Mobile cloud computing: innovation and creativity perspectives

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Abstract: Increased usage of multi-media mobile applications has lead to more focus on mobile cloud computing as a way to store and access electronic information. Mobile devices have been creative outlets for introducing consumers to new technological innovations, which has changed the way society relates to emerging technologies. The aim of this paper is to focus on the innovation and creativity embedded in mobile cloud computing and compare it to traditional cloud computing. This will help to predict new ways future creative processes can be embedded in technological innovations particularly in terms of the internet-of-things. A set of research propositions are discussed in this paper that link innovation and creativity to mobile cloud computing. The findings will help encourage more creative usages of technological innovations including mobile cloud computing.

Keywords: cloud computing; mobile cloud computing; technology innovations.

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1 Introduction

There has been a large growth in cloud computing as it can perform complex computing that was previously a time demanding task. This is due to cloud computing being useful as it "eliminates the need to maintain expensive computing hardware, dedicated space and software" [Hashem et al., (2015), p.98]. Part of the reason for the growth in cloud computing is due to there being an increase in the continual flow of data and information due to the use of multi-media applications. As a technological innovation cloud computing has transformed information communications technology by enabling large scale computing to occur.

Cloud computing has changed the competitiveness of the information technology industry by introducing more accessible services. Chou (2015, p.72) state that "cloud computing gained its popularity because it changed the physiognomies of the IT industry through the exercise of virtualization". This has led to more mobile device applications such as Google Apps, Instagram and Twitter transforming the way we utilise information communications technology (Shiau and Chau, 2016). The main benefits of cloud computing include better data service integration that can utilise security and virtual resources, which helps to process data that can be stored in a less costly manner.

Technological innovations in smart phones have meant more services are being offered via cloud computing (Ratten, 2007). This has meant mobile cloud computing can create synergy between wireless technologies and computing devices to enable better efficiency. Mobile cloud computing is defined as "an emerging distributed computing paradigm that aims to augment the resources of mobile devices by leveraging the resources and service of remote cloud" [Ahmed et al., (2015), p.156]. Mobile cloud computing utilises client servers but requires optimal remote resources that can facilitate a distributed computing environment (Ahmed et al., 2015). The benefits of mobile cloud computing is that it enables a dynamic interactive environment with large scale computing applications that can be accessed in a flexible format. The cloud is characterised by expedient, economical and ubiquitous resources that are useful in today's technological connected world (Ali et al., 2015). In addition, more individuals and businesses are shifting to the mobile cloud because of the scalable services that can provide better benefits.

The rest of this paper is structured as follows. Firstly, the importance of cloud computing in terms of innovativeness is discussed. This leads into a discussion of the creative uses of cloud computing technology. A set of research propositions are then stated that link cloud computing with entrepreneurship and innovation. Finally, suggestions for future research and managerial implications are stated.

2 Literature review

More consumers are utilising cloud computing to host all information technology services because they have greater access to information available on cloud computing that can be deployed depending on needs (Abbelmaboud et al., 2015). The shared resources from cloud computing enables consumers' better scalability of services with most individuals expected to rely on cloud computing for their technology services in the future (Garrison et al., 2015). This is due to cloud computing relying on external supplies of infrastructure. New market innovations can be implemented via cloud services which increase customer service but limit the need to buy updated technology services.

Cloud computing dynamically configures computing resources based on need and resource utilisation (Garrison et al., 2015). As mobile technology services rely on accessing specific computing resources, cloud computing provides access to shared resources (Ratten, 2013). This helps leverage computing resources based on storage applications that can correspond with demand (Garrison et al., 2012). As a service cloud computing offers the advantages of enabling infrastructure, platform and software (Mell and Grance, 2009). Infrastructure as a service (IaaS) means that computing resources are purchased on-demand using outsourced firms (Wang et al., 2011). This limits the

computing infrastructure that needs to be maintained independently, which may be costly to purchase and update based on new technologies (Garrison et al., 2015).

