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User centric cloud service model in public sectors: Policy implications of cloud services

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User Centric Cloud Service Model in Public Sectors

Policy Implications of Cloud Services

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Abstract

This study examines the acceptance of cloud computing services in government agencies by focusing on the key characteristics that affect behavioral intent. The study expanded upon the technology acceptance model by incorporating contextual factors such as availability, access, security, and reliability. The research model was empirically verified by investigating the perception of users working in public institutions. Modeling results showed that user intentions and behaviors were largely influenced by the perceived features of cloud services. Also these features were found to be the significant antecedents of cloud computing usefulness and ease of use. The findings should guide governments' promotion of cloud public services to increase user awareness by enhancing usability and appeal and ensuring security.

Keywords: Cloud computing, cloud services, cloud policy, public sector, technology acceptance model, security, reliability, access

1. Introduction

Cloud computing is one of the rising topics in information technology (IT) today. In fact, there is a growing awareness among consumers and enterprises of the ability to extensively position their IT resources through a utility model that is broadly called cloud computing. This term refers to the Internet-based design and use of technology in which the cloud represents the Internet (Behrend et al., 2011). The cloud includes a substantial technical infrastructure that users do not need to understand at any level of detail; rather, they only need to connect to it to access its resources (Voi, Light, & Rowland, 2011). Technically, cloud computing enables end-users to access computer software and hardware resources over the Internet without the need to have any detailed or specific knowledge of the infrastructure used to deliver those resources (Tian, Lin, & Ni, 2010).

As the diffusion of cloud computing has increased rapidly, the technology is increasingly being adopted in diverse public sectors (Jaeger, Lin, & Grimes, 2008). Companies are leveraging cloud computing to provide increased standardization of IT infrastructure and to increase efficiency in running technologies. While the private sector is fast moving toward the cloud, governments have begun to assess the potentials of this technology would bring. Cloud computing represents a fundamentally different way for government to architect computing resources, allowing governments to leverage powerful IT infrastructures in a fraction of the time it takes to provision, develop, and deploy similar assets in-house. Around world, governments of Asia Pacific countries are particularly gearing toward cloud computing. For example, cloud computing solutions are also very prevalent in Korea. The Korean government and private industry together have developed a cloud project named “Next-Generation Digital Service in a Cloud

Computing Environment” that is aimed at developing and constructing so-called “Cloud storage,” a subset of cloud computing. One example of such a project is the N-Screen Service, which enables data sharing on multiple platforms for mobile phones, tablet computers, televisions, and personal computers. It can be said that the surge in smart device has triggered the expansion of the cloud market in Korea.

Along with their phenomenal growth, various cloud computing services have recently suffered from increasing problems of security, privacy, and systematic risk (Lee et al., 2008; Paquette, Jaeger, & Wilson, 2010). In cloud computing, users directly use and operate the software and operating system, and even the basic programming environment and network infrastructure are provided by cloud service providers. Thus, the impact on destruction of the software and hardware cloud resources in cloud computing are worse than those on current Internet users. This issue becomes even more critical in the public sector, in which security and reliability are key factors in delivering stable public services (Hamner & Qazi, 2009). Thus, evaluations of user behavior and perceptions of safety are important research topics in cloud computing. For example, concerns about the possible risks of using radio frequency identification (RFID) have increasingly been indicated. Although concerns over cloud computing are not always obvious and direct, risks associated with RFID include the impact of electromagnetic radiation on health and indirect economic consequences such as job elimination through increasing automation (Lee et al., 2007). The most frequently voiced concern relates to the misuse of data generated by RFID, resulting in an undesirable invasion of individual privacy (Svantesson & Clarke, 2010).

Against rising concerns over security and usability, such issues have only been addressed in a few studies (Hossain & Prybutok, 2008; Jaeger et al., 2008; Thiesse, 2007). In light of such concerns, this study explores the factors influencing user perception of cloud computing to theorize its acceptance model. It also applies the theory of reasoned action (TRA) and modifies the technology acceptance model (TAM) to propose a new model that can be used to examine the acceptance of cloud computing. Technology acceptance research has been relatively limited in its application to the public sector. Therefore, there is a concurrent need to develop and gain empirical support for models of technology acceptance within the public sector, and to examine technology acceptance and utilization issues among public employees to improve the success of implementation in this arena. The new model builds upon the existing TAM by integrating contextual and specific features as primary influencing factors. These factors are driven by underlying perceived beliefs, namely benefit, availability, access, and security as enhancing constructs to predict user motivations to accept cloud computing technologies. The three research issues that guide this study are:

RQ1: What perceptions and attitudes exist among public sector officials in Korea that could contribute to, or impede, the acceptance of cloud services?

RQ2: What motivational factors contribute to public sector users intentions and behaviors regarding cloud computing in the public sector?¹

RQ3: What policy implications can be derived from cloud computing?

¹ A motive is the factor which causes one to act in a particular manner. An intention is an aim or a plan. A motive leads a person to construct so many actions with certain intentions (planned actions), so that the ultimate motive is realized (Venkatesh & Agarwal, 2006).

This study provides a new framework to identify the antecedents of users' intentions to adopt cloud computing in the public sector. TAM has been criticized for its lack of contextual understanding (Venkatesh & Brown, 2001), a factor that is even more essential in policy implications. It is unclear which specific factors facilitate and/or inhibit user acceptance in cloud computing in the public sector (Loo et al., 2009). This study addresses this question by providing structural correlations among the context-specific factors of cloud computing for use in policy provisions.

The findings herein should guide governments in promoting cloud computing services as a way to improve government business and public service. One of the most promising cloud computing opportunities for the public sector is the capacity to share information and communication technology (ICT) resources among various agencies simultaneously. One challenge is the deployment of cloud computing in the public sector featuring secure and user-friendly services (Kshetri, 2010; Zissis & Lekkas, 2011).

