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An Empirical Investigation of Cloud Computing for Personal Use

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ABSTRACT

Cloud computing is rapidly diffusing among individuals for personal use. By reviewing extant literature on individual adoption and use of information technology, this research develops a theoretical model to explicate the use of cloud computing for personal use. The proposed research model is empirically evaluated using a nationally drawn sample of 960 individuals. Partial Least Squares, a variance-based structural equation modeling technique, is used to analyze the research model. We discuss the results and identify areas for future research.

Keywords

Cloud Computing, Technology Usage, Perceived Usefulness, Perceived Privacy Concern

INTRODUCTION

Individual adoption and usage of information technology (IT) has been at the forefront of information systems (IS) research for the past four decades. Even as this research stream matures compared to other streams within IS research, we have not fully understood why people adopt and use information technology (Chin, Johnson, & Schwarz, 2008). Several factors such as context of adoption and use, nature of technology, cultural differences, and security concerns, to name a few, complicate a more complete understanding of the phenomenon and the universal applicability of the different theoretical frameworks (for example, TRA, TPB, TAM etc) across all contexts of adoption and use (Hossain & Prybutok, 2008; Liang & Xue, 2009). Consequently, the contemporary approach is to combine and extend key constructs from various theoretical perspectives to explain why individuals adopt and use information technology in specific contexts (Venkatesh, et al., 2003).

In this research, we adopt the contemporary approach to explicate factors that influence the use of cloud computing for personal use. Cloud computing is the provisioning of information technology resources as a service over the Internet (Hayes, 2008). Past research on adoption and use of IT has predominantly been in the organizational context and hence much of the theory built is more applicable to that context. In this research, we focus on personal use, which is different from use within organizations. Further, cloud computing is part of a new generation of IT, quite dissimilar to the IT of the 1980's and 90's where much of the original theoretical development occurred. Hence our research brings a new dimension to the research stream.

The rest of the paper is organized as follows. First, we detail cloud computing and its applicability for personal use. Second, we discuss salient research influencing our research and develop our research model. In the subsequent section, we detail our empirical validation of the research model. The final section concludes the paper by presenting our discussion and directions for future research.

CLOUD COMPUTING

Cloud computing is being heralded as the next big trend on the web and refers to the Internet based development and use of computer technology in which dynamically scalable resources are provided as a service over the Internet. Major components of the software used in cloud computing reside on unseen computers located in different countries (Hayes, 2008).

There is general consensus that cloud computing consists of three distinct sub-components that are interrelated to each other: Infrastructure as a service (IaaS), Platform as a service (PaaS) and Software as a service (SaaS) (Gray, 2009). Of these, IaaS and PaaS are organizational services and hence not suitable for our study. Software as a service (SaaS) refers to the paradigm where software and other solutions are delivered to the end user as a service using the Internet rather than as a product that can be installed on the user's computer. Examples of SaaS for companies include the customer relationship management applications by Salesforce.com and database applications by Coghead. Similarly, an example of SaaS for individuals is Google Apps consisting of Gmail, Google calendar and Google docs, which allow one to store and access documents online rather than on their personal computers. We will focus on the latter since the focus of our study is to investigate the adoption and use of cloud computing by individuals for personal use i.e., SaaS for individuals.

SaaS for individuals can be conceptualized in terms of 2 dimensions: cloud services and cloud storage (Vogels, 2009; Wikipedia, 2009). Similar to cloud services, which refer to the online delivery of software, cloud storage refers to the online delivery of data storage, for example, Amazon simpleDB - part of Amazon's web services. Cloud storage is more popularly known as Storage as a Service (STaaS). Storage as a service is gaining acceptance, especially in small and medium enterprises, because of the lack of start up costs associated with hard disks, IT staff, and servers. As with other services discussed earlier, pricing is flexible with firms paying only for the amount of storage space used. As detailed above, we follow a similar approach in this study and conceptualize SaaS in terms of two dimensions: Software as a Service (cloud services) and Storage as a Service (cloud storage), and develop appropriate measures as explained in the methodology section. To clearly differentiate the two components of SaaS, we denote cloud services as SFaaS, and cloud storage as STaaS in this research.

THEORETICAL BACKGROUND

Social psychology influenced theories of individual adoption and usage of information technology (IT) focus on the theoretical continuum that individual beliefs and attitudes form one's metacognition, cognition, and conation which in turn influence behavior. Theoretical frameworks such as the Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB), Innovation Diffusion Theory (IDT), Social Cognitive Theory (SCT) have all used this theoretical notion to explain why individuals adopt and use information technology. Consequently 'system use or usage' is an oft used behavioral construct, while 'perceived use', 'ease of use' have been employed to address cognitive constructs, and 'intention to use' as a conative construct. As the current research approach is to combine and extend key constructs from various theoretical perspectives to explain why individuals adopt and use information technology in specific contexts (c.f. Venkatesh, et al., 2003), we too adopt this approach in this research to explicate factors that influence the use (also referred to as usage) of cloud computing for personal use. The reader can obtain a more detailed discussion on these frameworks including construct definitions from Venkatesh et al (2003).

