



Explaining Intention to Use Cloud Computing Service to Expecting Sustainable Development: Antecedents and the Moderating Effects of Age

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Abstract

Cloud computing offer faster and convenient computing services in new developing generation. It could be helping businesses lower operating costs, and reduce carbon emissions for long-term and assist the sustainable development of enterprises. This research aims to use the UTAUT and security risk to develop an evaluated model to clarify individual cloud computing user's behavioral intention and find out whether various differences of behavioral intention exist between different age groups. The findings contribute to the extant literature that perceived ease of use, perceived usefulness, relative advantage, and compatibility have significant positive influences on attitude toward behavior for cloud computing but security risk has not significant influence consumer behavioral intention even it appears negative. In addition, the usefulness of cloud computing service has higher influence on attitude for the younger generation.

1. Introduction

The global economy has changed significantly in the COVID-19 pandemic period. There are 5.4 million new business applications in 2021, it's a whopping record by the U.S. Census Bureau (2022). The rapid and large-scale establishment of start-ups has an impact on the global economy. Most start-ups are small and medium enterprises, and these companies have very limited technological resources. In order to survive, start-ups must use technological tools to face rapid industrial changes. Especially focus on digital technologies for Industry 4.0, cloud computing will be one of the important projects. Cloud computing has brought changes and impacts to the global information technology industry, but also brought unprecedented new opportunities. Cloud Computing has positive influence on modern supply chain management,

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and maximizing economic benefit (Elena, 2020). Through the application of cloud computing, smaller enterprises could optimize and achieve sustainable development in the face of covid-19 and economic pressure.

With an “end-to-end”-vision, businesses erect cloud computing service to connect suppliers and customers efficiently (Alt et al., 2010). There are already quite a few organizations and scholars predicting that the usage of the cloud will increase rapidly in the future. The global will reach to \$1.3 trillion in cloud computing service by 2025 (IDC, 2021). Although some people believe that cloud computing is irrelevant for their daily lives, network applications such as Dropbox, Google Drive, Gmail, Hotmail, Google Calendar, Apple Mobile Me, Flickr, and Picasa are all regarded as cloud computing systems (Rose, 2011). Individual users can use different types of services from different applications. Dropbox, the current leading cloud storage provider, offers a service that allows users to store their files online (Wu et al., 2017). An iPhone user can choose Apple’s iCloud, whereas Cloud Drive is a better solution for music players. There is significant evidence that shows the economic scale of cloud computing has expanded, becoming a dominant global development trend.

Cloud computing is new developing generation in computing, and it offer faster and convenient computing services. There are numerous academic discussions, blogs, and forums that focus on applying cloud systems to enhance the level of services in various industries (Ali et al., 2018). However, some users avoid cloud computing because they are concerned about privacy infringements. Several studies have discussed information security and individual privacy without considering user intention. There is limited empirical work that captures and comparatively delineates the positive benefits and detrimental factors that promote or hinder customer adoption or rejection of cloud computing. Adopting cloud computing deployment to increase end-user demand has become more complicated (Khac et al., 2019). The examined determinants of cloud computing applications for high-tech firms include relative advantage (Low et al., 2011). Prior researches on the cloud computing adoption barriers identified by 38 organizations only presented descriptive statistics for their findings (Feuerlicht et al., 2011). However, the concept related to cloud computing advantages and risk are insufficient.

The current trend is devoted to cloud computing with common advantages. This research aims to examine and integrate various advantages of cloud computing to assess the level of individual user intensity following the popularization of cloud computing by international enterprises. This research proposes a theoretical model to explain individual user intentions for cloud computing system use based on security risk and attitude toward using issues by reintegrating the UTAUT, which are devoted to contribute to the future development of cloud service suppliers.

2. Theoretical background and hypotheses development

2.1 Cloud computing

Cloud computing offers opportunities for delivering a variety of novel technological applications. There are numerous cloud-based service models, such as software, data, platform, and infrastructure that have matured and gained mainstream usage (Wang et al., 2018).

