU	4.96	1.14	0.30	**0.82**	202.89	47.48	68.71	76.7	14.71	66.66	28.11
SR	4.67	1.35	0.01	0.00	**0.78**	241.03	263.57	302.58	254.69	229.22	283.87
ATT	5.09	1.06	0.37	0.23	0.00	**0.71**	41.83	78.52	28.44	49.42	31.67
SN	4.59	1.03	0.24	0.20	0.00	0.37	**0.70**	64.62	39.56	63.61	31.1
COMP	4.35	1.05	0.40	0.53	0.22	0.58	0.53	**0.73**	72.79	25.38	44.4
PBC	4.81	1.05	0.23	0.37	0.00	0.40	0.44	0.48	**0.71**	48.73	7.88
RA	4.76	0.97	0.24	0.18	0.00	0.31	0.34	0.34	0.36	**0.65**	39.63
CBI	4.58	1.10	0.23	0.30	0.00	0.40	0.46	0.42	0.58	0.40	**0.77**

The diagonal is AVE. Squared correlations are under the diagonal. Difference of Chi-square is above the diagonal.

Table 4 provides the means, standard deviations, and convergent and discriminant validity analysis. All mean scores were above the midpoint of 4.0, ranging from 4.35 to 5.09. This finding indicated an overall positive response to the constructs in the study. The standard deviations suggested a narrow spread around the mean. The AVEs for all constructs were between 0.65 and 0.82, which are above the recommended threshold of 0.50, showing evidence of convergent validity. The chi-square differences ranged from 7.88 to 302.58 ($p < 0.05$). Moreover, AVEs were all higher than the squared correlations of each construct, suggesting that the constructs under analysis were distinct and had discriminant validity.

4.2 Hypotheses Testing

SEM was performed to examine the constructed research hypotheses. The results indicated that the model fit was acceptable, with NFI = 0.91, IFI = 0.92, CFI = 0.92, TLI = 0.91, AGFI = 0.82, and RMSEA = 0.07—except for GFI = 0.86, which was slightly less than the threshold for acceptability.

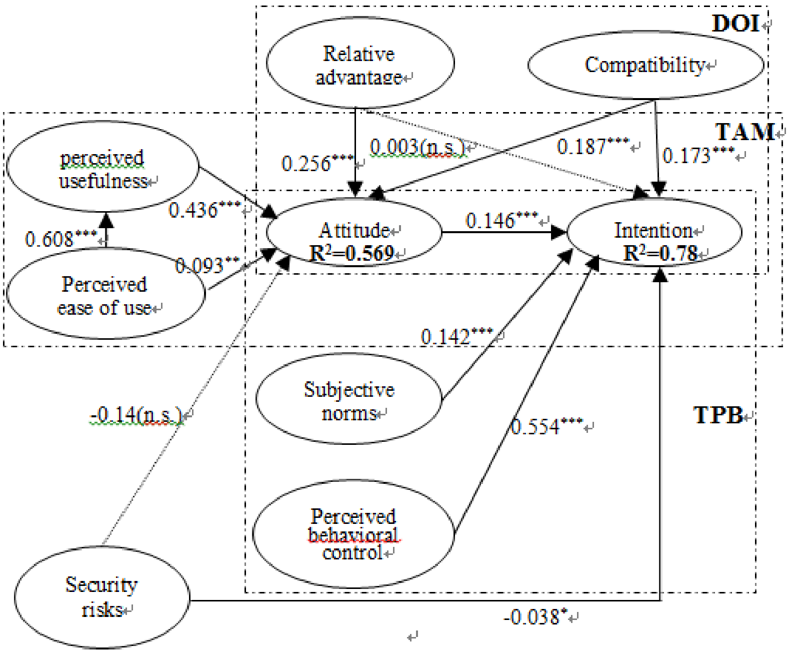

Figure 2. Structural Analysis of Research Model

Figure 2 shows the results of hypothesis testing. Supporting H1, the PEOU consistently exerted a significant positive and direct impact on PU (γ = 0.608, *p* <