Drawing from the theories above, we propose that two constructs will affect the adoption and use of cloud computing: perceived usefulness and perceived privacy concern. We also propose that the influence of these constructs will be moderated by an individual's age, gender, and experience (with the technology) and present our propositions next.

PROPOSITIONS:

Perceived usefulness (PU):

Perceived usefulness has been defined as the "degree to which an individual believes that using a particular system would enhance his or her job performance" (Davis, 1993, p. 477). We adopt this definition to define PU as the 'degree to which an individual believes using cloud computing would enhance his or her personal performance'. Prior research has indicated that perceived usefulness is the strongest predictor of the intention to adopt and subsequent use of a particular technology. We posit that it should equally predict the adoption and usage of cloud computing. While cloud computing promises a different paradigm of delivering software, it is quite likely that consumers will not use it unless they find it useful. Consumers may use cloud computing only if it is perceived to be more efficient in terms of performance and costs as compared to "packaged" software. Cloud computing promises easier integration and lower costs which should increase the perceived usefulness of that technology leading to its increased adoption and usage among users. Therefore, we posit:

Proposition 1: Higher levels of perceived usefulness will lead to higher usage of cloud computing.

Perceived Privacy Concern (PPC):

We define PPC as 'the degree to which an individual believes that using a particular system would be a threat to his or her privacy'. This definition is in line with the theoretical discussion that beliefs and attitudes can influence behavioral intentions and behavior. Just as perceived usefulness is a belief, so is perceived privacy concern. As data storage and applications are no longer on user computers but are on the service provider's servers. This raises the possibility of privacy violation by the service providers, or by others who are able to access the data due to lax security afforded by the provider. Hence we believe that the inclusion of this construct is appropriate in our context. Also, the anxiety construct in SCT relates to PPC. We posit that consumers will not adopt and use cloud computing if they perceive a higher risk to their privacy. This includes the possibility of hacking and consequent of data misuse, and data/file loss. Therefore, we posit:

Proposition 2: Higher levels of perceived privacy concern will lead to lower usage of cloud computing.

Age, Gender, and Experience:

We also propose that the influence of PU and PPC on the usage of cloud computing for personal use will be moderated by age, gender and experience. Prior studies in the area of IS adoption have already indicated significant effects of gender and age (Morris & Venkatesh, 2000; Venkatesh & Morris, 2000; Venkatesh, et al., 2003). We posit that a similar moderating effect is applicable to our research context since it deals with the adoption and usage of an IS technology as well and discuss it next.

Studies on gender differences have indicated that men tend to be highly task oriented (Minton & Schneider, 1980). Therefore, perceived usefulness as a construct, which focuses on task accomplishment may tend to be salient to men. Studies have also noted that younger workers tend to attach a higher value on extrinsic rewards (Hall & Mansfield, 1995), tend to be less risk averse and more willing to try new technologies than older workers. These reasons may make younger people more willing to adopt and use cloud computing than older people. Finally, we posit that past experience with a technology should influence the intent to adopt and usage of a new technology as past experience as a moderator has empirical in literature (Venkatesh, et al., 2003). If one has had positive experiences with the usage of a technology in the past, then they are more likely to have a positive disposition towards the intention to adopt and use cloud computing and vice versa. Therefore, we posit:

Proposition 3: Impact of PU on the usage of cloud computing will be moderated by age, gender and experience.

Proposition 4: Impact of PPC on the usage of cloud computing will be moderated by age, gender and experience.

Figure 1 summarizes our theory development and showcases our propositions. In the next section we detail the empirical validation exercise undertaken to evaluate our research model.

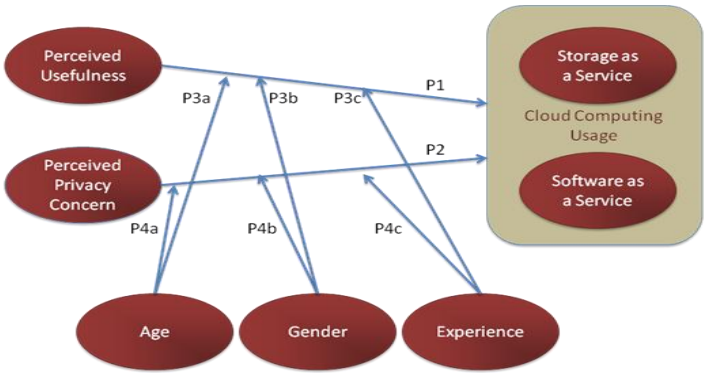

Figure 1. RESEARCH MODEL

EMPIRICAL VALIDATION

Data for this research was obtained from Pew's "May 2008 Cloud computing politics and adult social networking" report released Jan 15, 2009. While the survey contained responses from 2251 adults (18 years and older), our research used a subset 960 responses pertinent to our research.