Scalable Information Technology resources are delivered over the Internet, and can include applications, services, and operational infrastructure (Buyya et al., 2009). Cloud computing change the way people work and collaborate online (Miller, 2008). Sharing and using network applications and resources involves the priority of completing tasks, without undue concern

about the ownership or management involvement (Scale, 2009).

According to the above discussion, cloud computing that is equipped with essential functionality and domain opportunities is emerging to be a significant disruptive force for Information Technology vendors and users in the following century.

2.2 The Unified Theory of Acceptance and Use of Technology (UTAUT)

In order to better explain the relationships between user' technology acceptance level toward information technology and their intention to use it (Venkatesh et al., 2003) proposed the Unified Theory for UTAUT by synthesizing the Theory of Reasoned Actions (TRA) (Fishbein et al., 1975), the Technology Acceptance Model (TAM) (Davis, 1989), TAM 2 (Venkatesh et al., 2000), the Theory of Planned Behavior (TPB) (Ajzen, 1991), the Motivational Model (MM) (Davis et al., 1992), the Combined Model of TAM and TPB (C-TAM-TPB), the Model of PC Utilization (MPCU) (Thompson et al., 1991), the Social Cognitive Theory (SCT) (Compeau et al., 1995), and finally the Innovation Diffusion Theory (IDT) (Moore et al., 1991). During this period, a number of models of technology uptake have emerged (Venkatesh et al., 2000). With Venkatesh's spirit, this research reconstructs UTAUT integrating suitable factors from TAM, TPB, and DOI models, which combines the UTAUT idea and reserves the original concepts of TAM, TPB, and DOI models.

Performance expectancy is defined as the belief that using a particular innovation will lead to optimum outcomes, which is comparable to perceived usefulness (PU) from TAM (Van Raaij, 2008).

Effort expectancy, conceptually similar to perceived ease of use (PEOU) of TAM model (Van Raaij, 2008), is defined as a user's subjective evaluations of ease of engaging with an Information Technology system (Venkatesh et al., 2003).

Attitude (ATT) toward using is the degree of a person's favourable or unfavourable appraisal of a specific behavior (Fishbein et al., 1975). Freedom from physical and mental effort and the potential for improving job performance are significant factors in evaluating new technology such as cloud computing. It is clear that ATT of cloud computing are affected significantly by PEOU and PU (Davis, 1989). Following hypotheses:

H1 : PU positive influence ATT.

H2 : PEOU positive influence ATT.

ATT toward behavior is defined as an assessment of one's beliefs regarding the consequences of specific behavior, and an evaluation of the desirability of these consequences (Ajzen, 1985). Thus, when individuals form a positive (or negative) ATT toward cloud computing, they tend to have a higher (or lower) intention toward using it. There is empirical evidence of similar results in studies of other cases of Information Technology acceptance (Hong et al., 2006) (Lee, 2010).

H3 : Attitude toward cloud computing positive influence Customers Behavioral Intention (CBI) .

Social influence is defined as the extent to which important others are perceived to support the user's intention to adopt an Information Technology innovation (Venkatesh et al., 2003).

Inspired by the construct of social norm (SN) within the theory of planned behavior (Davis et al., 1992), social influence was conceptualized as an individual's perceptions of social benefit from using the innovation.

SN is the social pressure perception that influences behavior decisions (Davis et al., 1992). Therefore, individuals are more likely to use cloud computing services if their friends are cloud computing system users.

H4 : SN positive influence CBI.

The construct of facilitating conditions is the final component of the UTAUT model. Encapsulating perceived behavioral control (PBC) from the TPB, this construct is defined as the level of accessibility to technological and organizational resources that facilitate use of the Information Technology system (Venkatesh et al., 2003).

PBC is the perception of ease or difficulty in formatting the behavioral intention, and it is associated with beliefs about the presence of control factors that may advance or obstruct the performance of the behaviour (Liao et al., 2007). Thus, the more fundamental cloud computing skills that users possess, the more they are to have the behavioral intention to engage in cloud computing.