0.001). As anticipated, both H2 and H3 were also confirmed. Both PEOU (γ = 0.093, $p < 0.01$) and PU (γ = 0.436, $p < 0.001$) exerted a significant and direct impact on attitude toward behavior. Security risk exerted a significant negative influence on behavioral intention (γ = −0.038, $p < 0.05$). As predicted by H7, relative advantage exerted a significant positive impact on attitude toward behavior (γ = 0.256, $p < 0.001$). H9 and H10, which were related to the positive and direct impact of compatibility on attitude toward behavior (γ = 0.187, $p < 0.001$) and behavioral intention (γ = 0.173, $p < 0.001$), were also confirmed. As expected, H4, H5, and H6 were also confirmed. Moreover, ATT (γ = 0.146, $p < 0.001$), SNs (γ = 0.142, $p < 0.001$), and PBC (γ = 0.554, $p < 0.001$) exerted a significant and direct impact on behavioral intention. However, the impact of security risk on ATT (γ = −0.14, $p > 0.05$) and that of relative advantage on behavioral intention (γ = 0.003, $p > 0.05$) were nonsignificant. Thus, all the research hypotheses, except H8 and H11, were supported.

Table 5. Direct and Indirect Effects Accessing in Mediated Model

From	to	Direct coeff.	Indirect coeff.	Total coeff.
PEOU	**PU**	0.068*		0.068*
PEOU	**ATT**	0.093*	0.265***	0.359***
PU		0.436***		0.436***
RA		0.256***		0.256***
COMP		0.187**		0.187**
SR		-0.014		-0.014
PEOU	**CBI**		0.052***	0.052***
PU			0.064***	0.064***
RA		0.003	0.037**	0.041
COMP		0.173***	0.027**	0.2***
SR		-0.038*	-0.002	-0.04*
ATT		0.146***		0.146***

｜t｜≧1.96、*；｜t｜≧2.58、**；｜t｜≧3.29、***

The results of additional analyses of the indirect effects of relative advantage and security risk on behavioral intention are shown in Table 5. Relative advantage was found to be positively related to attitude, supporting H7 (γ = 0.256, $p < 0.001$). Nonetheless, this study predicted a negative but nonsignificant relationship between security risk and attitude (H11; γ = −0.14, $p > 0.05$). Finally, the results support that security risk exerts a negative, direct effect on behavioral intention (H12, γ = −0.038, $p < 0.05$). This provides evidence that security risks do not affect the behavioral intention that is not mediated by attitude. Surprisingly, relative advantage was not directly related to behavioral intention ($\gamma = 0.003$, $p > 0.05$), failing to support H8. The effects of relative advantage seem to be fully mediated by attitude.

4.3 Occupations' Moderating Role

A moderator is an independent variable that affects the strength or direction of the association between another exogenous (independent) variable and an endogenous (dependent) variable (Ro, 2012). Thus, investigating the moderating effect allows researchers to precisely describe the relationship between independent and dependent constructs. Pooling individuals with different occupations contributes to the generalization of findings. To examine the moderating effect of occupations, this study used multigroup causal analysis to compare differences in the coefficients of the corresponding structural paths of the multiple research models, as suggested by Chang and Chen (2008).

The sample used in this study was divided into two subgroups according to occupation (i.e., IT and non-IT, with 253 and 816 individuals, respectively), and this study investigated any differences in perceptions of usage intention between the groups. Table 6 presents the results of the invariance tests across occupations. This study measured the acceptable fit for all models. The χ^2/df ranged from 3.62 to 3.65, and the RMSEA values were consistently 0.05. The chi-square values of Models 6–17 were compared with that of Model 4. The analysis result indicated two moderating effects within the research framework. First, the $\Delta\chi2$ between Models 4 and 6 was 7.63 at 1 df, confirming that the moderating effects between PEOU and PU (H1) were significant ($p = 0.01$) and showing a higher effect for the IT group. The Internet coefficient was 0.66 (t = 13.84), which was slightly higher than the coefficient of the non-IT group (0.51, t = 16.36). Second, the $\Delta\chi2$ between Models 4 and 13 was 8.72 at 1 df, confirming that the moderating effect of IT between RA and CBI (H8) was significant ($p = 0.00$). When the two moderating variables were compared, the coefficient of the IT group was 0.22 (t = 2.78), which was higher than that of the non-IT group, −0.06 (t = −1.17), confirming that IT occupations have a more significant moderating effect.