So far, there has not been researched enough the difference between public and private. Key differences existing between private commercial organizations and public sectors may result in different adoption behaviors of technology acceptance in public sectors. Private commercial organizations are ultimately motivated by maximizing profit whereas public sectors are not. In fact, cloud service is designed to provide more cost effective and efficient governmental services to citizens. Further, other differences between private commercial organizations and public sectors such as organization structure, organizational culture, and social norms, may also result in cloud service adoption in public sectors being different from that in private commercial organizations.

The findings of the present study offer a set of guidelines that will help governments better understand the development of user-perceived features and how they contribute to usability.

2. Trends and concerns

2.1. Global adoption of cloud computing in the public sector

At the present time, cloud computing is becoming increasingly adopted in the worldwide public sector. It is the U.S. that has initiated cloud computing and it launched a “Cloud First” strategy (Wyld, 2010). This national level of plan has been enabled by the the U.S. Federal Budget for 2011, which included cloud computing as a key area of its strategy to realize efficiency and reduce costs.

Cloud adoption in the public sector in China is being driven at the local level in cities such as Dongying and Wuxi. The municipal government plans to transform the city of Dongying from a manufacturing-based economy to a high-tech services-oriented economy. The Yellow River Delta Cloud Computing Center, which is being built by IBM, will provide a cloud-based platform to allow the petroleum industry to develop more innovative application services. Furthermore, the center will provide software development and testing resources through the Internet to start ups and other companies that establish their presence in the city. As part of future phases, there are plans to implement a solution that will enable “Smart Roads” and a “Smart Airport” based on data analytics (Wyld, 2010).

The Hong Kong Government is evaluating the use of cloud computing for sharing infrastructure, software components, and data. The government believes that

collaboration and communication – internally, between departments, and with citizens – hold maximum potential with a shift to cloud technologies and that this will be one of the focus areas of the cloud strategy. However, the Government will take a cautious approach toward choosing the areas in which cloud computing will be implemented to ensure that data security and privacy are maintained. Adoption of the cloud strategy, which is still a work in progress, will occur over a period of time rather than a big band transformation, the time frame for which has not yet been planned.

The Government of Japan's Ministry of Internal Affairs and Communications (MIC) launched plans to build an all-of-government cloud computing infrastructure as part of a wider "Digital Japan Creation Project." To be built in stages from now until 2015, the MIC intends that the new infrastructure will consolidate all government ICT systems into a single cloud to improve operational efficiency and reduce costs.

Singapore is well positioned to leverage the current investments of market participants, a strong network infrastructure to establish a dominant position in the global cloud computing market. To promote cloud computing in the country, the Infocommunications Development Authority (IDA) of Singapore has begun to design the relevant infrastructure as a primary focus area. IDA has been calling proposals to identify service providers to take up specific infrastructure development projects (Wyld, 2010).

2.2. Justification of Korea as a case study

There are two good reasons that Korea was selected as a case target in this study: (1) cloud service is booming in Korea such that Korea has been the test-bed for new emerging IT services (Shin, 2012); and (2) IT utilization in public sector in Korea has

been exemplar such as e-government, e-governance, and IT development index (KCC, 2011; Shin, 2008).

It is known that Korea is the first country in planning to adopt cloud computing, in Asia (Kshetri, 2010). Korea is evolving their infrastructure to take advantage of virtualization and cloud computing. Korea plans to invest 610 billion won in its cloud computing market (about \$522 million U.S.) into the market by 2015 (KCC, 2011). The country's Ministry of Public Administration and Security and the Ministry of Knowledge Economy co-authorized the plan, under which the government plans to quadruple the size of the domestic cloud computing market to 2.5 trillion won (\$2 billion U.S.) and increase its world market share to 10% within four years.

Cloud computing solutions are also a critical part of the Korean government's green technology initiatives that focus on low-power devices for PCs, televisions, displays, and servers. The initial demand for cloud computing will be driven more by government organizations and private companies. The Korean government, nevertheless, seems intent on acquiring a leading role in the establishment of cloud computing. The government has prepared 100 billion won for the Public Administration's project of cloud hardware resources. It is expected that about 19 billion dollars will be spending for the cloud computing program with about 47 billion won being spent on integrating cloud solutions with Internet protocol television and wireless Internet networks.

For Korea and the rest of world, it remains unclear how far people will be tolerable on the security issues and how it offsets with their data control (Lee et al., 2007, 2008). Unfortunately, Korea has been constantly criticized for its vulnerable security standards (KCC, 2011). To many people (public sector users as well as citizens who use

public cloud service), it is still strange feeling that connecting different terminals to a single cloud server.

2.3. The challenges and policy issues

While cloud computing may become mainstream in the near future, it has yet to overcome a number of difficult hurdles, including concerns related to the availability of broadband spectrum, the ability of diverse systems to work together, and the privacy and quality of service (Yoo, 2011). In particular, security concerns cause the most hesitation about cloud services because of lingering perceived security issues (Mell & Grance, 2009). These concerns are even more concerning in public sectors, in which secure and quality services must be reliably offered (Paquette et al., 2010; Zissis & Lekkias, 2011). Similarly, cloud computing raises a range of important policy considerations, including issues of access, security, anonymity, broadband capacity, cybercrime, data governance, reliability, liability, and others (Jaeger et al., 2008). While these issues are important, an effective approach to beginning an analysis of the policy issues related to cloud computing consists of considering user expectations and experiences. Jaeger et al. (2008) discuss three aspects users will expect a cloud system to provide: (1) reliability and liability; (2) security and privacy; and (3) access and usage. Concerns regarding cloud computing relate to the privacy of users' data as well as the access and use of software that are recorded on and accessed by remote equipment that is ultimately accessible by people outside of the consumer's own personal control. All these issues together constitute the accountability of cloud service (Lee et al., 2007). Lee et al. (2005) argue that accountability is an embedded concept of reliability, security, and availability.