H5 : PBC positive influence CBI.

Compatibility of DOI model 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) and this research adds it into the facilitating condition construct concept. Diffusion of innovation (DOI) theory is concerned with the technology innovation adoption process from broad social psychological or sociological perspectives (Kauffman et al., 2005). Compatibility is one of the theory's factors and (Rogers, 1983) suggests the compatibility of an innovation is positively related to its potential for adoption. Individual users definitely would like to keep consistent with existing technology usage experiences and expect higher job effectiveness. Thus, if cloud computing is perceived to have greater compatibility, it is easily to be adopted more quickly.

H6 : Compatibility positive influence CBI

2.3 Security risk

Security is defined as preventing a threat that would otherwise create a circumstance, condition, or event that would cause potential damage to data or network resources, e.g., destroying, exposing, or altering data, leading to denial of service (Kalakota et al., 1997). (Stone et al., 1993) proposed that security risks (SR) undermine consumers' confidence, causing concern about information security. The critical question is a matter of trust toward cloud computing. If providers are trusted with sensitive information and security detail, there is a tendency towards a higher degree of trust between an organization and its cloud computing provider. For online users, SR leave them vulnerable to potential damage from hackers or other fraudulent activity that pose as a trustworthy entity to acquire information and compromises the security of usernames, passwords, and credit card details (Reavley, 2005). Security and the organizational capability to fulfil the promise of integrity, confidentiality, and availability of personal information assets is the primary barrier preventing the positive intention to become engaged in and routinely use cloud computing. Numerous studies on SR have found that the greatest

challenge to virtual service is winning the trust of customers on privacy, confidentiality, and security issues (Conti et al., 2018). Previous research has shown similar results that concern about security risk is one of the main primary barriers for adopting cloud computing (Feuerlicht et al., 2011).

Unlike other virtual services, cloud computing service is a data warehousing that has a critical role in providing vast different users' storage space providing by one firm. Cloud computing is considered to have “significant implications for the privacy of personal information” (Subashini et al., 2011). It is hard to assess the status of information in the cloud and to protect the personal privacy and confidentiality because of legal uncertainties. Therefore, the following hypotheses are presented:

H7 : SR negative influence CBI.

2.4 Moderating effects of age

Generation is one of the factors influencing cloud computing usage. In Taiwan, the proportion of university education is the highest. Therefore, the age condition of this study is divided by 22 years old. That is, the relationships between PU, PEOU, ATT, SN, PBC, Compatibility, SR and CBI might be influenced by the generation that is a moderator in the perception process (Carter et al., 2000).

H8: The effects between research variables vary according to age during the perception of cloud computing usage.

This study proposed the research model in Fig.1.

