Information & Management 53 (2016) 355–365

Contents lists available at ScienceDirect

Information & Management

journal homepage: www.elsevier.com/locate/im

Understanding behavioral intention to use a cloud computing classroom: A multiple model comparison approach

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ARTICLE INFO

Article history:
Received 15 November 2014
Received in revised form 9 October 2015
Accepted 29 October 2015
Available online 6 November 2015

Keywords:
Cloud computing classroom
Innovation
Behavioral intention
Self-efficacy (SE)
Service quality (SQ)
Innovation diffusion theory (IDT)

ABSTRACT

Cloud computing is an innovative information technology that has been applied to education and has facilitated the development of cloud computing classrooms; however, student behavioral intention (BI) toward cloud computing remains unclear. Most researchers have evaluated, integrated, or compared only few theories to examine user BI. In this study, we tested, compared, and unified six well-known theories, namely service quality (SQ), self-efficacy (SE), the motivational model (MM), the technology acceptance model (TAM), the theory of reasoned action or theory of planned behavior (TRA/TPB), and innovation diffusion theory (IDT), in the context of cloud computing classrooms. This empirical study was conducted using an online survey. The data collected from the samples ($n = 478$) were analyzed using structural equation modeling. We independently analyzed each theory, by formulating a united model. The analysis yielded three valuable findings. First, all six theoretical models and the united model exhibited adequate explanatory power. Second, variance explanation, Chi-squared statistics, effect size, and predictive relevance results revealed the ranking importance of the theoretical models. Third, the united model provided a comprehensive understanding of the factors that significantly affect the college students' BI toward a cloud computing classroom. The discussions and implications of this study are critical for researchers and practitioners.

1. Introduction

Innovation is one of the most critical forces in creating new services and products, developing new markets, promoting organizations' competitiveness, and transforming industries [30]. Cloud computing is an innovative technology that evolved from distributed, grid, and utility computing. Relevant products, such as mobile device applications including Gmail, Facebook, Twitter, YouTube, and Google Apps for Work, are proliferating [4] as more people use cloud computing services. Thus, cloud computing is a popular topic and global trend. This innovative technology comprises three types of services, namely infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS), providing diverse applications for customers [4,64]. IaaS encompasses the complete infrastructure required for cloud computing, including virtual computers, servers, and storage devices (e.g., the Amazon S3 storage service and EC2 computing platform, and the Joyent, Terremark, and Rackspace cloud servers). PaaS provides computing models that run remotely on a platform, requiring hardware, an operating system, database, middleware, web servers, and other software (e.g., Salesforce's force.com, Microsoft's Azure services platform, Google App Engine, Amazon Relational Database Services, and Rackspace cloud sites). SaaS provides applications that run through the cloud; thus, users need not install any software (e.g., Salesforce, Google Apps for Work, and personal applications such as Gmail, Facebook, and Twitter) [4]. These three types of cloud computing services offer potential advantages including reduced costs, expected switching benefits, omnipresent services, collaborative support, access to infinite computing resources on demand, simplified operation, and increased use because of resource virtualization [4,52]. Seeking these advantages, many universities have implemented classroom-based cloud computing, called cloud computing classrooms, to enable students to learn from anywhere and at anytime [33,40,65]. Thus, a cloud computing classroom is defined as a ubiquitous learning environment that supports IaaS, PaaS, and

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http://dx.doi.org/10.1016/j.im.2015.10.004
0378-7206/

SaaS in forms such as programs, objects, and websites and that can provide learning opportunities for individuals in and out of the physical classroom.

Theorists have attempted to explain and predict individual behaviors and have determined that behavioral intention (BI) is the dominant factor in the use of information systems (ISs) [72]. For example, the theory of reasoned action/theory of planned behavior (TRA/TPB) and technology acceptance model (TAM) are appropriate theories for explaining students' BI. In order to attract students to use cloud-based resources, student motivations should be considered. Motivational model (MM) theory can be used to assess student motivations. Cloud computing provides students with access to software and product services; therefore, students must be able to use these resources, and thus self-efficacy (SE) plays a critical role in their behavior. Service quality (SQ) and cloud services are also critical factors in the use of cloud computing classrooms. Thus, SE and SQ are suitable theories for explaining student behaviors. Cloud computing is an innovative technology that can be used to construct online classrooms and facilitate student learning. Innovation diffusion theory (IDT) is appropriate for investigating students' BI in the context of a cloud computing classroom. According to the preceding discussion, we focused on BI in the six theoretical models, namely the TRA/TPB, the TAM, the MM, SE, SQ, and IDT. Those who show a strong BI usually exhibit a correspondingly high level of use. Consequently, numerous studies have attempted to explain and predict BI [10,14,56,63]. However, these studies have typically applied only one to three theories to explain BI [14,63,75]. This method is limited to a complex phenomenon. Similarly, in the 19th century, the poet John Godfrey Saxe [61] wrote the poem *The Blind Men and the Elephant*, in which six blind men attempt to describe an elephant that they can feel, but not see. They conclude that the elephant is like a wall, spear, snake, tree, fan, or rope, depending on where they touch and engage in a heated debate that fails to yield the truth. Only by aggregating their descriptions can a comprehensive picture of the elephant be formed. In the context of cloud computing research, the elephant is BI and the blind people are the researchers who have attempted to empirically determine and explain BI by using a limited approach.