With regard to reliability and liability, end-users assume the cloud system to be a dependable resource, particularly when cloud providers are responsible for the operating mission-critical applications, and will expect a clear delineation of liability should serious problems occur (Kshetri, 2010). In addition, users will expect cloud providers to prevent unauthorized access to both data and code and ensure that sensitive data remain private. Users will also expect that the cloud provider, third parties, and the government will not monitor their activities. Finally, users will expect access to and use of the cloud where and when they wish without hindrance from the cloud provider or third parties and the assurance that their intellectual property rights are being upheld (Paquette et al., 2010). These three issues provide policymakers with implications on how information should be treated as it moves from the PC to the cloud system and how it will be treated as it moves within the cloud system.

In the connected network era, data are becoming increasingly stateless as they flow across platforms, providers, and borders. In light of this reality, the pivotal questions include, “Do government regulations need to change to allow agencies to embrace cloud computing?” and “Does public sector acceptance differ from private sector adoption?” Despite the growing number of people using cloud services such as hosted email and online photo storage, many users are not fully aware of the privacy and security implications (Svantesson & Clarke, 2010). The current study attempts to clarify these questions from the user’s perspective in the public sector, focusing on their experiences and expectations.

2.4. Cloud policy and regulation in Korea

While Korea has been touted as the leader of cloud computing as far as in Asia, there is no specific policy and regulation regarding cloud computing. There is no single law in Korea that offers a thorough management of privacy matters or data protection. There is a series of guidelines regarding security and privacy, but organizations adopting cloud computing autonomously deal with such issues. While this autonomous facilitates the diffusion of cloud, it also adds confusions and technical problems at times in the area of interoperability and standard issues. With the increasing problems, there is rising needs of specific policy on cloud computing. This need is particularly growing in public sectors as the issues of security and assurance are especially critical. In the public sector in Korea, legal and policy constraints will be especially important. The public sector has faced a range of general governance and management challenges in adopting cloud computing. For example, there must be assurance that particular cloud computing arrangements comply with legal and policy constraints discussed above, and with others such as internal and external audit requirements.

3. Hypotheses and research model

This study proposes a cloud computing acceptance model that consists of several key features: availability, security, reliability, privacy, and access (Behrend et al., 2011; Jaeger et al., 2008; Kshetri, 2010; Marston et al., 2011; Paquette et al., 2010; Svantesson & Clarke, 2010; Yoo, 2011). These variables are proposed to affect the perceived usefulness (PU) and perceived ease of use (PEoU), which together influence intention. The utility of considering TAM is based on the fact that cloud computing is heavily

driven by technology and is user-oriented. Cloud computing is enabled by highly cutting-edge technologies, which should be user-based. When cloud computing is implemented as a public service, it should be more user-centered (Verdegem & Verleye, 2009). Thus, this model is well suited to reflect the nature of cloud computing because it embodies the evolutionary progression of cloud technologies.

Behavioral intention

The TRA argues that an individual's behavior is determined by his or her behavioral intention to do that behavior and that behavioral intention is jointly determined by the person's attitudes and subjective norms (SNs; Ajzen & Fishbein, 1980). The best predictor of behavior is intention, the cognitive representation of a person's readiness to perform a certain behavior and is considered to be the direct antecedent of behavior (Chen & Chen, 2009). Behavioral intention gauges a person's relative strength of intention to perform a behavior. Extensive studies have shown that behavioral intention affects usage and the linkage finally shapes usage pattern and behavior.

H1: Behavioral intention of cloud computing positively affects usage behavior.

PU and PEOU

As to PU, this study highlights the “capable of being used advantageously” aspect compared with traditional computing services. This study also attempts to conceptualize PU with regard to its relative advantage: how users perceive cloud computing as being useful and advantageous compared with other computing services.

PEoU refers to the extent to which a user believes that using a certain system would be effortless (Davis, 1989). TAM studies have extensively found a positive correlation between PU/PEoU and intention. In particular, TAM has been widely used in IT acceptance in the public sector (Hamner & Qazi, 2009; Hung et al., 2006; Hung et al., 2009; Loo et al., 2009). Based on the wide applicability in the public sector and the findings of previous studies (Brown & Venkatesh, 2005; Davis, 1989; Shin, 2008), the following hypotheses are proposed:

H2: PU of cloud computing positively affects intention.

H3: PEoU of cloud computing positively affects intention.

Perceived availability

Perceived availability has been researched primarily in the area of IT user acceptance. Shin's study (2008) shows that mobile users' attitudes and intentions are influenced by the perceived availability of a mobile device. According to the study, there is unrealized gratification with regard to mobile device use and that users may be influenced by this unrealized gratification. In information system (IS) literature, perceived availability has been treated as perceived ubiquity. Perceived ubiquity is an individual's perception of the extent to which ubiquitous technology provides a personalized and uninterrupted connection and communication with other individuals and/or networks (Kim & Garrison, 2008). According to the study, perceived ubiquity has a positive effect on the intent to use distributed computing.² This factor of perceived

² A positive effect is a direction of effect, + or – in the path coefficients of SEM.

availability can be applied to the cloud in public service since it offers real-time content and services on a ubiquitous basis. Users may believe cloud technologies constitute a technological service that is available everywhere as a part of pervasive computing, ambient informatics, and tangible media.

H4: Perceived availability positively influences the PU of cloud computing.

H5: Perceived availability positively influences the PEOU of cloud computing.

Perceived security

The security of information held in cloud computing environments poses a significant concern for governments (Paquette et al., 2010). Public organizations and government agencies, particularly in defense and law enforcement, may be reluctant to let important data flow outside their own firewalls. A service provider residing outside of a government's legal or territorial jurisdiction may put access or security at risk. Perceived security is defined as the extent to which a person believes that using a particular application will be risk free (Xu et al., 2003). The current study approaches perceived security from a broader perspective, which includes not only technical aspects such as confidentiality and authentication (Flavian & Guinaliu, 2006) but also refers to a person's comprehensive sense of security and well-being in the cloud environment. Udo (2001) reports that security concerns were a major barrier to new IT adoption, which has been extended to the cloud computing environment.

