Understanding User's Acceptance of Personal Cloud Computing: Using the Technology Acceptance Model

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Abstract Personal Cloud Computing (PCC) is a rapidly growing technology, addressing the market demand of individual users for access to available and reliable resources. But like other new technologies, concerns and issues have surfaced with the adoption of PCC. Users deciding whether to adopt PCC may be concerned about the ease of use, usefulness, or security risks in the cloud. Negative attitudes toward using a technology have been found to negatively impact the success of that technology. The purpose of this study was to understand users' acceptance of PCC. The population sample consisted of individual users within the United States between 18 and 80 years of age. The theoretical framework utilized in this study was based on the technology acceptance model (TAM). A web survey was conducted to assess the measurement and understanding of patterns demonstrated by participants. Our results shows that in spite of the potential benefits of PCC, security and privacy risks are deterring many users from moving towards PCC.

Keywords Personal Cloud Computing · Cloud computing · Technology Acceptance Model

1 Introduction

Recently, cloud computing has been injected with new life from companies such as Google, Microsoft, IBM, Amazon, and others who now offer cloud computing

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services for personal use. In this paper, we refer to PCC as the private and hybrid cloud computing for the individual user's usage. PCC has emerged as a new paradigm model for individual users. It has transformed the user's computer device from being device-centric to information-centric [1-7]. PCC enables individuals to share music, photos, videos, documents, and applications using any computer devices connected to the network. It provides portable access from anywhere in the world to information held centrally.

Though PCC demonstrated great potential in terms of scalability and agility, and is therefore enjoying great popularity and attention, storing data and applications in the cloud is becoming very risky [8]. Many cloud users have become concerned about security and protection of privacy [9], perhaps not surprisingly as the cloud functions to store and share private data [10]. The main challenge and disadvantage users see in the adoption of cloud computing is that they lack full control over the hardware [11]. There are, therefore, several issues related to privacy and security that must be addressed before PCC can be considered reliable.

Very often, data stored in the cloud is seen as valuable to those with malicious intent [12]. Storing data and applications in the cloud is becoming very risky. It is very important for users to take personal precautions in order to secure personal, sensitive information—information they would have stored in their local computer device (laptop, desktop, phone, tablet, etc.), and now store in the cloud. It is critical for users to understand the security measures that the cloud provider has in place [13].

Predicting technology usage and adoption has become a topic of mainstream study [14]. The rapidly growing importance of technologies has led researchers to study user technology acceptance intensively. Negative attitudes toward a technology, its ease of use, and its usefulness may negatively impact the success of that technology. Indeed, several IT scholars considered the user's acceptance of a technology to be the key success factor for the adoption of that technology [15].

The remaining of the paper is organized as follows: in the next section, we present the objectives of the study. Section 2 discusses and articulates our theoretical framework. Section 3 presents the research questions and hypothesis. The population sample information are discussed in section 4. A detailed discussion of the study's data collection and validation are provided in section 5. Section 6 discusses the data analysis of the study.

Section 5 presents methods used for data collections. Section 6 discusses the data analysis. Section 7 discusses our findings; and additional findings are discussed in section 8. Our recommendation and discussion are presented in section 9. Finally, section 10 concludes the paper.

2 Theoretical Framework

This research was deductive in nature. Therefore, a quantitative method was selected to understand user's acceptance of PCC. In particular, a non-experimental quantitative approach was used. The theoretical framework utilized in this study

was based on TAM—a widely recognized model in the field of IT, introduced by Davis in 1986 [16]. Davis [16, 17] recommended TAM as the best model for investigating end user attitudes towards and acceptance or rejection of a technology. According to Gao [18], "TAM can serve the purpose of predicting user acceptance of a technology before the users get heavily involved in the technology and thus is a cost-effective tool in screening potential candidate systems or programs" (p. 3). This theoretical framework was used in this study to examine factors influencing PCC adoption.