The benefit of IaaS is that the hardware, servers and storage capabilities are based on-demand and the costs of updating the technology can be shared amongst users (Mell and Grance, 2009). This increases computing networks and makes operating systems work more efficiently for cloud computing services. IaaS enables virtual computing to occur through the use of external servers and storage devices. Examples of IaaS include the Rackspace cloud servers and Amazon S3 storage services (Shiau and Chau, 2016). IaaS enables customers to control the operating systems and network components they utilise (Singh et al., 2015). Due to the need for more network capacity there has been increased adoption of IaaS because of its ability to use infrastructure for service and software requirements.

Platform as a service (Paas) is defined as "a cloud-based service where vendors provide buyers with the computing platform that allows the buyer to create software applications without the complexity of having to purchase and maintain the requisite infrastructure" [Garrison et al., (2015), p.379]. PaaS has been integral to the increase in mobile cloud computing as it helps develop new innovations. This is useful with mobile phone applications that utilise advanced web resources (Ratten, 2014). PaaS can be customised depending on the type of computing required and the availability of both financial and non-financial resources. Individuals with non-technological expertise can test their new applications on PaaS lowering their administrative time (Wang et al., 2011). This has been helpful with more start-ups relying on ideas and innovation rather than high costs associated with managing computer servers and learning how to use computing platforms (Garrison et al., 2015).

PaaS utilises databases and other software to act as the intermediary between user and technology platform. Examples of PaaS include Microsoft's Azure services platform and sales forces force.com (Shiau and Chau, 2016). In PaaS, consumers control their configuration requirements which enable better management of information systems needs (Singh et al., 2015). Cloud computing is the most dominant utility computing solution that has emerged as a game changer for the way information is stored and accessed. PaaS includes the use of web servers and computing programs to conduct services that need specialised programs to use. PaaS enables access to online resources that are needed to build applications. These include the hosting of computing resources that can help with the design of technology services.

Software as a service (SaaS) means that software is purchased on demand or via a subscription basis (Garrison et al., 2015). This helps reduce unnecessary purchases of software that might be rarely needed. SaaS is useful because it enables access to updates that may be costly to acquire. SaaS suggests that users do not have to install any software, which can be sometimes difficult to acquire (Armbrust et al., 2009). SaaS enables better communication applications for e-mail and networking sites. This helps people to access software when needed rather than buying specialised equipment.

There has been an increased focus on resource orchestration to exploit cloud computing usages. The deployment of cloud computing services has required the coordination and knowledge about how best to use resources. This helps ensure cloud computing is delivered in a seamless way that makes it easy for consumers. The management of cloud resources is important as people have different functional specifications. This is difficult when there are proprietary concepts that are standardised for all consumers based on mass market appeal (Ferreira et al., 2016b). Cloud computing

has service-orientated architecture that enables minimal management effort. This autonomic style of computing provides for more convenient access to a pool of configurable resources such as networks and programs.

Cloud services can be delivered via hybrid, private or public forms (Garrison et al., 2015). Hybrid cloud services enable that combined use of private and public cloud technology. This is useful when large computing servers are available for public usage via public clouds but people want the privacy of private cloud providers. Most public cloud services are free so it also enables people to access these services when they are limited financially by the services provided by private cloud providers. Private cloud services are provided on an independent basis that charge for the use of their resources. The benefits of private cloud services are due to privacy and restricted access to client data and information. Due to corporate espionage and the importance of maintaining intellectual property private cloud services are popular particularly for financial service companies. There is also the benefit of control over systems that is linked to security being an issue for many cloud computing services (Garrison et al., 2015). Private cloud computing can also tailor services based on systems performance that might not be possible using public cloud services that usually offer the same services to everyone. Public cloud services are available to anyone as they are freely available (Mell and Grance, 2009). Some public cloud services have better technological capabilities depending on where the servers are geographically located. The benefits of public cloud services are that they operate in a shared-service environment maintained by a service provider (Garrison et al., 2015). Public clouds have their own policies and uses that enable the general public to access their services. Private clouds are normally developed for a specific business or purpose and have better security. There are some challenges to cloud computing such as the lack of freedom in directly accessing computing servers that may make it difficult with security concerns.