H6: Perceived security in cloud computing positively influences PU.

H7: Perceived security in cloud computing positively influences PEOU.

Perceived reliability

Reliability represents a major determinant of overall electronic service quality and refers to the correct cloud computing technical functioning and service delivery accuracy. In the context of cloud computing, perceived reliability is defined as the extent to which users feel that using cloud computing works well. In principle, cloud services should provide mature and reliable services, particularly in public sector operation. Drawing on cloud computing insights from the literature, the perceived reliability of cloud computing can be integrated into the model as an antecedent of PU and PEOU (Jaeger et al., 2008). Thus, in keeping with the arguments, the following hypotheses are generated:

H8: Perceived reliability positively influences the PU of cloud computing.

H9: Perceived reliability positively influences the PEOU of cloud computing.

Perceived access

Accessibility can be a key factor in explanation of technology adoption (Venkatesh & Brown, 2001). Extensive research has shown that it is a central reason accounting for the variances in technology usage (Hoffman et al., 2000). As observed by Porter and Donthu (2006), perceived access barriers influence the use of personal technology. In applying the concept of a perceived barrier to the cloud computing context, the concept of perceived access should be conversely applied. Perceived access can be conceptualized as a belief that cloud computing is both convenient to use and easy to

access.

H10: Perceived access positively influences the PU of cloud computing.

H11: Perceived access positively influences the PEOU of cloud computing.

Subjective norm

Previous research has consistently shown that the SN is a determinant in the adoption and utilization of new technologies (Brown & Venkatesh, 2005; Davis, 1989). This premise has been also validated in public sectors (Hung et al., 2006; Hung et al., 2009; Loo et al., 2009). SN is defined as an individual's perception of whether people important to them think the behavior should be performed. Given that SN has been widely adopted in various computing environments, it is hypothesized that SN directly affects the intent to use cloud computing.

H12: SN positively influences users' intentions to use cloud computing.

4. Research methodology

The survey method used in the present study consisted of multiple phases. As a first step, in-depth interviews were conducted with current end-users of cloud technologies such as N-Screen Services, Google App Engine, Amazon Web Services, Hadoop, and Google Android. Ten respondents were recruited from the public sector and asked to explain their attitudes and experiences using these technologies. In these

interviews, the most commonly used cloud services in the public sector were the Google service and Microsoft Cloud.

With the help of cloud service providers based in Seoul, Korea, five focus groups of current and prospective users in government agencies were organized, and group interviews were conducted in which groups of four to six individuals discussed their current use of cloud services and the factors that influence their use of cloud technologies. The goal of the individual interviews and focus group sessions was to test and validate the research model, identify any missing items, and gain a preliminary understanding of the factors that impact usage behaviors.

Then, a final survey questionnaire was developed through several comment rounds of an expert panel consisting of professors, researchers, and government officials. Prior to its use, the questionnaire was tested in a pilot survey among possible users who, in turn, provided a comprehensive review of individual responses to the pretest survey. Thirty respondents from the public sector participated and the tests were given at one-week intervals. Prior to answering the questionnaire, participants were instructed to question any items that they did not understand. With these precautions, the possibility of participants filling out some questions without understanding the content of those questions was reduced.

The finalized survey was administered to government agencies in Korea. The surveys were sent out to 23 government central ministries, 39 regional government offices, and 31 government-supported research institutes. In an effort to increase the number of responses, relatively large organizations were selected. In administering the surveys, a marketing firm specializing in survey development, data collection, and

analysis assisted the data collection and processing. The final sample reflects the general population of cloud computing users. SPSS's AMOS, a maximum likelihood-based structural equation modeling software program, was used for the statistical analysis.

Additionally, to compare the public and private sector adoption, data from private sector were collected as a post-hoc analysis.

4.1. Measurement development

The variables in the model are well established in the previous TAM, IS, and cloud computing studies. A pilot test for measures was conducted prior to further study. The participants indicated their agreement with a set of statements using a seven-point Likert-type scale. Each variable had three measurement items. The final scales used in this study consisted of 18 items, all of which included three items for each variable. As the items in the survey were adapted from previously validated work, the content validity for these two constructs was established through literature review.

4.2. Instrument validity and reliability

A pretest was undertaken to examine test-retest reliability and construct reliability before the fieldwork was conducted. Forty current users who were interested in cloud computing and other similar services participated in the two pretests over a two-week interval. After eliminating the measured items that failed in either the retest or the α test, Cronbach's α was applied to identify items with poor item-to-total correlation. The α values ranged between 0.860 and 0.932, suggesting acceptable construct reliability. When theoretical models do not exist, these pretests are useful in the early stages of empirical

analysis in cases for which the basic purpose is exploration. Additionally, using principal component analysis, the instrument's construct validity was confirmed. After three items of the original item survey were removed due to high cross-loading, all item loadings were >0.5 , with no cross-loading >0.4 (Hair et al., 1995). Similarly, discriminant validity was confirmed as the correlation between items in any two constructs being lower than the square root of the average variance shared by items within a construct (Fornell & Larcker, 1981).

5. Results

5.1. Structural model

Table 1 shows the structural modeling estimate. The overall model fit was satisfactory, with all of the relevant goodness of fit indices being >0.90 . Chi-square statistics showed non-significance for both the measurement and the structural models, indicating that the two models adequately fit the data. The goodness of fit index was 0.95, the adjusted goodness of fit index was 0.91, and the Tucker-Lewis index was 0.91. Similarly, there was no evidence of misfit, with the root mean square error approximation showing a fairly satisfactory level of 0.067, which favorably compares to the suggestions by Joreskog and Sorbom (1996), who suggested that values ≥ 0.06 reflect a close fit. The standardized root mean square residual, at 0.027, was also very good, well below the threshold for a good overall fit. Another positive test statistic was the normed Chi-square value of 1.98, a value that was appropriately well below the benchmark of 3, indicating good overall model performance. Since the model shows satisfactory fit indices, the path coefficients of the structural model can be assessed.

