A Proposed Theoretical Model of Users' Acceptance of Mobile Cloud Computing

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Abstract

Although, the value of Mobile Cloud Computing (MCC) is increasing and it is receiving a substantial attention in the scientific and industrial communities, there is a paucity of research of users' adoption of this technology. In this paper, we propose a user acceptance model for mobile cloud computing based on the famous Technology Acceptance Model (TAM) by highlighting factors that can contribute in predicting future use of MCC. This research has the potential to significantly contribute to the development of attitude-behavior theories that would better explain users' acceptance of MCC applications. The findings could also provide a structured and more systematic approach for mobile cloud service providers on how to build their services and promoting them to the market.

Keywords : mobile cloud computing, technology acceptance, adoption

Introduction

There are several definition of MCC, but we take a more detailed definition of Chang et al. [1]as "an emergent mobile cloud computing paradigm which leverages mobile computing, networking, and cloud computing to study mobile series models, develop mobile cloud infrastructure, platforms, and services application for mobile clients. Its primary objective is to delivery location-ware mobile services with mobility to users based on scalable mobile cloud resources in networks, computers, storages, and mobile devices [2]. Mobile Cloud computing has been the topic of research for quite some time now. It is a model for enabling convenient, ubiquitous, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, applications, and services including security, application development, etc.) that can be rapidly provisioned and released with minimal management effort or service[3] .

There are many potential benefits of MCC that makes it an appealing venture to industry and researchers including: increasing the processing power and battery life time of mobile devices, coping with the increasing services and application needs of most mobile users with low-end mobile devices, maximizing the resource sharing and reuse of existing computing resources in cloud infrastructures and Internet based applications and services. Further, MCC has the potential to eliminate existing limitations of the current mobile devices and to Leverage the mobile handsets to the existing and future cloud based network and mobile enabled service infrastructures[4] .

Featuring a plethora of potential benefits, MCC research is relatively new and suffers from a lack of research especially with regards to users' adoption. By following recent research on IT and MCC adoption [4] [5] in identifying the adoption issues of MCC, we can conclude that MCC is a kind of technology which allows IT service providers to provide infrastructure, platform and software as a service. These components can cause some challenges that affects users' acceptance and adoption to use such a service. Building up on the explanation of Koehler et al.[6] [7] and on Opitz et al. [8] about the value of different attributes (for example costs, resource mobility, security, and MCC service provisioning) of mobile cloud service configurations from a consumer perspective, we extract the following research question: *What are the main factors that affect the acceptance and adoption of mobile cloud computing?*

To answer this question, a thorough literature review was conducted on adoption issues that affect user's acceptance of MCC applications. Based on previous research on users' behavior in technology acceptance, we propose a research model by adopting the technology model (TAM) [9] and the theory of planned behavior (TPB)[10] to explain the factors affecting users' perceptions and acceptance of MCC. We take advantages of the strong theoretical and empirical foundation of TAM by borrowing its proven factors and adapt them to fit the MCC dynamic environment. Further, we proceed in examining these factors closely to measure their influence on users' attitude and intention to use MCC applications. The paper is an extension of our previous paper on MCC challenges and adoption (Allam, et al., 2017). The rest of this paper starts with a background of MCC users' adoption issues and an overview of users' behavior with Technology through a TAM briefing. From this, a research model is proposed, and the methodology and main results are summarized and discussed. The conclusions and limitations close the paper.

Related Research

1.2 Recent Mobile Cloud Computing Issues

Considering that MCC is a relatively new technology started in 2009, there are many challenges that arose upon experimenting with the systems and after establishing several clouds led by different Cloud Service Providers (CSPs). Each CSP and cloud may have their own set of issues resulting from various variables, but some issues are common and seen in most clouds mobile cloud computing initiatives. Those issues are worth addressing and require further exploration.

1. User Interface Issues

Mobile device sizes are relatively small. This means that most apps rely on interfaces that have few static elements, such as scroll bars, palettes, and pop-up menus and icons. Another drawback is the reduced typing speed due to lack of screen size. Such interfaces are considered easy-to-use, but further development is required to design easy interfaces without static elements. Another issue is that the tasks performed on mobile phones are assumed different from regular desktop tasks. Mobile devices are assumed to be used for viewing data and less data entry, contrary to desktop computers. Accordingly, user interface designers keep that point in mind when designing software [11][11].

1. Limited Computational capacity and Battery Life

When it comes to battery capacity, the mobile devices are relatively limited compared to stationary devices where is a lot of space to implement stronger, longer-lasting energy sources. Mobile phones have a limited computational capacity that limits many of its functions. For example, the use of location services like GPS consumes a lot of energy because it involves extensive use of sensors. Likewise, some apps that require a huge processing capacity, like image processing for video games, speech synthesis, natural language processing, augmented reality and wearable computing. Such services represent a computational challenge to application developers, because they are not able to implement applications that meet such a need. Given the fact that this limitation is dictated by the limited battery capacity and the small size of mobile devices, it is more likely for this problem to be solved using software developments than hardware ones [12].