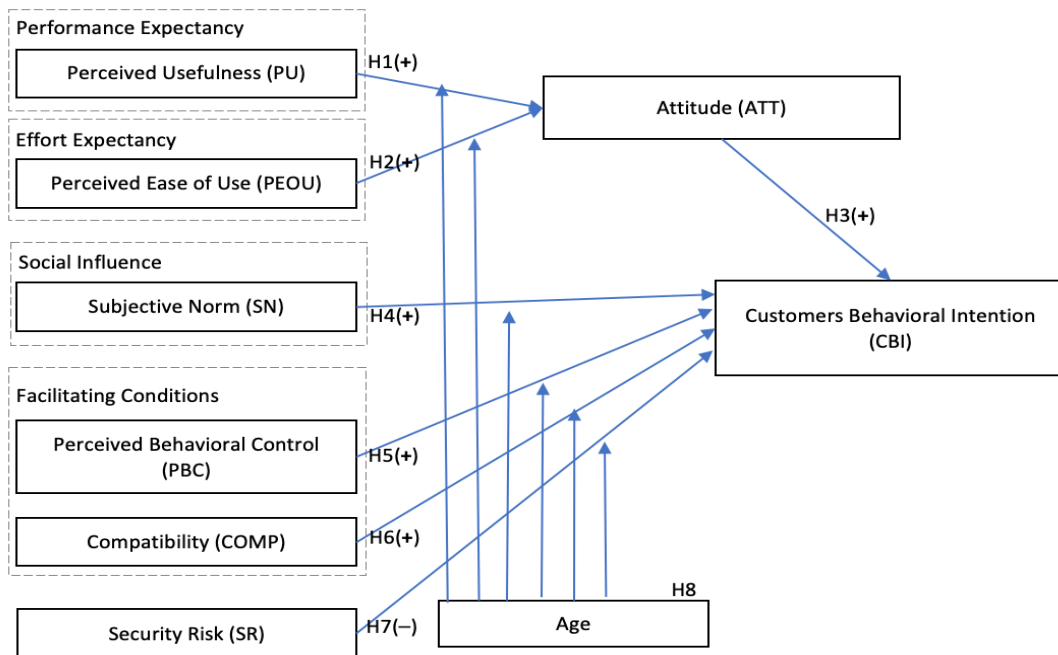


Fig. 1 Proposed research model

3. Research methods

The questionnaire items modified to make them appropriate based on literature reviews for assessing consumers' PEOU, PU, and Attitude were adapted from (Davis, 1989); SN and PBC were adapted from (Taylor et al., 1995); Compatibility was adapted from (Rogers, 1983); SR and CBI were measured using three-item scales developed by (Stone et al., 1993), and (Bhattacharjee, 2001), respectively. Items were measured using the Likert-type scale, 7-point (1 = strongly disagree, 7 = strongly agree).

The survey was held by a professional marketing company in Taiwan. In total, 1,069 valid questionnaires returned. Of the respondents who returned the questionnaires, men are more than women, with the majority aged between 23-45 years. Most of the respondents (88.4%) received tertiary education. Work in information technology sector (23.7%) and traditional industry workers (18.3%), whereas others are evenly distributed.

4. Data analysis and results

4.1 Data examination

AMOS software is used to examine the CFA results and to test the significance of each hypothesis in this research.

The model fit of CFA was conducted to support the accuracy of the scales used in this study, is illustrated as the χ^2/df of 3.587, GFI=.957, AGFI=.934, CFI=.978, IFI=.978, NFI=.97, SRMR=.031 and RMSEA=.049, all indicating a good model fit to the data (Hair et al., 2009). Cronbach's α ranging from the .824 to .909, and CR values ranging from the .825 to .911, exceeded the minimum threshold of .7 (Komiak et al., 2006), thus satisfying the reliability requirement (see Table 1).

Table 1: Analysis of Measurement Accuracy

Constructs	Items	Factor loading	t-value	Cronbach's α	CR	AVE
PEOU	I think that using cloud computing can enhance personal learning performance.	.866***	32.804	.873	.874	.776
	I think that using cloud computing can enhance personal learning effect.	.895***	34.322			
ATT	I think that using cloud computing is a good idea.	.810***	29.823	.824	.825	.702
	I like to use cloud computing.	.865***	32.453			
PU	It isn't difficult to learn how to use cloud computing.	.800***	30.255	.874	.876	.702
	It is easy for me to use cloud computing proficiently.	.874***	34.498			
	In general, I think it is easy for me to implant cloud computing.	.837***	32.352			
SN	Many important relatives around me support that I use cloud computing.	.842***	31.746	.846	.846	.733
	People who have an influence with me think I should use cloud computing applications.	.870***	33.160			
PBC	I can control the cloud computing application.	.851***	33.494	.872	.873	.774
	I have a enough hardware devices, knowledge, and computer ability to use cloud computing.	.908***	36.913			
COMP	Using cloud computing fits my working style.	.881***	35.466	.901	.901	.753
	Using cloud computing fits current my situation absolutely.	.897***	36.484			
	I think that cloud computing implantation is my favorite working style.	.824***	32.036			
SR	I think that using cloud computing will let me have the security concerns.	.787***	30.169	.909	.911	.775
	I feel unnecessary emotional anxiety when using cloud computing because of data security.	.923***	38.113			
	I think that using cloud computing will let me nervous unnecessary.	.924***	38.182			
CBI	I use cloud computing regularly.	.926***	38.604	.903	.904	.825
	I use cloud computing frequently.	.890***	36.275			
			Overall	.904		