TAM proposes two independent variables—perceived ease of use, and perceived usefulness (PU) of a technology—to predict the user's attitude toward adopting a technology [18]. Davis [16, 17] defined PU as the degree to which a user believes that the adoption of a particular technology will improve the performance of his or her job. The perceived ease of use, on the other hand, is the degree to which a user believes that using a particular technology would be effortless [17].

Since the purpose of this study was to understand users' thoughts, experiences, expectations, and security concerns with respect to the adoption of PCC, TAM was found to be the most suitable theoretical approach due to its validity and reliability in exploring and explaining users' attitudes toward using technologies [16]. Cloud computing is a new approach to computing [19], and as new technologies are introduced and are adopted, concerns and challenges emerge [20]. Therefore, this study on PCC technology has a legitimate place in research on user technology acceptance.

This research study extended TAM to include attitude towards using (ATU) as an additional independent variable. This study adapted a survey instrument tested by Davis [16], and validated by Venkatesh [21]. Overall, this study included three independent variables and one dependent variable. The independent variables are perceived ease of use (PEOU), attitude toward using PCC (ATU) and perceived usefulness of PCC (PU). One dependent variable—Intention to Use PCC (ITC)—was used broadly in this study.

3 Research Questions and Hypothesis

3.1 Research Question 1: How Does Perceived Ease of Use Influence the Acceptance of PCC?

$H1_A$: Perceived ease of use positively influences attitude toward the acceptance of PCC.

$H1_0$: Perceived ease of use has no correlation to attitude toward the acceptance of PCC.

The independent variable PEOU determines the degree to which a user believes that using PCC would be effortless. PEOU is measured on a typical scale of seven ordered continuum of response categories: Strongly disagree, Disagree, Slightly disagree, Neutral, Slightly agree, Agree, Strongly agree.

3.2 Research Question 2: How Does Perceived Usefulness of PCC Influence the Acceptance of PCC?

H2A: Perceived usefulness positively influences attitude toward the acceptance of PCC.

H20: Perceived usefulness has no correlation to attitude toward the acceptance of PCC.

The independent variable PU determines the degree to which a user believes that the adoption of PCC would improve the performance of his or her job. PU is measured on a typical scale of seven ordered continuum of response categories: Strongly disagree, Disagree, Slightly disagree, Neutral, Slightly agree, Agree, Strongly agree.

Research Question 3: How does attitude toward using PCC influence acceptance of PCC?

$H3_A$: There will be a correlation between attitude toward using PCC and the user's acceptance of PCC.

$H3_0$: There will be no correlation between attitude toward using PCC and the user's acceptance of PCC.

The independent variable (ATU) determines the degree to which a user's acceptance of PCC relates to that user's attitude toward using PCC. ATU is measured across a typical scale of seven ordered continuum of response categories: Strongly disagree, Disagree, Slightly disagree, Neutral, Slightly agree, Agree, Strongly agree.

4 Population Sample

This study used a simple random sample from Survey Monkey engineering and IT professionals panels. The minimum representative sampling size (n) was estimated to be 384 participants for this study, based on a confidence interval of 5% and a confidence level of 95%. As many participants as possible were included to increase the accuracy of statistical sampling data.

A total of 464 participants were randomly chosen to participate in the study. However, only 399 of the chosen participants fully completed the survey; 20 participants opted out and 45 were disqualified either with unanswered questions or with providing partial data. Only fully completed responses were admitted. There was a 95.69% completion rate of surveys. Thus, the number of completed responses exceeded the estimated, representative minimal sample size of 384. Several items in the survey—gender, age range, education, state, and census region—were included to further describe demographic characteristics of the sample.

5 Data Collection and Validation

This study used a web survey to collect data from participants. The survey was hosted by SurveyMonkey.com, which is considered one of the leading providers of online survey solutions. The identity of participants was kept confidential and anonymous. Participant had the right to withdraw from participation at any time. Participants were required to complete a consent form as soon as they login to the SurveyMonkey.com. The consent form store collected information confidentially. Information collected by the survey included: gender, age range, state of residence, and level of education.