3 Mobile cloud computing

Mobile cloud computing is defined as "an infrastructure in which different mobile devices (i.e., smart phones, tablets, and laptops) can access various computing resources anytime and anywhere" [Arpaci, (2016), p.151]. The migration to mobile cloud computing is facilitated by better collaboration amongst user and technology providers that increases agility and process efficiency. Examples of mobile cloud computing storage that are growing in usage are Dropbox, iCloud and Google drive (Arpaci, 2016). As more people have mobile devices the benefits of mobile cloud computing is in the ability to synchronise devices. This collaboration across computing devices has been referred to as the internet of things and enables better usability. More people are using this connectivity to share and manage information in a seamless manner that increases efficiency.

There are two major benefits of mobile cloud computing: service and technological (Garrison et al., 2015). Mobile cloud computing enables more simplified services that have access to infinite resources and collaborative support (Shiau and Chau, 2016). This is useful in offloading storage and processing to cloud servers who can handle large amounts of data (Gai et al., 2016). Due to the increased interest in green computing there has been more attention placed on mobile cloud computing as a way to be sustainable through its usage of technological innovation. There are still some challenges in using

mobile cloud computing due to weak or unavailability of wireless communication in some areas.

Mobile cloud computing utilises the internet, computing and cloud in a flexible format that can be accessed from multiple geographic locations (Gai et al., 2016). The increased advances in mobile communications have meant that there has been more integration with cloud computing devices. The advantage of mobile cloud computing is that it can facilitate technical complexities that previously would be hard to do without access to high performance computing services. Innovative usages of mobile cloud computing include making data storage and access more energy efficient.

Mobile users of cloud computing services such as software and infrastructure rely on the speed of wireless technology. This is due to there being an unprecedented increase in cloud computing services due to the increase in the knowledge economy (Stantchev et al., 2015). The increased usage of online services and communications has led to a need to access data in a mobile format. In addition, more interaction between consumers and businesses on online purchases has meant cloud computing technology has been utilised to keep up to date with demand.

Some industries such as education and retail have been using cloud computing for a longer time period due to their need to store large amounts of data (Al-Hudhaif and Alkubeyyer, 2011). This is due to there being better information visibility provided by cloud computing due to the faster and easier deployment of information (Singh et al., 2015). Cloud computing is delivered via service orientated architecture that utilises innovative information technology (Singh et al., 2015). Therefore, it enables people to have secure access to remote information technology resources (Sharma et al., 2016). This has been popular for producing a way to add technological capacity without investing large financial resources. This is helpful in adding to existing services by limiting time taken to license new software and increase communication infrastructure. Therefore, this leads to the first proposition:

Research Proposition 1: Mobile cloud computing compared to traditional cloud computing has more capacity to be innovative and creative.

4 Innovation

Knowledge sharing is crucial to establishing a creative process that extends current thinking and organisational practices (Ferreira et al., 2016a). More people are willing to share knowledge when there are good communication and cohesion in a group (Lee et al., 2015). Research by Sawng et al. (2006) suggests that greater levels of team cohesiveness will lead to more knowledge being shared. This means that knowledge sharing occurs when a person spreads information to others about events, occurrences and processes (Lee et al., 2015). The type of knowledge shared will depend on the willingness of people to engage in conversation and impart their intellectual capital to others. This enables individuals to have both intrinsic and external motivations about whether they are able to share knowledge (Wasko and Faraj, 2005). Some workplaces have designated knowledge-based systems to encourage information to be exchanged based on work needs (De Nisi et al., 2003).

Both innovation and creativity have been acknowledged as being amongst the most critical resources for an organisation (Sigala and Chalkiti, 2015). Sigala and Chalkiti

(2015, p.114) states that the difference between innovation and creativity is "innovation is often defined as the implementation of ideas, whereas creativity is related to the production of ideas". This means that normally having creativity is important for innovation to develop. Furthermore, innovation and creativity are linked because of their connection in terms of learning and knowledge dissemination (Teece, 2007). This linkage is important in determining whether innovation can be copied by other entities. Some knowledge that is integrated into innovation is of a tacit and intangible nature making it hard to transfer or substitute (Sigala and Chalkiti, 2015). Knowledge that is used for creative purposes enables more revitalisation and increased competitiveness. This is important in encouraging better flexibility for both individuals and organisations, which is important in the changing business environment. An individual's creative nature is embedded in their social relationships and environment (Aubke, 2013).