Significance levels: * $p < .05$; ** $p < .01$; *** $p < .001$

Convergent validity was executed by examining factor loadings to verify convergent scale validity. This study also assessed whether the $AVE > .5$ (Fornell et al., 1981), showing convergent validity for the construct. The discriminant validity was shown by AVE values higher than squared correlations between all latent dimensions (Wu et al., 2017), and the fit significantly reducing the fit reported in the baseline CFA (i.e., $\Delta\chi^2 > 3.84$, $p < .05$) (Hightower et al., 2002). All discriminant validity indicators are within acceptable ranges, in Table 2.

Table 2: *Analysis of Difference of Chi-square, AVE and squared correlation*

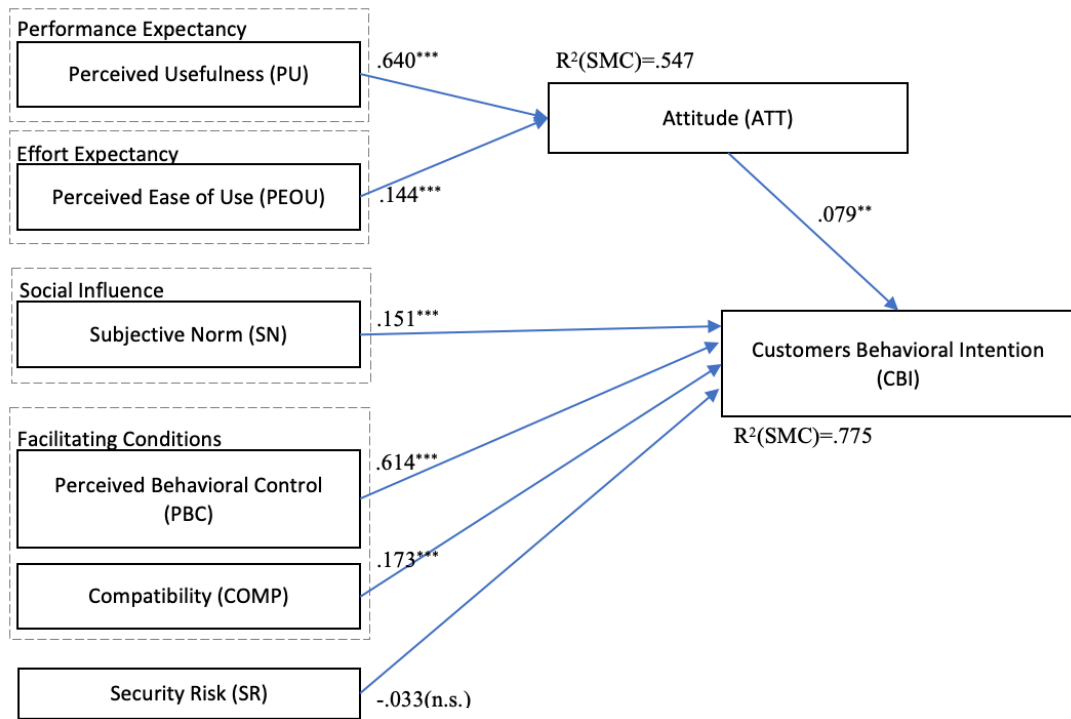
	PEOU	ATT	PU	SN	PBC	COMP	SR	CBI
PEOU	0.776	523.06	600.77	615.81	548.92	820.30	982.19	662.70
ATT	0.271	0.702	333.07	373.98	352.37	563.86	721.58	405.15
PU	0.393	0.489	0.702	576.93	718.72	1379.86	1595.92	945.09
SN	0.257	0.434	0.300	0.733	415.23	484.45	821.53	381.89
PBC	0.440	0.475	0.286	0.464	0.774	718.89	973.12	229.25
COMP	0.192	0.228	0.154	0.411	0.298	0.753	2227.50	795.35
SR	0.0001	0.0003	0.005	0.001	0.001	0.001	0.775	1216.50
CBI	0.355	0.428	0.262	0.518	0.724	0.401	0.0002	0.825