Table 6. Invariance Test across Occupations

	Model	χ^2	df	χ^2/df	RMSEA	Nested Models	$\triangle\chi^2$	△df	P	IT		non-IT	
										Coeff.	t value	Coef.	t value
1	Base model	3265.56	874	3.74	0.05								
2	Equal loadings	3298.47	897	3.68	0.05	2-1	32.91	23	0.08				
3	Intercept	3320.19	918	3.62	0.05	3-2	21.72	21	0.42				
4	Measurement error	3471.34	950	3.65	0.05	4-3	151.15	32	0.00				
5	Structural Coefficients	3502.50	962	3.64	0.05	5-4	31.16	12	0.00				
6	PEOU→PU (H1)	3478.97	951	3.66	0.05	6-4	7.63	1	0.01	0.66	13.84	0.51	16.38
7	PEOU→ATT (H2)	3471.40	951	3.65	0.05	7-4	0.06	1	0.81	0.09	1.28	0.07	2.18
8	PU→ATT (H3)	3472.21	951	3.65	0.05	8-4	0.87	1	0.35	0.33	4.57	0.41	11.60
9	ATT→CBI (H4)	3474.93	951	3.65	0.05	9-4	3.59	1	0.06	0.04	0.64	0.18	5.69
10	SN→CBI (H5)	3473.76	951	3.65	0.05	10-4	2.42	1	0.12	0.25	3.63	0.11	2.57
11	PBC→CBI (H6)	3473.77	951	3.65	0.05	11-4	2.42	1	0.12	0.48	7.34	0.60	13.76
12	RA→ATT (H7)	3474.98	951	3.65	0.05	12-4	3.64	1	0.06	0.44	4.71	0.23	4.21
13	RA→CBI (H8)	3480.06	951	3.66	0.05	13-4	8.72	1	0.00	0.22	2.78	-0.06	-1.17
14	COMP→ATT(H9)	3472.16	951	3.65	0.05	14-4	0.82	1	0.37	0.11	1.29	0.20	4.00
15	COMP→CBI (H10)	3471.90	951	3.65	0.05	15-4	0.55	1	0.46	0.14	1.96	0.20	4.33
16	SR→ATT (H11)	3473.19	951	3.65	0.05	16-4	1.85	1	0.17	-0.05	-1.39	0.01	0.25
17	SR→CBI (H12)	3474.50	951	3.65	0.05	17-4	3.16	1	0.08	-0.07	-2.64	-0.02	-0.91

5 Conclusions and Implications

This study developed a new hybrid technology acceptance model by combining the TAM, TPB, and DOI with the dimension of security risk to explore the factors affecting individuals' BIU for cloud services. The results provide support for the research model presented in Figure 1 and for the hypotheses regarding the directional linkage among the model's variables. The overall explanatory power of the proposed model had an R^2 of 78% for the intention to use cloud services. This finding suggested that the integrated model explains a relatively high proportion of the variation of the intention to adopt cloud services.

The findings of this study showed that PU exerted a significant effect on the ATT for using cloud services, exerted a significant, indirect effect through ATT on BIU for cloud services, and mediated the influence of PEOU on ATT. PEOU did not exert a direct impact on the intention to use, although it affected the PU, which in turn led to greater acceptance of cloud services. The results are consistent with those of previous studies (Pikkarainen, 2004; Chan and Lu, 2004). Accordingly, to increase users' PU and PEOU, service providers should pay attention to practical functions, extend key features that are frequently required, and design the systems to be more user-friendly and more relevant to individual needs (Chen *et al*., 2007; Gangwar *et al*., 2015). Moreover, in the current study, ATT was predicted by PU, PEOU, RA, COMP, and SR. ATT also exerted a significant impact on the behavioral intention to adopt cloud services.

