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Conceptualizing a model for adoption of cloud computing in education

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ABSTRACT

Cloud computing is a pervasive computing paradigm that has revolutionized how computer infrastructure and services are delivered. Current research trends on cloud computing have been focused on the technology, applications, costs, benefits, and security of cloud computing at the organizational level within small and medium sized enterprises. Little research attention has been paid on adoption and usage of cloud computing at educational establishments and how contextual factors can influence diffusion and adoption of cloud computing. Universities in developing countries are faced with challenging socio-economic and political constraints that limit their ability to invest in expensive information systems to compete on the global stage. Using constructs from the diffusion of innovation theory and the technology acceptance model, this paper proposes a model that takes account of contextual, economic, and technological influences in the perception and adoption of cloud computing at universities in sub-Saharan Africa. Results from a pilot study, based on the model, through a survey of university lecturers and IS experts shows reliability and validity of the instrument and supports its usage for a more extensive study. Implications, potential contributions to research, and suggestions for future study are discussed.

1. Introduction

Cloud computing has been propounded as a paradigm shift in the delivery of information technology (IT) resources and services. It has been dubbed by proponents of the technology as the fifth utility after water, electricity, gas, and telephone utilities (Monroy, Arias, & Guerrero, 2013). Cloud computing has changed the fundamental building blocks of computing and how this is being used in businesses, organizations, and individual operations. The IDC predicts that public cloud computing will become a $127 billion dollar industry by 2018 and that by 2020, it will cease to be called cloud computing altogether and will simply be the standard way of provisioning IT resources and services as well as doing business and personal computing (IDC, 2014).

A unified and standard definition of cloud computing is provided by the National Institute of Standards and Technology (NIST) in the USA, which defines cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell & Grance, 2011). A more commonly used technical definition describes cloud computing as clusters of distributed computers (largely vast data centers and server farms), which provide on-demand resources and services over a networked medium (usually the Internet) (Sultan, 2010). Cloud computing providers allow users to dynamically scale up or scale down their use of the services based on their requirements using a metering capability to charge subscribers for actual usage only (Mell & Grance, 2011). Cloud computing opens up a new way by which businesses around the world can harness the power of the cloud infrastructure to benefit from high performing IT systems without initial capital expenditures (CAPEX). This possibilities offered by cloud computing has opened up a new way of provisioning IT systems that can allow universities, firms, and governments in developing countries to have access to the same advanced and powerful computer systems that are currently only available to large corporations and universities in developed countries, thereby leapfrogging the technological divide. The cloud computing model is based on the idea of outsourcing corporate IT infrastructure to third party data centers with a shared pool of computing infrastructure, storage, and networking resources with services becoming accessible rapidly and on demand over the Internet. The forecasted benefits include elastic and dynamic resource provisioning, simpler and automated

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administration of IT infrastructures, and sharing of nearly unlimited CPU, bandwidth, and storage space. This is made possible through resource virtualization, with scalability improvements and massive cost reductions in terms of infrastructure management.

Developing countries have often been left behind in the technology diffusion, adoption, and implementation drive due to various bottlenecks. These impeding factors to technology adoption include infrastructure, knowledge, cost, government policies, education, user resistance, and security concerns (Kshetri, 2010a; Svantesson & Clarke, 2010). The disparity in economic growth between developed and developing countries is largely due to the level of technological advancement between the two with access to appropriate technology by firms in developing countries proving particularly problematic (Moodley, 2003). The developing world's cloud computing sector is beginning to receive considerable attention from global and local IT players, national governments, and international agencies with cloud provisioning companies like IBM establishing cloud computing centers in many developing countries such as China, India, Vietnam, Brazil, South Africa, and South Korea. Other global cloud providers such as Microsoft, Amazon, VMware, Salesforce, Dell, and Parallels are actively searching for opportunities and implementing cloud computing centers in the developing world (Kshetri, 2010a). The rise in cloud computing adoption will open up a whole new future for developing countries, which can benefit from the lower upfront cost and the elasticity of cloud computing services. Kshetri (2010b) further asserts that the developing economies can catch up with the West as cloud computing allows them to have access to the same IT infrastructure, data centers, and applications due to their ubiquitous nature.