The survey questions in this study were designed to express a clearly negative or positive opinion and avoided neutral opinions to solicit more definitive responses. The researcher transcribed the data collected through Survey Monkey into digital documents. Data was downloaded by the researcher after the completion of data collection. Only fully completed surveys were employed in this study. Some participants were disqualified either with unanswered questions or with providing partial data. Incomplete responses and partial data were completely discarded. Additionally, Survey data was assessed for multicollinearity, homoscedasticity, linearity, and normality [22].

6 Data Analysis

The multiple regression test was performed as follows: (1) predictors were selected using their semi-partial correlation with the outcome; (2) predictors were entered into the model based on a mathematical method using Statistical Package for the Social Sciences (SPSS) Version 19.0; (3) the selection of predictors was performed in steps [23].

Descriptive statistics, ANOVA, Chi-square, and Multiple regressions were performed to explore the relationship between the continuous dependent variable (ITU) and independent variables (PEOU, PU, and ATU). Several descriptive statistics techniques were used to depict the sample population characteristics. ANOVA was used to analyze both dependent and independent variables. In addition, the multiple regression test was performed to assess the impact of each independent variable (PU, PEOU, and ATU) on the dependent variable (ITU).

7 Findings

TMultiple regressions were performed to explore the relationship between the continuous dependent variable (ITU) and independent variables (PEOU, PU, and ATU). This research study tested the relationship between perceived ease of use, usefulness, attitude toward using PCC, and the acceptance of PCC. The model's adequacy was tested in terms of normality, linearity, and collinearity [24].

7.1 First Regression Model

The first regression was performed to determine the relationship between the independent variable PEOU and the dependent variable ITU. Six predictors of the independent variable PEOU were tested to address the first research question. The relationship between the predictors and the outcome were measured using a stepwise method, so that the unique contribution of each predictor could be assessed to explain variance of the outcome [24]. The following research question and hypothesis were tested at this stage:

How does perceived ease of use influence the acceptance of PCC?

$H1_0$: Perceived ease of use has no correlation to the acceptance of PCC.

The results of the regression analysis demonstrated a positive correlation between PEOU and the acceptance of PCC. It was found that approximately 23.5% of the variance in the acceptance of PCC can be accounted for by PEOU. Therefore, the null hypothesis was rejected and the alternative was supported.

This result is consistent with other studies showing that there is a positive correlation between PEOU and the user's acceptance of a technology. Davis [16] argued that perceived ease of use positively influence attitude toward using a technology. Perceived ease of use plays an important role in determining and predicting the user's intention to use a technology [25]. Ramgovind [26] stated "The success of modern day technologies highly depends on its effectiveness of the world's norms, its ease of use by end users and most importantly its degree of information security and control" (p. 1).

7.2 Second Regression Model

The second regression was performed to determine the relationship between the independent variable PU and the dependent variable ITU. Five predictors of the independent variable PU were tested to address the first research question. A stepwise regression was performed to build the model. The unique contribution of each predictor was measured to explain the variance of the outcome [24]. The following research question and hypothesis were tested at this stage:

How does perceived usefulness of PCC influence the acceptance of PCC?

H20: Perceived usefulness has no correlation to attitude toward the acceptance of PCC.

The results of the regression analysis demonstrated a positive correlation between PU and the acceptance of PCC. It was found that approximately 78.2% of the variance in the acceptance of PCC can be accounted for by PU. Therefore, the null hypothesis was rejected and the alternative was supported. This result is consistent with other studies showing that there is a positive correlation between PU and the user's acceptance of a technology.

7.3 Third Regressions Model

The third regression was performed to determine the relationship between the independent variable ATU and the dependent variable ITU. Four predictors of the independent variable ATU were tested to address the first research question. The relationship between the predictors and the outcome were measured using stepwise regression. The unique contribution of each predictor was measured to explain the variance of the [24]. The unique contribution of each predictor is measured to explain the variance of the outcome. The following research question and hypothesis were tested at this stage:

How does attitude toward using PCC influence user's acceptance of PCC?