Regarding the other two factors of TPB, SNs and PBC played significant roles in determining behavioral intention. The results demonstrated that users' behavioral intention is determined not only by their attitude but also by other factors such as peers' opinions and their own resources and abilities. Nonetheless, the effect of these two factors was slightly lower than that of the other four factors. This finding is consistent with that of Shiue (2007), in which the subjective environment was found to weakly influence the actual use of technology. The effect of SNs is similar to that of network externalities. When users find that people known to them have adopted cloud services, they will be more willing to use them. This illustrates that individuals' perceptions of innovations are strongly influenced by important people in their lives. To increase SI, service providers should demonstrate successful customer applications of cloud services and the benefits of adopting these services, thereby inducing competitive pressure. PBC reflects the abilities and resources of users. Without these prerequisites, users may have low intentions of using cloud services. PBC was the most significant motivator of intention in this study, exerting a far greater effect than that of SN, ATT, ATT, RA and COMP. Because intention is determined by PBC, implementing methods to facilitate cloud service adoption and providing learning opportunities about various functions might be useful for promoting customer loyalty.

The results for the two DOI factors are consistent with those of previous studies, in which COMP exerted a significant, positive, and direct effect on a user's behavioral intention (Coursaris *et al*., 2012). It also exerted a significant, indirect influence through ATT on BIU for cloud services. This finding implied that cloud services are suitable for users' work and overall lifestyle, prompting users' interest in adopting innovations. When users or prospective users perceive that using cloud services is completely compatible with their current lifestyle, they tend to adopt it. Moreover, RA may not exert a positive influence on behavioral intention toward cloud computing, but it exerted a significant, indirect influence through ATT on behavioral intention. This may be because most Internet users use these services for personal information demands rather than work demands. RA has been shown to be associated with profitability, productivity, and reduced labor requirements (Tornatzky and Klein, 1982). Based on the finding that users' adoption intention is primarily affected by RA and COMP with existing values and needs, service providers should emphasize these dimensions of cloud services in their advertisements and cloud application designs.

Consistent with previous research (Lee, 2009; Feuerlicht *et al*., 2011; Coursaris *et al*., 2012), this study found that SR exerted a significant effect on the behavioral intention to adopt cloud applications. In the context of cloud computing, this finding is expected, given the extensive criticism of its lack of security and privacy. However, SR did not exert a significant impact on ATT toward behavior for cloud computing. The most probable explanation is that cloud computing users can directly decrease their use of cloud computing when confronted with security risks, although this is not reflected by their attitudes toward adopting cloud computing. Therefore, to inspire high confidence from potential customers, service providers should search for risk-reducing strategies and provide encryption and strong authentication to prevent fraud and identity theft.

This research contributes to the literature by clearly describing whether the integrated model provides a solid theoretical basis for examining the behavioral intention of cloud services and presents several key findings and implications regarding the determinants of cloud service adoption by individuals. This integrated model provides a valuable reference for future research. In addition, the findings have significant practical implications for service providers. The model can be used to assist service providers in developing marketing strategies for designing and promoting cloud services. Service providers should focus on these major antecedents to increase customer willingness to use cloud services, collaborate with customers to enhance compatibility with their businesses, and differentiate themselves from their competitors to increase customer loyalty.

6 Limitations and Future Research Recommendations

As in most empirical studies, this study has certain limitations. One is that the sample was drawn from Taiwan alone, which implies that the results reflect only the situation in that country. Thus, the results may not be generalizable to businesses in other nations. Future studies should examine this topic in various countries, including cross-country comparisons, to provide more global insights.

Another limitation is that this research did not subdivide data through four deployment models (private, community, public, and hybrid) or three service models (SaaS, PaaS, IaaS). Future studies could formulate a model for each deployment or service model, rather than a comprehensive model that combines the characteristics of innovation as a single control, to investigate new groups of participants and how they use technology.

Finally, the major constructs of the research model of this study were not explicitly indicated. Future research could consider applying the unified theory of acceptance and use of technology proposed by Venkatesh *et al*. (2003), which integrates eight models and has been demonstrated to be up to 70% accurate for predicting user acceptance of innovations in IT (Lin *et al*., 2013).

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