The cost of acquiring, implementing, and maintaining a robust and reliable IT infrastructure is very high and has led many universities in developing countries to lag behind in technological advancements in ICT infrastructure compared to those used by universities in developed countries. This cost impediment can be substantially reduced through the adoption and usage of cloud computing by universities in developing countries, which can, in turn, bring them up to the same competitive stature as their counterparts in western developed economies. Meanwhile, universities in western developed countries have been forced by the recent economic downturn to adopt cloud computing to cut their costs due to the reduced budgets available to them from their respective governments (Sultan, 2010). Despite the possibilities offered through cloud computing such as low initial capital investments and elasticity through which computing resources can be dynamically allocated and de-allocated according to the needs of the users, there is still a very slow pace by universities in developing countries toward adopting this technology, which can offer them greater research, collaboration, and teaching capabilities by leveraging the power of high performing IT infrastructures offered through cloud computing. A review of the recent academic literature on cloud computing adoption in developing countries has revealed a gap in the research regarding factors that influence university decision makers and ICT experts to adopt and use cloud computing. There is little research about the diffusion and adoption of cloud computing in higher educational establishments in developing countries especially in sub-Saharan Africa. Furthermore, there is a gap in assessing the impact of contextual, economic, and technological factors on the adoption of cloud computing at universities both in developed and developing countries.

This paper proposes an adoption model for cloud computing at universities that will be used in an attempt to answer the following research questions: (1) What contextual factors influence the adoption and usage of cloud computing? (2) How can existing technology adoption theories be used to model cloud computing adoption? (3) What effects do organizational characteristics have on adoption and usage of cloud computing? The model developed will help to address these questions by looking at the relationships between technology adoption drivers and the propensity to adopt and use new technology such as cloud computing. The impact of contextual factors together with constructs from the two main technology adoption models along with moderating factors from organizational characteristics will provide a first step towards filling the gap on what factors can influence cloud computing adoption at universities. The proposed model will be more fully validated through a more extensive data collection process across universities in several countries in the sub-Sahara African region, which builds on the pilot study reported here. The findings will potentially contribute to research and practice by elucidating the crucial factors that will impact cloud computing adoption at universities especially in developing countries.

2. Theoretical and conceptual background

The last part of the 20th century saw a slow pace of adoption of innovation in developing countries compared to the spread of innovation in western industrialized countries. However, the emergence and portability of information systems has led to an accelerated rate of innovation diffusion to developing countries with the potential of supporting development strategies that can help in bridging the digital divide between developed and developing countries (Steinmueller, 2001). However, Steinmueller (2001) also asserted that achieving the benefits of leapfrogging by implementing technology transfer strategies is not straightforward as it sounds due to various challenges. These challenges include: adaptation of the technology to local needs, costs, skills required for effective operation; and limitations due to local market dynamics. Limited knowledge and expertise related to imported information systems also leads to failed implementations; thus, preventing developing countries from benefiting from the technologies (Moens, Broerse, Gast, & Bunders, 2010). Even though ICT innovation places a lot of emphasis on the socioeconomic context, there are significant epistemological differences regarding the process used for such innovation adoption (Avgerou, 2010). Innovation diffusion must be backed by institutional willingness and support to ensure successful adoption.

Technology adoption helps to drive economic growth and sustainable development within communities. However, the rate of adoption varies across various social and cultural boundaries, which are often neglected during the diffusion process. The multidimensional nature of technology adoption and innovation diffusion entails a difference in the rate of technology adoption, which cannot only be attributed to economic and technological factors but also to socio-cultural factors (Guan & Liao, 2014). Innovation diffusion and adoption must take into consideration existing social and cultural conditions of the adopters, which can impact the eventual success or failure of the technology adoption process (Herbig & Dunphy, 1998). The socio-cultural and economic conditions for adopters of cloud computing in developed countries will be vastly different from those of adopters in developing countries.

Educational establishments around the world have seen their budgetary allocations cut due to the prevailing global economic downturn. This has led to many university administrators looking at cost cutting measures to remain competitive within their industry (Sultan, 2010). Cloud computing and its flexible operational model has emerged as a real alternative to the cost-cutting measures required by educational establishments without impacting their performance and efficiency. Moreover cash-strapped educational establishments and new institutions that are still being setup will find the benefits of scalability and the pay-as-you-go cost structure in the cloud computing model more appealing (Sultan, 2010). In addition to cutting the cost of ICT implementation and support,