Table 1. Fit indices of the measurement model and the structural model

Fit statistic	Measurement Model	Structural model	Recommended value
Normed Chi-square	1.99	1.86	<5
AVE	0.75		>0.50
P value	0.000	0.000	<0.05
GFI	0.97	0.97	>0.9
AGFI	0.91	0.91	>0.9
RMSEA	0.064	0.072	>0.06
Standardized RMR	0.042	0.037	≤ 0.05
TLI	0.92	0.94	Approaches 1

AVE, average variance extracted; GFI, goodness of fit index; AGFI, adjusted goodness of fit index; RMSEA, root mean square error approximation; RMR, root mean square residual; TLI, Tucker-Lewis index

5.2. Structural paths and hypothesis tests

The hypothesized causal paths were estimated to test the structural relationships, and nine hypotheses were supported while two were rejected. The results are reported and depicted in Table 2. Overall, the results support the proposed model, confirming the antecedents of PU and PEOU in cloud computing. Most paths in the model were statistically significant, highlighting the significant roles of the cloud computing features in determining user PU and PEOU, which then affect intent to use cloud computing (H2 & H3).

Although intention is significantly influenced by exogenous variables, the effect of intention on usage behavior was moderate or weak in this model ($H1$, $\beta = 0.21$, $t = 2.981$, $p < 0.05$); probably because users want to confirm their behavioral intention using other factors. In other words, while users might have strong intentional will, they may still have lingering doubts that limit their actual behavior. In fact, there might be other factors that lead users to actual usage. Interestingly, actual behavior is significantly influenced by SN ($\beta = 0.52$, $t = 3.304$, $p < 0.001$). Both endogenous variables, intention to use and behavior, showed significant correlations with their exogenous variables. Thus, the question of why positive intention did not lead to actual behavior was raised. There is a clear gap between intention and actual behavior. Approximately 54% of the variance in the intention to use cloud computing was explained by the variables in the model ($R^2 = 0.541$). The R^2 of actual behavior was explained by about 29% using the exogenous model constructs. Because both R^2 values were fairly high, it can be reasonably inferred that there is a missing link between the two.

This finding implies that while cloud computing users might have a strong intention influenced by PU and PEOU, this intention does not automatically lead to actual behavior. While users might cognitively perceive the excellent features of cloud computing, they may not actually intend to use the system unless the important issues are addressed. These users may want to personally ensure that cloud computing is reliable and dependable. While the model shows a pattern that highlights the importance of both utility and usability, the model underplays the link between intention and behavior compared with those in previous studies employing TAM. A gap between intention and behavioral intention in cloud computing may be inferred. Social influences like SN can

play a facilitating role between intention and behavior. This role sheds light on possible advancement in terms of theory and practice. Thus, further tests are needed to uncover possible underlying effects.

Table 2. Adjusted t-statistics and standardized path coefficients

Hypothesis	Path coefficient (β)	t-value	Support
H1: Intention→Behavior	0.23*	1.834	Yes
H2: PU→Intention	0.41**	3.874	Yes
H3: PEOU→Intention	0.21*	2.832	Yes
H4: Availability→PU	0.38**	2.844	Yes
H5: Availability→PEOU	0.35*	2.831	Yes
H6: Security→PU	0.47**	2.854	Yes
H7: Security→PEOU	0.20	4.294	No
H8: Reliability→PU	0.59***	3.871	Yes
H9: Reliability→PEOU	0.19	2.094	No
H10: Access→PU	0.41**	2.875	Yes
H11: Access→PEOU	0.28*	2.624	Yes
H12: SN→Intention	0.51***	3.009	Yes

* $p < 0.05$; ** $p < 0.01$, *** $p < 0.001$

5.3. Comparing public vs. private

As the findings in the public sector show a significant result, it is worthwhile to compare and contrast with private sector. The public sector adoption model in place, this study further collected survey data from private sector. To compare with the public sector

model, data from private sector were collected the equal number of respondents of the public sector. A marketing firm specialized in data collection, survey design, and survey administration collected data from various private sectors (banking, IT, manufacturing, retailing, and research).

Table 3. Comparison between public and private sector in the adoption model

	Public		Private	
Hypothesis	β	t	β	t
H1: Intention→Behavior	0.23*	2.834	0.21*	3.832
H2: PU→Intention	0.41**	2.874	0.53***	4.629
H3: PEOU→Intention	0.21*	2.832	0.44*	5.190
H4: Availability→PU	0.38**	2.844	0.52***	2.293
H5: Availability→PEOU	0.35*	2.831	0.45***	3.388
H6: Security→PU	0.47**	2.854	0.31*	5.553
H7: Security→PEOU	0.20	4.294	0.42**	6.294
H8: Reliability→PU	0.59***	3.871	0.44***	6.583
H9: Reliability→PEOU	0.19	2.094	0.53***	5.953
H10: Access→PU	0.41**	2.875	0.56***	3.304
H11: Access→PEOU	0.28*	2.624	0.61***	4.134
H12: SN→Intention	0.51***	3.009	0.21*	4.436

* $p < 0.05$; ** $p < 0.01$, *** $p < 0.001$

Interestingly, the result from private sector adoption shows a similar result from the public sector, yet there were different pattern and importance (Table 3). Just like the public sector case, all twelve hypotheses were supported with sufficient path coefficients and t -value. There were noticeable different pattern between the sectors. For example, access factor shows moderately significant to the public sector (* $p < 0.05$; ** $p < 0.01$), whereas it shows high significance (both *** $p < 0.001$). Similarly, while availability shows a moderate significance to the public sector, high significance shows to the private sector. Same thing happens to reliability. It can be inferred that while the factors in the public sector are equally important in the private sector, different matrix of importance exists across the sector. Access, reliability, and availability may be important in operating private sector, security and usefulness may be key criteria in providing public sector. In this light of difference, SN may also play a higher role in public than private.