$H3_0$: There will be no correlation between attitude toward using PCC and user's acceptance of PCC.

The independent variable ATU was used for determining the degree in which there is a correlation between attitude toward using PCC and users' intention to use. The results of the regression analysis demonstrated a significant correlation between ATU and the acceptance of PCC. It was found that approximately 38.2% of the variance in the acceptance of PCC can be accounted for by ATU. Therefore, the null hypothesis was rejected and the alternative was supported.

8 Additional Findings

Statistically significant differences were found between age group means, as indicated by results of the one-way ANOVA (F (5, 2.801)=2.801, p=.017). The output result of the one-way ANOVA showed that the age group significantly contributed to the variation in the respondent's acceptance of the PCC technology. Because the output result of the one-way ANOVA test demonstrated significant differences between the age groups, a Post Hoc test was conducted to further investigate which means were significantly different from each other. The Post Hoc test result

indicated that the score of the age group 40-49 was much higher than the other age groups. Also, age groups 21-29 and 30-39 appeared to accept PCC more easily compared with age groups 18-20, 50-59, and 60-80.

A chi-square test of independence was performed to examine the relation between independent variables (PU, PEOU, and ATU) and the acceptance of PCC. A significant relationship was found between the independent variables and the frequency of acceptance of PCC at p-value <0.01, and degrees of freedom of 36. Additionally, a chi-square test of independence was performed to examine the relation between age group and acceptance of PCC. No significant relationship was found between age group and the frequency of acceptance of PCC, X2(10, N=399) =17.24, p-value=.069. The acceptance of PCC among the age group was as follows: approximately 66.6% of the age group "18-20;" 75% of the age group of "21-29;" 73% of the age group "30-39;" 80.5% of the age group "40-49;" 69.9% of the age group "50-59;" and 67.3% of the age group "60-80." Overwhelming majority of users that accepted PCC were in the "40-49" age group. On the other hand, the majority of users that did not have intention to use PCC were in the age group "60-80."

9 Discussion and Recommendation

Given the results of the data analysis in this study, it is arguable that PCC is here to stay. However, there are several issues related to security and privacy that must be tackled to increase user's acceptance of PCC. Hardly a day goes by without hearing news about privacy and security concerns of users. The findings of this study demonstrated that users are concerned about the way security and privacy is handled in the cloud. Protecting users' privacy in the cloud is big business for cloud providers. The success of a technology depends greatly on its ease of use but even more crucially its degree of security [26]. According to Koved [27], "When end-users' perceptions of risk are not aligned with those on which the system is based, there is a mismatch in perceived benefit, leading to poor user acceptance of the technology" (p. 1). Thus, users' understanding of privacy and security in the cloud rapidly becomes obsolete as the PCC technology progresses. Privacy and security must be evaluated continuously to achieve information privacy and security objectives and, thereby, user acceptance.

Prior research has shown that perceived privacy and security risks in the cloud negatively influence attitude toward using cloud computing. There are always security risks when moving towards cloud computing [28]. Though computer users would like to use PCC, they are concerned with utilizing a system they do not control. Data stored in the cloud is often seen as valuable to those with malicious intent [12]. It is very important for users to take precautions in order to secure personal, sensitive information—information they would have stored in their local computer device and now store in the cloud. It is critical for users to understand the security measures the cloud provider has in place before moving toward PCC [13].

10 Conclusion

The study's objective was to understand users' acceptance of PCC and a web survey was conducted to assess it. Several key findings emerged from this research study. The results of the data analysis showed that the majority of respondents had a positive view about PCC, but the participants seemed particularly concerned about security, privacy, and data theft in the cloud. User's attitude towards PCC appeared to be the most critical factor among the three suggested determinants of PCC acceptance in this study.

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