1. Connectivity

Maintaining connectivity across different connection mechanisms used in a challenge for MCC. In case of 3G connectivity, there is an increased data cost and latency. As users move, there is variability in signal strength that disrupts ongoing processes. This could be due to variability in location signal reception or the present of blind spots that have no connectivity at all. Accordingly, development of systems that overcome such problems is necessary for MCC to manifest its promising potential[13] .By nature, mobile devices have limited network bandwidth, compared to wired networks. The Quality of Signal (QoS) delivered to the user is affected by non-proportionate delay in execution of the applications, the dismissal of always-on connectivity, and the excess utilization of limited mobile resources. Not only does this limitation in resources affect signal, but it also takes its toll on the processes of applications[12] .

1. Data Security and Privacy Issues

One of the major issues facing MCC is data security. Parasad and Gyani [14]noted that users are more concerned about MCC data security such as loss of physical security, handling of encryption and decryption keys, security and auditing issues of virtual machines, less norms for data integrity, and services platform incompatibility from various vendors. Further, when offloading data to the cloud, there is concern about data safety and privacy. The offloading process places the data of the user at risk of data breach and invasion of personal information. There is also the concern about intended violations, which are seen as a specific person hacking a particular device for the sake of sabotaging or stealing important information. Although different from hackers who violate the data of random users, such premeditated attacks could even be more harmful and have a negative impact of user's privacy [15]. Moreover, a flaw in the encryption algorithm on the CSP's part can result in unauthorized access to one's information. Any user can access sensitive information when security fails to protect the data of the victim user [16](. Fernanddo and Rhayan [13]noted that MCC users are concerned about the security issues related to their payment online. They noted that Social media and online payment seem to be the most vulnerable resources for hacking since it carries important and crucial data for users and users seem to be less careful when sharing information especially with social media (Ruay-Shiung-Chang et al., 2013). Another issue with lack of security is piracy. When pirated material is distributed among mobile networks, they have a much wider exposure to unwanted users than they do in other devices. An encryption and decryption procedure can restrict access to such material by providing keys prevent unauthorized access to digital materials .

1. The Role of Malware in Security

The wide array of mobile applications used by mobile phones to access other mobile devices isan attractive medium for malware creators. The issue is no longer caused by unauthorized users accessing unauthorized data. Rather, it is happening because people are agreeing on installing malware on mobile devices that can transfer and leak personal data to malware creators [12].

1. Heterogeneity

Heterogeneity in MCC is the existence of various types of hardware, architectures, infrastructure, and technologies of mobile devices, clouds, and wireless networks. MCC is used in a heterogeneous environment ranging from different interfaces on the wireless network different nodes in the mobile device, and different wireless technologies such as WiMAX, GPRS, WLAN, CDMA2000 and WCDMA. Heterogeneity could cause MCC to fail to fulfil its proposed benefits as being efficient in energy use of mobile devices, always being connected, and scalability of on-demand wireless connection [17] . The standard architecture of mobile cloud involves three elements: Mobile client, Transmission channel and Cloud. This basic structure involves latency as the request is sent to the cloud and back to the mobile device upon completion. Further, Part of the accessibility issue originates from the added security layers to prevent unauthorized access to data [18] .

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1.

AlthoughMCCisrapidlygrowinginpopularity,only a few studies have examined determinants of how user perceptions are shaped in mobile cloud computing.Hence,thereisapaucityofinformationonhowpsychologicalfactorsaffec study identifies that trust and convenience are motivators and perceived uncertainty is a mitigator for adopting mobile cloud computing services.Otherstudiesshowedthatcognitivefactorsmightcontributetoshapingusers'attitudetowardstheadoptionofMCCservices.For example, Park and Kim [19] noted that user acceptance of mobile cloud services is largely affected by a group of factors combines including perceived mobility, connectedness, security, quality of service and system, and satisfaction.

TechnologyAcceptanceModelFactors

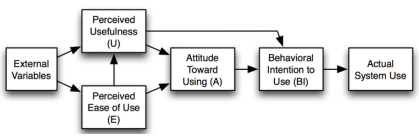

Figure 1: Technology Acceptance Model (Davis, 1989)

TAM (figure1) or Technology Acceptance Model was introduced by F.D. Davis [9], based on the Theory of Reasoned Action (TRA)[10] which states that individuals act upon something based on some reasons that make sense to them. TAM's popularity comes from its strong theoretical and empirical support in information systems research. This is reflected in the number of paper that referenced reaching over 37,803 times in information system research papers of the time of the paper.

TAM proposes two predictors are believed to be the facts, perceived usefulness and perceived ease of use, as the main connection to the computer acceptance behavior. The chart of TAM can be seen in Figure 2. Perceived usefulness is defined as the degree to which a person believes that using a particular system can improve its performance, and perceive ease of use is defined as the degree to which a person believes that using the system is not required any effort (free of effort). Perceive ease of use also affects the perceived usefulness which may mean that if a person feels the system is easy to use, the system is useful for them. TAM explains the issue of how users accept and use a specific technology, as results of the causal relationships between systems design features, perceived usefulness, perceived ease of use, attitude toward using, and use. The TAM denotes that user's acceptance and effective use of an information system are determined by their intention to use a system, which is in turn determined by perceived usefulness, ease of use and attitudes toward using the system. Accordingly, perceived usefulness and perceived ease of use are the two main factors that determine the effective acceptance and use. The variables. However, TAM2, which was modified by Davis and Venkatesh,(Venkatesh & Davis, 2000) add more factors including social influence processes and cognitive instrumental processes.