Furthermore, few studies have aggregated more than five theories to explain BI. For instance, Venkatesh et al. [72] developed a unified view of user intentions to use an IS and the consequent usage behavior, called the unified theory of acceptance and use of technology (UTAUT). Venkatesh et al. [72] reviewed and integrated constructs from the following eight theories and models: TRA, TAM, MM, TPB, a combined TPB and TAM (C-TPB-TAM), the model of PC utilization (MPCU), IDT, and social cognitive theory (SCT). In the cloud computing classroom context, cloud computing service is a focal point, and cloud computing efficacy is a critical factor in the initial learning stage of the cloud computing classroom. We provide an alternative view of user intention in contrast to UTAUT, particularly in cloud computing service by SQ theory and cloud computing efficacy by SE theory. Furthermore, Venkatesh et al. [72] used only variance (R^2) to compare the theoretical models. In our study, we used four criteria to evaluate the theoretical models: R^2, Chi-squared (X^2) statistics, effect size (f^2), and predictive relevance (q^2). This study was aimed at developing an integrated view of intention to use cloud computing by reviewing and integrating numerous well-known theories, namely TRA/TPB, TAM, MM, SE, SQ, and IDT. This paper not only examines the effects of individual theories and the unified model on college students' intentions to use a cloud computing classroom, but also uses a multiple model comparison approach to empirically verify and examine their intentions. The following research questions are addressed: (a) Which theories or models most effectively elucidate BI in a cloud computing classroom? (b) What are the critical factors of a unified model determining BI toward classroom-based cloud computing? The evaluated theories are compared and unified to elucidate BI. The remainder of this paper is structured as follows: Section 2 introduces the literature review; Section 3 details the research model and hypotheses; Section 4 presents the research methodology; Section 5 presents the data analysis and results; Section 6 provides a discussion, implications, and limitations; and Section 7 offers a conclusion.

2. Literature review

2.1. Cloud computing in the classroom

Educational organizations always seek opportunities to rationalize their resource management. Cloud computing is likely an immensely adoptable technology for many organizations because of its dynamic scalability and use of virtualized resources. For example, the University of Westminster in the United Kingdom has embraced Google Apps for Education, which provides free email, messaging, and shared calendars, and displays no advertisements. The Google platform also provides word processing, spreadsheet, and presentation support, facilitating collaboration on group assignments. Several other institutions of higher education in the United Kingdom (e.g., Leeds Beckett University, the University of Glamorgan, and the University of Aberdeen) have adopted Google Apps because of their low cost. In the United States, the University of California, Berkeley adopted Amazon web services to move its courses from the local infrastructure to the cloud. The Washington State University (Electrical Engineering and Computer Science) adopted the vSphere 4 cloud platform (VMware) to expand the services it offers to faculty and students. The vSphere 4 platform involves virtualization technology and is used to aggregate and manage IT resources, providing a seamless, flexible, and dynamic service with nearly limitless scalability. Cloud computing benefits educational institutions and has a significant impact in the classroom. For example, Stantchev et al. [65] investigated the motivations that lead higher education students to switch from using several learning management system (LMS) services for information sharing and collaboration to using cloud services. LMSs, also known as virtual learning environments, are like classrooms wherein they offer high levels of functionality regarding learning activities and features for course management and tracking. Cloud services encompass the functions of LMSs, enabling files to be stored and shared over the Internet through file synchronization. Stantchev et al. [65] reported that cloud hosting services were perceived as more user friendly than LMS services and that cloud services presented higher levels of perceived usefulness (PU) than the standard learning management tools. Lin et al. [40] studied a cloud-based learning environment aimed at developing students' self-reflection abilities to enable them to improve their learning motivation, comprehension, and performance. Conventional self-reflection methods are usually applicable only in classroom environments; however, cloud computing classrooms could be adopted for distance learning or after-class activities. Lin et al. determined that the cloud computing learning environment can effectively facilitate student reflection abilities and enhance their learning motivation, comprehension, and performance. Stein et al. [66] conducted a case study in rural high schools in North Carolina using the state's Virtual Computing Lab cloud service to access dynamic geometry and algebra software. The researchers found that a cloud service designed specifically for education can be applied to and improve K–12 education. Jou and Wang [33] studied how learning attitudes (ATTs) and academic performances were affected by the utilization of cloud computing technology, specifically computer-aided design (CAD) software. Students with a vocational high school