6. Removing the obstacles to a clear cloud future in public sectors

The objective of this research was to develop a groundwork model of cloud computing acceptance in the public sector that can explain the development of user behavioral intentions to accept the cloud environment and use its technologies. New constructs that might reflect the features of cloud computing were developed and incorporated into the model. While the findings of this study largely conform to the previous research models (Beherend et al., 2011; Jaeger et al., 2008; Tian et al., 2010), this study clarified a range of key factors characterizing cloud computing that then provided implications for its diffusion and policy. Overall, the results showed that the

model demonstrates good predictive power and explains behavioral intention regarding cloud services in the government sector. The results aid in the understanding of user attitudes, the intention to use cloud computing in a new dimension of the cloud environment, and the implications for developing effective cloud services and applications.

The most important cloud computing contribution for the public sector is the sharing capacity of IT resources among multiple agencies. While governments have attempted to make frameworks of shared services, these have often been failing trials. The computing provides an easier and less burdensome way to more effective and efficient public sector information management. These features of public sector are well reflected in the findings particularly in the PU/PeoU and their antecedents.

Differences among the path coefficients in the model were statistically significant except for the two paths relating PEOU in terms of reliability and security. This finding is interesting because it contradicts with the previous TAM studies that have consistently shown that reliability and security affect convenience. In this model, the role of PEOU was rather weak compared to that of PU. Among the four correlations, only two were moderately significant at $p < 0.05$ (availability, 0.23; access, 0.29). In addition, the R^2 of PEOU explained that only 23% of the variance using four exogenous variables. It can be inferred that government employees generally have a certain level of IT mastery and thus have little difficulty using cloud services. It also implies that the ease of use in cloud computing is no longer an important matter, or at least that the term should be redefined in a cloud computing context. PEOU was originally defined and approached as a matter of technology or service use. In advanced computing like that in cloud systems, ease of use

may refer to convenience of use and, thus, there may be benefits of using such technologies. In other words, the ease of use in cloud computing may be closely related to the functional utility that provides users with a certain ability. For example, cloud computing provides applications with ease-of-use interfaces to run them anywhere: desktops, laptops, and embedded and mobile devices. This inference is consistent with the detected correlation between availability (0.34*) and access (0.29*).

Perceived security was found to be a significant antecedent of PU/PEoU, implying the unique features of cloud technologies. Studies have found that the security factor plays a significant role in different contexts, including online trading systems (Roca et al., 2009), Internet websites (Flavian & Guinaliu, 2006), ubiquitous computing (Shin, 2010), and e-commerce (Chellappa & Pavlou, 2002). The current study confirms the significant role of security in the new context of cloud computing. Thus, it is inferred from these factors that government users are very much concerned with the security and privacy issues of cloud computing.

In addition, the path of perceived availability to PU is notable. A cloud computing environment provides users with anytime and anywhere information/content/service access (Beherend et al., 2011). This ideal vision allows users to have perceived availability, and users seem to consider this as a criterion of the benefit or usefulness of cloud technologies. Perceived availability is the equivalent of perceived ubiquity in findings of ubiquitous technologies such as mobile TV (Shin, 2008), u-government (Belanger et al., 2005), wireless broadband (Shin, 2007), and wireless local area networks (Yoon & Kim, 2007). Through perceived availability, users feel psychological readiness to access computing resources at anytime. Users of cloud services may want quality of

service, reliability, and content, such as high-quality streaming videos, at any time. Shin (2008) argues that perceived availability is based on embedded gratification or unconscious assurance, i.e., user perception of connectedness with the world and its resources and people. Although still vague, Shin's conceptualization is consistent with the findings in this study that users can be gratified or comforted with psychological connectedness and/or technological readiness and that they can enjoy content at their convenience that used to be available only through traditional IT. It can be said that users would like to believe cloud services are more useful because of their perceived availability on a ubiquitous basis.

This inference is supported by other paths of perceived reliability and perceived access. The path of reliability to usefulness shows the highest coefficient figure ($\beta = 0.52^{***}$), while the path of access to usefulness also shows a fairly significant coefficient ($\beta = 0.42^{**}$). For example, users will expect to be able to access and use the cloud where and when they wish without hindrance from either the cloud provider or third parties. At the same time, users will also expect the cloud to be a reliable resource, especially if a cloud provider assumes the task of running mission-critical applications. These relationships shed light on the distinctive features of the cloud services: reliability, access, availability, and security are not separate or disconnected factors, but rather are a series of closely related factors that cloud services should offer in a ubiquitous manner with reliable availability and security assurance. Given that all four factors were highly significant, it can be reasonably inferred that the four factors constitute a single variable with four dimensions. In other words, the four factors equally constitute cloud computing and cannot be considered separately; rather, they should be understood as

interrelated concepts. For example, security is concerned with privacy, reliability enhances security, access is enabled and facilitated by availability, and reliability is increased by secure access and wide availability. In fact, there is a growing expectation of a quality of service from users that services should be seamless and security should be ensured for trust, privacy, and freedom from serious risk (Shin, 2010; Lee et al. 2007; Lee et al., 2005).

7. Theoretical and practical implications

The results highlight several implications for researchers and the public sectors in Korea as well as around the world. With regard to practical implications, cloud computing should be viewed for its capacity to empower government organizations to perform business both in an efficient and effective manner. It should also be evaluated for its capacity to allow achievement of e-government goals and support increased public sector operation (Loo et al., 2009). From this perspective, the findings in this study should be useful for cloud governments in two ways. First, they can be used after an initial prototype is developed to determine if a particular application would gain extensive long-term user acceptance to justify investing in its further development. Second, the findings of this study can be used to further iterate on a public cloud development by identifying weaknesses that need to be addressed to increase user acceptance and, thus, promote diffusion.