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

4.2 Hypotheses testing

This research performed SEM to examine the constructed research hypotheses. The results for the measurement model indicate the model fit is acceptable, with NFI=.957, IFI=.965, CFI=.651 and RMSEA=.061.

Fig. 2 shows the results of the hypotheses testing. As anticipated, both H1 and H2 are also confirmed. A significant direct impact was observed regarding the effects of both PE ($\gamma = .640$, $p < .001$) and PEOU ($\gamma = .144$, $p < .001$) on attitude. Consistent with H3, the consistent pattern is that ATT has a significant positive and direct impact on CBI ($\beta = .079$, $p < .01$). As expected, H4, H5, and H6 are also confirmed. A significant direct impact was observed for the effects of subjective norm ($\gamma = .151$, $p < .001$), PBC ($\gamma = .614$, $p < .001$) and COMP ($\gamma = .173$, $p < .001$) on behavioral intention. However, the impact of security risk on behavioral intention ($\gamma = -.033$, $p > .05$) is non-significant. Thus, all the research hypotheses, except H7, were supported.



Model Fit indices:
 $\chi^2/\text{df} = 4.955$, GFI = .940, AGFI = .913, NFI = .957, RFI = .943, IFI = .965, CFI = .965, RMSEA = .061, SRMR = .053
 Significance levels: * $p < .05$, ** $p < .01$, *** $p < .001$

Fig.2 Structural model results

4.3 Moderating effects testing

Concerning the moderating role of age, the multi-group analysis indicated that the tested model has a slightly good fit between the data and the model ($\chi^2/\text{d.f.} = 2.889$; CFI = .961; RMSEA = .042). Based on the Chi-Square difference test, age does moderate the relationship between PU and ATT toward cloud usage since the difference was statistically significant (see Table 3). The younger user has higher effect between the above variables, thus partially confirming H8.

Table 3: *Invariance Test across Age*

	Model	χ^2	df	χ^2/df	CFI	RMSEA	$\Delta\chi^2$	Δdf	<i>P</i>
1	Unconstrained	815.162	260	3.135	.963	.045			
2	Equal loadings	833.721	271	3.076	.962	.044	18.560	11	.069
3	Equal loadings, factor intercorrelations	859.554	292	2.944	.962	.043	25.833	21	.213
4	Equal loadings, factor intercorrelations, measurement errors	883.374	307	2.877	.961	.042	23.819	15	.068
5	Equal loadings, factor intercorrelations, measurement errors, structural coefficients	898.362	314	2.861	.961	.042	14.988	7	.036
6	PU → ATT	889.666	308	2.889	0.961	.042	6.292	1	.012
		Coff.		<i>t</i> value					
	Age~22	.825		8.13					
	Age 23~	.572		13.458					

5. Conclusions

5.1 Discussion

This study attempts to explain why consumers usage cloud computing behavior. Drawing on previous research, this study reconstructs UTAUT (integrating TAM, TPB, and DOI) and security risk explores the usage behaviors. Support is found for the theory that factors of UTAUT have a significant impact on attitude and usage intention. The PEOU and PU have positive influences on attitude toward behavior for cloud computing. This research also observed evidence that ATT, SN, PBC and compatibility have a positive influence on CBI for cloud computing. By adding one trust-based construct (“Security Risk”) to the UTAUT theory, surprisingly, this study noticed that security risk has a negative influence on consumer behavior intention but not significant. The most probably explanation is that digital security risks prevention in the virtual environments is a fundamental requirement with successful operation right now. In addition, when confronted with cloud computing security risks, users could decrease their usage.