Research Model and Hypotheses

Our research model is based on TAM given that it gain theoretical and empirical validity. Flowing the TAM, we propose that perceived mobility and perceived ease of use of MCC will positively impact users' attitude to use MCC which in turn positively influence users' intention to use MCC. Further, users' attitude positively influence their actual use of MCC. Perceived Usefulness is defined as the users' belief that specific information system will positively affect their job performance, while perceived Ease of Use is extent to which the user believes that the target system will be free of effort [9]. Further, Davis defined the concept of attitude as the desirability to use a technology. In other words. TAM postulates that individuals' behavioral intention (BI) to use a technology is decided by their attitude towards using the technology, which in turn is decided by perceived ease of use and perceived usefulness. In this paper, the target system that TAM refers to is MCC. Further, Perceived usefulness is adopted to perceived mobility to reflect the nature of MCC. Since TAM was approved by numerous research[4][15][20], we propose that perceived usefulness and perceived ease of use will positively impact the attitude towards using mobile cloud computing applications which in turn affect users' intention so use MCC. Further, users' positive attitude towards using MCC application will have a strong influence on their actual use of mobile cloud computing. Finally, following the footsteps of TAM, perceived ease of use will have a positive impact on the usefulness of the MCC applications which in turn has a positive influence on users' intention to use MCC. Accordingly, we introduce the following hypotheses:

Figure 2: Proposed Theoretical Model

H1: Perceived usefulness will have a positive impact on attitude to use MCC

H2: perceived ease of use will have a positive impact on users' attitude to ue MCC

H3: Users' attitude to use MCC will have a positive influence on users' intention to use MCC

H4: Users' intention to use MCC will have a positive influence on users' actual use of MCC

H5: Perceived usefulness will have a positive impact on intention to use MCC

H6: Perceived ease of use will have a positive impact on perceived usefulness

Methodology

Questionnaire Design

In this research, we plan to use structured questionnaire consisting of two parts to test our theoretical model. The first part of the questionnaire will measures the constructs included in the research model, while the second part collects demographic information about the participants. The items of the constructs will be measured using a seven-point Likert scale, with answer choices ranging from "strongly disagree" (1) to "strongly agree" (7). All constructs will be derived from the literature, primarily from previously tested survey instruments. Regarding the survey design strategies, prior research noted factors such as topics, length, ordering, and formatting of web surveys can affect the response rate [21] [22].These studies also recommended the use of presurvey procedures such as a panel of experts or pilot studies to assess the quality of the survey. For the current study, a decision was made to ask a panel of experts for their views regarding the survey. Further, we plan to use a systematic process for converting the proposed theoretical concepts into operational constructs that can be quantified and measured using already established and verified measures from the literature. First, we plan on revisiting the final proposed model to give an overview of the constructs that have been operationalized into questions. Second, each construct will be discussed along with its adaptive items. Lastly, a validity check will be conducted to ensure each set of questions are measuring their own constructs.

Technology adoption, acceptance, conditions, and success are typical research areas addressed in information Systems (IS) research. To address these areas, researchers have to define, formulate, and understand abstract constructs such as beliefs, perceptions, motivation, and attitude. Since it is difficult to measure such abstract constructs, these constructs are mostly measured as latent variables (LVs) that can only be measured through a set of questions (indicators) that attempt to reflect the concepts of constructs in hand. Structural Equation Modeling (SEM) is one of the methods commonly used by IS research to model the relationships between latent variables. Partial Least Square (PLS) algorithm is one of the techniques used to estimate the relationships between latent variables based on a given dataset[23] (Urbach and Ahlemann, 2010). The following section presents an overview of SEM and PLS and how they fit the proposed model of this dissertation.

Partial Least Square (PLS) was used for data analysis. PLS is known for its common use when measuring the influence of latent constructs [24].

Conclusion

MCC is an important evolution of information systems technology. It features attractive packages to companies such as agility, scalability, and cost efficiency. Despite the touted advantages of MCC and that, companies are rushing to adapt mobile cloud based solutions to reap out such advantages, little is known about what motivates end users to accepting such technology, given the disruptive nature of such technology and that it has not reached a level of maturity. In this paper, we propose a theoretical model of possible determinants of what make users accept such technology. We utilized the famous and verified TAM to include including perceived usefulness and perceived ease of use as extrinsic motivator for explaining the attitude and intention of use of mobile cloud computing applications. This study has the potential to provide evidence about the acceptance of an important technology such as mobile apps a potential system with longitudinal data from users ranging from IT professional to students who took the initiatives to use this unestablished cloud services.

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