With regard to specific factors, the empirical findings here demonstrate that perceived availability, access, security, and reliability would be key variables of cloud computing acceptance in public sectors since they were found to be influential in

predicting the behavioral intention to use cloud technologies. Perceived availability can be interpreted as user perception of connectedness with the world. In other words, users can be comforted with a status of psychological connectedness that allows them to enjoy quality content on demand. During use of cloud computing services, perceived availability would indicate a sense of synchronicity and continuity with other users, resources, activities, and social norms (Shin, 2010). The public sector users of cloud technology want to feel as if they are emotionally and virtually connected with the world and its resources and people. Thus, governments should construct seamlessly connected solid networks.

As the finding implies, ease of use in cloud computing differs from that in other contexts, and the public sector should address the increased ease of use for cloud services. Ease of use is clearly one reason to accept cloud computing in the public sector, but it is unclear what ease of use specifically refers to in public service. The findings in this study imply that ease of use may be a facilitator of other key variables; that is, ease of accessing available resources both reliably and securely. In light of this insight, the government sector should focus not only on the ease of use for cloud public services but how to provide substantial benefits to public users. In other words, the ease of use of cloud computing in public services is not a simple matter of use but also involves the benefits provided to public users (citizens). Citizens may expect cloud public services to be easy to customize, easily scalable, easy to migrate, seamlessly connected.

This study also identified the vital role of security in cloud services. Security variables were found to be significant factors affecting attitude and intention. This finding corroborates the Marston et al. (2011) argument implying that governments

should invest significant resources into establishing public user trust as well as developing and delivering highly secured services. For this, a third party seal of trust in cloud computing like that in e-commerce may be suggested to increase user trust.

As for scholarly contributions, this study clarified the four factors of cloud computing and further showed the correlations among them. The implication that the four factors are related is worthwhile to note. Although research (Behrend et al., 2011; Jaeger et al., 2008; Kshetri, 2010; Marston et al., 2011; Paquette et al., 2010; Svantesson & Clarke, 2010; Yoo, 2011) has commonly proposed several factors, it remains unclear how such factors are complicatedly interrelated and how we should approach the factors, partly because studies have neglected to empirically test the factors of cloud computing. Such neglect further worsens, particularly in the case of the public sector since no studies have been performed in the area of cloud public services. The current study shows the tangled correlations on which we argue that the four factors are a closely related set of concepts and thus cannot be separately understood or approached.

This finding might be a modest contribution, but it sheds light on a new theory by grounding novel variables in TAM, developing a new model, and applying the model in actual ongoing cloud computing projects. As to TAM theory, employees of public sector agencies have seldom been the unit of analysis. Business managers and students have been the traditional subjects of technology acceptance and usage research. The strength of the current study is that its subjects comprise both public sector employees, allowing a comparative analysis of research results. This study has filled an important gap currently present in the TAM literature. Gaining a deeper understanding of how the government employees differ from those in the private sector—in terms of acceptance and adoption of

technology—could result in a faster and more efficient diffusion of e-government activities.

Based on the findings, practical guidelines of cloud services in public sectors can be drawn (Table 4). Public sector ICT managers preparing for adoption of cloud computing should consider following factors:

Table 4. Guidelines for public sector cloud services

Actions	Related factors
• Find which data cannot be held in public cloud computing environments for legal and/or risk-mitigation reasons.	Security, reliability, availability
• Identify all possible opportunities for switching from legacy computing arrangements to cloud services.	PU, PEoU
• Assure that in-house infrastructure complements cloud-based services. Virtualization will be a key element of a compatible infrastructure.	Availability, reliability, PEoU,
• Design a cost/benefit and risk-evaluation framework to support decisions about where, when, and how cloud services can be adopted.	Availability, PU & reliability
• Develop a roadmap for optimizing the current ICT environment for adoption of public and/or private cloud services.	Availability & PU
• Designate a cross-functional team to monitor cloud computing services, providers, and standards, and to determine if they influence the roadmap.	PU, PEoU & access
• Identify and secure in-house competencies required to manage effective adoption of cloud services.	Security, reliability & PU
• Assess technical challenges that must be addressed	Security, reliability &

when moving any current information or applications into a cloud environment. Experiment with and pilot various services—both internal and external—to identify where issues will arise.	availability
• Warrant that the networking system is ready for cloud computing.	Security & reliability

8. Policy recommendations for cloud computing

The findings of this study offer policy guidelines for Korean regulators and lawmakers who plan to foster the development of cloud computing in both the public and the private sector. These recommendations are also generalizable to other countries as the concerns and issues are similar, to differing degrees, around the world. Although the model in this study is a collective typology and, thus, does not provide specific answers, the structural correlations of the factors in the model provide important implications for information policy regarding cloud computing, which is itself a combination of numerous factors in the ever-changing cloud ecology. Studies (Behrend et al., 2011; Jaeger et al., 2008; Tian et al., 2010) have shown various factors of cloud computing such as security and reliability. However, these studies described specific economic factors in limited settings and failed to provide the contextual picture of how the individual factors are structurally related to overall factors in the information context. Given the significant results of this study, regulators and policy makers may draw insights from this study on how to promote cloud computing and what regulatory intervention, if necessary, is needed to increase competition and public benefit.

First, as Yoo (2011) argued, governments should promote transparency about the security practices in public cloud services. Public providers of cloud services must make

a significant effort to make users believing that their data are safe. Although market forces may drive service providers to differentiate themselves with regard to security, the government should play a role by proactively implementing cybercrime laws and data-breach legislation. A policy should deter intellectual property theft through a sound enforcement policy and clarity about rights and remedies. At the same time, governments may heighten awareness that cloud service users need to be vigilant in understanding the risks of data breaches in this new environment.

Second, from availability and access findings, policies must clarify the application of trade disciplines to the delivery of cloud services. The diffusion of the cloud has been hindered by the lack of businesses supplying such services (Etro, 2009). Users must be linked to the Internet for cloud-based services to thrive. The government can boost availability and adoption of cloud computing through tax adjustment to service providers, subsidies to low-income people, and directive of the wireless spectrum. Fostering data portability through market-led and technology-neutral policies is highly suggested and should be performed to ensure wide diffusion of services. Policy interventions such as expansion of broadband capacity can be included. Policies should also consider intervening in international agreements in favor of unrestricted data flow across borders.