The study’s results reveal that, among influencing factors, PU and PEOU are the important determinants of users’ attitude and intention to use cloud computing service. Users have more favourable intention to use cloud computing when (1) they believe that using them is useful in their daily lives; (2) families and friends promote them to use; (3) it is an innovation Information Technology and used wildly; (4) it makes efficiency in their work. PU constructs significantly influences ATT constructs than PEOU (Keh et al., 2009) (Lee, 2009). In this study, PEOU could influence a usage cloud computing service through ATT, (.011= .144*0.079) but was not very strong. This result is understood PEOU is a basic requirement for cloud computing system design (Wu et al., 2005). Hypothesis H4 between SN and usage intention of cloud computing service and H6 between compatibility and usage intention of cloud computing service were supported. Its path coefficient values (.151; .173) were low. Hypothesis H5 between PBC and usage intention had high path coefficient value (.614). These results imply that customers’ behavioral intention is more influenced by the perception of ease in performing the behavior of

cloud computing service than social pressure and innovation. In the other finding, the usefulness of cloud computing service has higher influence on attitude for the younger users than order. The users less than 22 years, are most students learning new technology frequently, thus they accept new innovation Information Technology and study how to operate quickly.

5.2 Managerial implication

This study reveals that PU, PEOU, SN, PBC and compatibility were the salient factors in predicting consumer attitude and intention for cloud computing adoption. Cloud computing service manager should promote the usage rate as follow. Firstly, the PU and PEOU impact the use cloud computing service attitude; therefore, managers should design the cloud computing service interface and functions useful. If the consumer impresses what the benefits from the cloud computing service, then it will increase their usage attitude. Secondly, cloud computing service interface should be designed for consumers can operate easily and freely to improve the ease of use of cloud computing and then lead to greater acceptance. Thirdly, since SN is an important factor for CBI, the family or friends could enhance users' intention. Consumers accept cloud computing service to integrate social trends. Managers should be aware that individuals may use cloud computing if they are persuaded by their supervisors, peers, or subordinates, or if it is shown to increase their level performance. Service companies can widely publicize through the media. In addition, managers should be aware that users adopting cloud computing can generated by relative advantage and compatibility.

5.3 Theoretical implication

Most technology research has used the TAM and TPB models, some of which were added to DOI or to the other dimensions (i.e., security risk), but are incomplete. This study demonstrate the validity and generalizability of reconstructed UTAUT integrated from TAM,TPB and DOI theories in the context of cloud computing service compared to the prior technology acceptance studies frequently using single model to exam the framework individually. Based on the 1069 respondents in Taiwan, ATT and CBI can explain by the extended model. The UTAUT dimensions gathered from TAM, TPB and DOI theories were able to explain as much as attitude (54.7%) and consumer behavioral intention (77.5%) to adopt cloud computing service. This reintegrated model with Venkatesh et al's approach and TAM, TPB and DOI original ideas provides a valuable reference for future research.

5.4 Limitations and future research

Given the range and depth of the reported findings, future researchers should recognize the knowledge gaps related to this field. First, this research considered only online consumer perceptions, using an online questionnaire. Future research should target more diverse samples to understand cloud computing more clearly. Second, this study did not subdivide cloud computing according to deployment usage (i.e., private, community, public, and hybrid), and future researchers should continue to different participants and realize how they use technology. Third, future research can rigorously analyze Generation X, Generation Y, and Generation Z in terms of age. Finally, a failure in validation suggests the unremarked existence and role of numerous moderators and other factors such as different countries and regions, different kind of applications, or the socio-economic status of users. These should be considered in future research that observes the moderating effects of real life variables on the proposed conceptual model of the growing cloud.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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