The predictor constructs PU and PPC, measured using Likert-type scales, were modeled as reflective constructs. Cronbach's alpha measure of reliability for PU was 0.72 and that for PPC was 0.77, both greater than the minimum acceptable value of 0.7 for exploratory research (Hair, Anderson, Tatham, & Black, 1998). Both PU and PPC were unidimensional with all measures for each construct loading on only one factor. The variance extracted by PU was 54.3% and that by PPC was 56.8%. In addition, the factor loadings were greater than minimum acceptable 0.5 (Hair, et al., 1998). Both the dependent constructs were measured as a yes/no response. They were modeled as formative constructs in this research and hence reliability and unidimensionality evaluations are not required for these criterion constructs (Diamantopoulos & Winklhofer, 2001). Age and (Internet) experience were measured as ratio level variables in years. The average age of survey participants was 47.1 years, with a minimum of 18 and a maximum of 94 years. The average Internet experience was 4.8 years. 48.1% of the respondents were male and 51.9% female.

Partial Least Squares (PLS), a second generation analytical technique was used to evaluate the research model shown in Figure 1. PLS, a variance based structural equation modeling technique, is suitable for theory building exercises, where an initial assessment of the research model is required (Chin, Marcolin, & Newsted, 2003). Also, PLS helps assess both the measurement and the structural model at the same time. To evaluate the significances of the path coefficients of the structural model, and the loadings and weights of the measurement model, a bootstrapping resampling technique with 200 samples was used as recommended by Chin et al (2003). The T statistics for the loadings of the reflective constructs indicated significant loadings. So did the T statistics for weights of the formative constructs. These significances are one indicator of the soundness of the measurement model (Chin, et al., 2003). The results of the PLS analysis is shown in Figure 2. Only practically significant paths are shown in the figure.

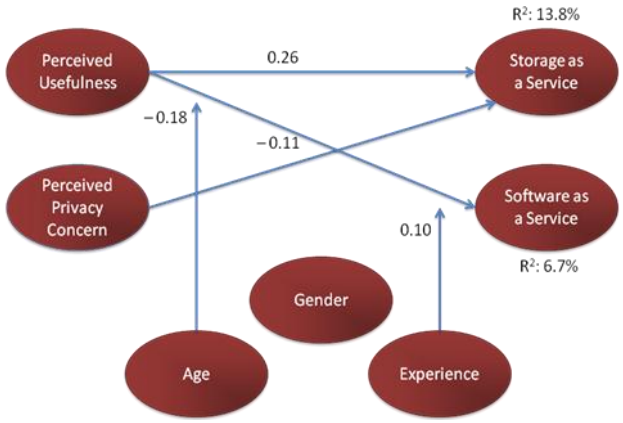

Figure 2: PLS Analysis Results

DISCUSSION AND CONCLUSION

Not all effects, especially the moderated effects, materialized as proposed. PU positively influenced STaaS as proposed but its effect on SFaaS was inconclusive. Similarly PPC negatively influenced STaaS and its effect on SFaaS was also inconclusive. These results need to be interpreted in the context of this study. First, though the data was made available in January 2009, it was collected in April 2008, when cloud computing was still in a nascent stage. Second, this is a volitional, personal use context. As a result, we need to understand individual needs and wants as related to personal computing. Personal productivity software such as Microsoft Office is still widely available and popular for personal use. Also, the sharing of files for collaborative work is lower when compared to job/work related needs. As a result, SFaaS such as Google Apps is not in much demand for personal use, though the product is free for personal use. In addition, there is a perceived learning curve for a new application, which slows adoption. However, it is surprising that data indicated the same results for webmail services such as gmail and yahoo mail. This matter needs to be investigated further in future studies.

Age, gender, and experience did not moderate the impact of PU or PPC on STaaS. This could be interpreted as follows. First, the primary driver of STaaS for personal use is for personal photos storage and sharing. This need is common across gender and all age groups to the extent that the proposed moderators are not significant. Second, this is an easy-to-use technology. Third, the concerns of privacy are same across different user segments. On the other hand, SFaaS such as Google apps is a relatively new concept for personal use, and as mentioned above, there could be a perceived learning curve. As a result, older

user groups may not be comfortable with this service, and those with high levels of Internet experience more inclined to use such services. So the observed moderating effect of age and experience on the impact of the PU on SFaaS is plausible.

This research employed secondary data to empirically validate the model. This could be construed as a limitation of the study, and also considered a cause for the inconclusive nature of some of the proposed relationships. Future studies using primary data are encouraged to alleviate this potential problem. However, unlike many other studies that measure the intention to adopt a particular technology, our study studies the actual usage of a technology, i.e., cloud computing in a TRA/TAM theoretical framework. We consider this to be a salient contribution of this study.

REFERENCES

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