There are concerns over the use of cloud computing particularly in terms of continuity and unauthorised access (Paquette et al., 2010). These concerns mean that further technological innovations are required to enhance security and safety mechanisms associated with cloud computing. The use of cloud computing services is influenced by the perception of data confidentiality as privacy is important for most people and organisations. The location of some cloud computing services has given rise to people concerned about how laws and regulations affect the access to electronic information (Arpaci, 2016). This has led to security challenges from cloud computing including the identity management and trust systems (Rong et al., 2013). As there is free data movement by users of cloud computing the monitoring system is important. Some businesses see security, convenience and cost reduction being the most relevant factors for the adoption of cloud computing (Gupta et al., 2013). In addition, the readiness of a business to utilise cloud computing in a secure manner is important. Most cloud computing services are utilised to store data rather than as a source of shared information due to issues about trust (Gupta et al., 2013). Trust in cloud computing can take a variety of forms such as type of information shared, data protection and location of servers (Duranti and Rogers, 2012). Sultan (2010) suggested that cloud computing has environmental benefits due to less use of power. This means that cloud computing enables people to share their usage of electricity. Mobile cloud computing storage services are often provided free so people can store and access information (Arpaci, 2016). Therefore, the next proposition is:

Research Proposition 2: More innovativeness of mobile cloud computing will lead to higher expectations of consumers around technological improvements.

5 Creativity

Creativity is a social process as the interaction with people helps to build ideas (Hemphala and Magnusson, 2012). By communicating with others in a social setting it facilitates feedback and iteration. Some of the knowledge needed to be creative stems from the accessibility to diverse viewpoints (Sigala and Chalkiti, 2015). This is due to ideas emerging once they have been dispersed amongst a pool of individuals who can give opinions and provide feedback. Some social structures are more conducive to creativity due to there being a more flexible work environment. This helps build collaborative networking that focuses on ways to be creative (Perry-Smith, 2006).

Creativity should be both novel and potentially useful for it to have an effect on innovation (Amabile, 1988). This means that creativity involves producing new ideas that impact on procedures, products, practices or services (Sigala and Chalkiki, 2015).

Often creativity is associated with problem solving behaviour because it helps to solve limitations in current behaviour. In order for creativity to impact innovation it should introduce radical or path breaking ideas into current business practices. Personal characteristics such as entrepreneurial orientation and motivational level can affect creativity. Creativity can be fostered through informal networks that are based on mutual trust. The knowledge needed for creativity to develop can be enhanced when there is reciprocity amongst members of a social network regarding communication and ideas. Research by Ratten (2013) stated that new ways of behaving and thinking are developed from social networks. This helps increase creativity as knowledge issues are shared and adapted depending on the social environment. Creative activity can depend on the collective sharing of knowledge and practices. More interest has been placed on creative thinking due to its impact on performance.

The creative environment helps to produce an atmosphere conducive to innovation. This means that collaboration, learning and participation are integral to producing creativity (Wang and Miao, 2015). Wang and Miao (2015, p.2377) states that "innovative culture values flexibility, shows willingness to find and implement novel solutions, appreciates unconventional ideas and ritualizes innovation events". For creativity to be successful there needs to be adequate time and resources devoted to introducing new ideas (Hurley and Hult, 1998).

Creative interactions can take place via verbal and non-verbal communication depending on the circumstances (Biasutti, 2015). The way creativity is communicated can be via collaboration, cooperation or instruction (Seddon and Biasutti, 2009). Collaboration means individuals come together with the purpose of exchanging ideas for mutual gain. Cooperation occurs when an individual seeks the help of another to obtain knowledge for a certain purpose. Instruction involves telling an individual how to obtain information that can lead to the acquisition of knowledge. Communication can occur via horizontal or vertical interactions (Burnard and Younker, 2008).