Third, policymakers and regulators should ensure a high standard of privacy. Cloud public providers should concentrate on the concerns about privacy: protecting data from illegal access by the government; restricting data misuse for profit-making purposes; and safeguarding data from competitors. The purpose of privacy regulation must protect people data from inappropriate government scrutiny and to define what commercial rights companies have regarding users' data. Unfortunately, no specific regulation of

privacy has yet been established for cloud services. As is frequently the case with emerging technologies, the law lags behind the technology development of cloud computing.

Fourth, governments must ensure open access across public cloud services. Access to the fundamental infrastructure of cloud computing should not be driven by biased pricing and should not offer an unfair benefit to other users. Industry can play a key role in clarifying openness rules for the marketplace and governments should actively enforce existing laws designed to ensure open access. Related to this issue, policies should provide a detailed guideline to warn of the risk regarding the level of tolerable scalability. Cloud computing scalability allows users to guard against the possibility that demand might be either unexpectedly high or unexpectedly low. Although the benefits from aggregating demand are theoretically inexhaustible, they are subject to the principle of diminishing marginal returns. Given the risk premium that cloud computing firms must charge, these firms should prepare for scalability risks.

The above recommendations are based on the factors drawn from the model of this study. Beyond those factors, there is a series of important social and regulatory questions raised by cloud public services, such as:

- Do public employees have any concerns about the monitoring of their activities in the cloud by providers or by the government?
- Do citizens trust cloud computing for certain types of functions only?
- Do expectations vary among individuals, corporate users, academic users, and governmental employee?

- Can existing information policies for desktop computing environments be translated to apply to cloud computing?

These kinds of questions are relevant to the greater issues of the relationship between technology and policy in the cloud environment. Future research on these questions would also be extremely valuable in crafting a public policy response to the issues raised by cloud public services.

Given the above recommendation, specific policy reference for Korea can be drawn. There is no single law in Korea that provides a comprehensive treatment of data protection or privacy issues. There might be two main methods that help guide industry and regulate the accessibility of data via the cloud. First, Korea may adopt a self-regulatory model that allows industry the ability to decide whether it will comply in order to engage in the transfer of data from others, and which does not force full compliance in order to participate. Second, Korea may consider national legislation that requires compliance, and which empowers users while providing more a tool for enforcement. The need for national regulation of this particular technology is clear. Due to the fact that organizations are allowed to avoid around the requirements so easily, the program is rendered useless. This poses a significant risk for citizens, as their data is capable of transfer to other nations, which enables their data to be processed with little respect paid to their rights.

Whether Korea takes the first of the second approach, it is necessary for Korea to establish a special agency to exclusively deal with cloud computing. The agency charges operational activities. It ensures following:

- Use of cloud computing services must comply with all current laws, IT security, and risk management policies.
- Use of cloud computing services must comply with all privacy laws and regulations, and appropriate language must be included in the vehicle defining the cloud computing source responsibilities for maintaining privacy requirements.
- Government-wide authorizations of cloud computing services under the government may be leveraged to facilitate use of these services. An appropriate Authorizing Official, sufficiently familiar with the context of the use of the service, and adequately informed of the associated risks through a risk assessment, must document an acceptance of risk and formal authorization of the use of the service.
- For external cloud computing services that require users to agree to terms of service agreements, such agreements must be approved by the government.

9. Limitations and future studies

Despite the meaningful findings of this study, it bears several weaknesses that future studies should further address.

First and most importantly, user experiences in public cloud services are limited because cloud services are currently under development and not yet available on the full scale. As the technology continues to evolve, with cloud development still in its early stage of development, a longitudinal study of the long-term basis should be conducted to

investigate how user attitudes and perceptions toward public cloud services change over time. It is plausible that people's security concerns toward cloud computing are largely due to the immaturity of the technology and their unfamiliarity with the cloud environment. With further advancements in cloud computing, it is possible that more effective security-enhancing features will become available that may help alleviate consumers' privacy concerns related to cloud computing. Therefore, a time-series analysis that examines user security-related concerns in different stages of cloud computing would be of interest to academic researchers and of high relevance in practice and adoption.

Second, the respondents in this study were government officials; as such, it is possible that the Hawthorne effect applied in that they positively improved or modified their survey responses to be socially desirable. As such, the survey results may raise questions such as (1) how seriously did the respondents take the possibility of cloud computing in this study, and (2) to what extent are the samples representative of the entire population that is currently engaging in cloud services in the public sector? Future studies will be able to sample larger populations and obtain more generalizable results.

Third, as an exploratory attempt, this study used a simplified parsimonious model. It did not research complicated correlations among the factors, such as between perceived security and perceived access, between perceived availability and perceived access, and between perceived availability and perceived reliability. Although this study argues that all of these factors are closely related, the argument lacks empirical validation. These possibly significant links can be a starting point for future studies as it might be

helpful to unravel the complex multi-dimensional functions of human security in the cloud computing environment.

Finally, this study did not include individual differences as factors in cloud technology acceptance (e.g., demographics, user experience, personal innovation). Given a significant increase in usage variation discovered in user acceptance research, it may be essential to include individual variables as argued by Venkatesh and Brown (2001). Closer inspection of individual differences and their direct and indirect effects on attitude and behavior may offer rich opportunities for future research.

As to future topics, other study may further investigate whether the model identified in this study is applicable to other contexts, such as private sectors and other countries. This topic is worthwhile to be thoroughly examined because such possible difference has not been discovered yet so far. A public sector is not profit-driven and the end beneficiary of the services offered by the public sector is the general public. Cloud services offered by private sector are driven by profit, and it is the general consuming population who take advantage of the services offered by private sector. These differences clearly translate to different adoption and varying levels of acceptance in cloud services. The difference of TAM between private and public sector may be an interesting topic for future cloud studies.

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