Creativity centres on novelty and meaningfulness when applied in a business setting (Im et al., 2015). Rubera et al. (2010) found that consumer's assessment of creativity is influenced by their knowledge of a product. Consumers tend to be interested in the benefits of a product whilst managers consider product features more important (Im et al., 2015). Sometimes consumers are confused by novel features from creative products that take time for them to digest (Im et al., 2015). Creative services require more time in terms of learning about the new product attributes that are different to other products. There is a psychological benefit associated with creativity as it requires people to think in different ways and learn new behaviours.

Mobile cloud computing has gone further by providing real time access to services in a flexible geographical setting that limits the cost of buying high computing devices. More computing in the future will utilise mobile services particularly in terms of big data technologies (Agrawal et al., 2011). Most research about mobile cloud computing is at a nascent stage due to the recent advancement of information communications technology. There can be greater customisation of technology services using cloud computing due to the usage of data analytics. This helps encourage more reliability for the usage of cloud computing services that has been in conjunction with more global publicity surrounding this technological innovation. Most mobile cloud computing services are utilised by

private firms due to their willingness to invest in this new technology (Kundra, 2010). Therefore, this leads to the next proposition:

Research Proposition 3: Increased focus on creativity of mobile cloud computing services will lead to increased adoption rates.

6 Managerial implications

Managers need to recognise that cloud computing presents an innovative and creative technological innovation and need to review research about cloud computing services to see how its innovativeness may apply to their organisation. This will enable organisations to utilise cloud computing services in a more creative manner and increase productivity. This will help organisations overcome their reluctance to learn about cloud computing services by highlighting the positive aspects of the technological innovation. Increased management support of mobile cloud computing would increase its usage by organisations particularly those needing to access information from multiple geographic locations. Organisations need to have policy guidelines about the usage of mobile cloud computing to ensure proper usage. This is important as trade sensitive information may be accidently shared when accessed inappropriately on mobile cloud computing devices.

Innovativeness and creativity are influential determinants for the usage of mobile cloud computing. This implies that enhanced innovative capabilities of mobile cloud computing are critical to the success of the service. More investment in innovations about mobile cloud computing will be conducted when organisations have trust and faith in the security of their electronic information. There has been a large increase in the usage of mobile cloud services due to their increased computing power. Organisations that are working on projects with multiple people in different geographic regions can utilise mobile cloud computing as a time efficient way to conduct business.

7 Future research

The practical and quickly changing nature of cloud computing means it has transformed the way information technology is integrated into society. Despite the widespread interest in cloud computing because of its practical nature there are still many research questions that need to be addressed. The first issue is the need for more research about mobile cloud computing from an interdisciplinary perspective that encompasses sociological avenues to technology innovation. This is important as it can help forecast future needs of mobile cloud computing in terms of emerging technological innovations. Research activities need to focus on projecting how new technology such as augmented reality will be integrated into cloud services. This may include how big data and data analytics will transform mobile cloud computing so that it becomes more interactive and acts like a predictor of future behaviour.

The second issue involves more research focusing on understanding the role of relational assets in mobile cloud computing adoption. This includes examining how the security and privacy of users affects the computing capability on mobile cloud servers. This would strengthen our understanding of how mobile cloud computing is integrating with other technological devices. This would require significant research that needs more

examination about how mobile cloud computing is being creative and innovative. The innovations of mobile cloud computing can be a way to differentiate technology services in the marketplace. This means that there are a number of issues that need to be taken into account for future research around mobile cloud computing. Future studies need to investigate if mobile cloud computing is more creative than traditional cloud computing to see how the internet-of-things is changing technological innovations. In addition, it may be helpful to include longitudinal data about the key factors affecting the change to mobile cloud computing. This would enable an analysis of innovation in mobile cloud computing and to see how future innovations will change the technology. Whilst this paper contributes to a more holistic understanding about creativity and innovativeness in mobile cloud computing, future studies can extend this research by addressing the emerging technological innovations.

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