Assimilation of the Cloud: Report on the Benefits and Challenges of Adopting Cloud Technology

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Executive Summary

While it is widely acknowledged that cloud computing has the potential to transform a large part of the IT industry, issues surrounding the adoption of cloud computing have received relatively little attention. What research has been conducted has tended to focus on technical issues and is based on a rather simplistic binary view of adoption – either the technology has been adopted or it has not. This study goes beyond a binary view of adoption and instead examines the more complex nature of cloud computing assimilation. It examines challenges to (i) acceptance - the extent to which an organisation's members are committed to the adoption, (ii) routinisation - the extent to which the use of cloud becomes a normal activity, and (iii) infusion - the extent to which its use is extensive, integrated and emergent. Drawing on a field study of cloud assimilation across ten organisations, this study will contribute to the existing cloud technologies literature that does not address the complex and multi-faceted nature of adoption. Secondly, it will provide an insight into cloud computing adoption by focusing on the benefits and challenges associated with implementation in organisations.

Keywords: Cloud Computing, Adoption, Benefits, Challenges, Field Study

1. INTRODUCTION

The rapid emergence, prevalence and potential impact of cloud computing has sparked a significant amount of interest amongst IS and IT industry and research. In wide ranging surveys of CTOs worldwide, cloud computing first appeared on the list of "Key Technology Applications and Investments" at 17th in 2009, but jumped to 2nd place

when the same survey was carried out a year later (Luftman and Zadeh, 2011). Despite its marked youth as a topic of research, Armbrust et al. (2009) describe cloud computing as being the "new-term for the long-held dream of computing as a utility". The concept of cloud computing is generally regarded as the evolution or at least a culmination of previous theories such as grid computing, utility computing and cluster computing (Vouk, 2008; Iyer & Henderson, 2010; Yang and Tate, 2009; Foster et al., 2008). However, there is currently no single, universally accepted definition of the term "cloud computing" (Foster et al. 2008; Vouk 2008; Yang & Tate 2009; Iyer & Henderson 2010; Weinhardt et al. 2009; Foster et al. 2008). From a review of the literature it is clear that many definitions exist (e.g. Armbrust, 2009; Motahari-Nezhad et al, 2009, Mell and Grance, 2011), however, the term is vague, polymorphous and multi-dimensional, and is often interpreted and applied inconsistently in the literature (Leimeister, 2010). The US National Institute of Standards and Technology (NIST) has published a working definition (Mell and Grance, 2011) that is often cited and viewed as one of the more articulate, clear yet comprehensive classifications of cloud computing, and as Sriram & Khajeh-Hosseini (2010) state, has "captured the commonly agreed aspects of cloud computing". This definition, which will be the one adopted in this study, describes cloud computing using:

i) Five characteristics: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service.
ii) Four deployment models: private clouds, community clouds, public clouds, and hybrid clouds.
iii) Three service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

Reports of the size and value of the cloud computing services market vary, but despite the rapid emergence and ubiquity of cloud computing, empirical research on adoption of cloud services is quite limited. While some research and industry efforts seek to take advantage of these markets, and identify potential challenges and solutions affecting adoption, these efforts have been largely dedicated to addressing technical problems (Khajeh-Hosseini, 2010; Leimeister et al, 2010). Additionally, the perceived benefits and challenges of cloud computing lacks strong empirical validation, as despite a small

amount of research (e.g. Iyer and Henderson (2010)), the body of knowledge is comprised of position papers (e.g. Armbrust et al., 2009) and relies heavily on anecdotal evidence found mainly in white papers, web articles, technical reports and practitioner papers Brohi and Bamiah, 2011; Forbes, 2011; Guilbert, 2008; Channel Insider, 2010; Dialogic, 2010; Farrell, 2010 Goodburn and Hill, 2010; Geelan et al., 2008. Furthermore, as discussed below, the adoption of any innovation is not binary, but rather a staggered, multi-faceted and often highly complex phenomenon. No research to date has studied the adoption of cloud technology from this perspective. This study goes beyond viewing adoption in a binary manner and instead examines the more complex nature of cloud computing adoption, drawing on assimilation theory (e.g. Gallivan, 2001; Zmud, 1990; Saga and Zmud, 1994). Thus, the objectives of this paper are therefore to (a) examine the benefits of cloud technology adoption and (b) examine the challenges to (i) acceptance, (ii) routinisation and (iii) infusion of cloud technology

We begin by describing the theoretical framework that guides the research objective (Section 2). This is followed by a discussion of the field study (Section 3) and the findings (Section 4). Finally we conclude by discussing the implications of our work (Section 5).

2. THEORETICAL BACKGROUND

The theory of innovation, and in particular information systems innovation, suggests that adoption or assimilation of an innovation is often far from simple. Meyer and Goes (1988) define assimilation as "an organisational process set in motion when individual organisation members first hear of an innovation's development". Assimilation is rarely binary however, and when one examines the introduction or non-introduction of a technology for example, there are often many different points in time where that assimilation may intensify or deteriorate (Gallivan, 2001; Zmud, 1990; Saga and Zmud, 1994). Very often the cause for this success or failure may be very subtle. An assimilation stage describes how deeply an adopted innovation penetrates the adopting unit (company, group or individuals) (Gallivan, 2001). Many frameworks to understand the various stages of innovation assimilation have been proposed, along with many others to study the factors and events that influence them (e.g. Zmud, 1990; Saga and Zmud, 1994).

Amongst the most commonly cited is that of Gallivan (2001) who proposes a six-staged model (Table 1), based on the work of Cooper and Zmud (1990) and Saga and Zmud (1994).

Stage	**Description**
Initiation	A match is identified between an innovation and its intended application environment.
Adoption	The decision is made to adopt the innovation.
Adaptation	The innovation is developed, installed and maintained, and organisational members are trained to use the innovation.
Acceptance	Members are committed to using the innovation.
Routinisation	Usage of the innovation is encouraged as a normal activity in the organisation; the innovation is no longer defined as something out of the ordinary.
Infusion	The innovation is used in a comprehensive and sophisticated manner. Infusion is measured in three different ways: • *Extensive use*: using more features of the innovation; • *Integrative use*: using the innovation to create new workflow linkages among tasks; • *Emergent use*: using the innovation to perform tasks not in the pre-conceived scope.

Table 1: Stages of Innovation Assimilation (Gallivan, 2001)

When studying assimilation stages, one must consider the extent to which we may assume that an organisation, group or individual's progression through the assimilation stages is sequential. For example, Cooper and Zmud (1990) imply an "unfreeze-refreeze" sequential model of stages by associating initiation with Lewin's (1952) 'unfreezing' stage, adoption and adaptation with the 'change' stage, and acceptance, routinisation and infusion with the 'refreezing' stage. However, models such as Lewin (1952), which assume sequential assimilation, have been criticised. Firstly, they have been criticised for failing to account for feedback, or for the situated nature of actions (Orlikowski and Hofman, 1997; Palmer and Dunford, 1997). Secondly, empirical research has demonstrated a non-linear progession through stages (Gallivan, 2001; Rosch, 2002). Additionally, Cooper and Zmud (1990) claim the sequential model may be more appropriate for technologies that are borrowed or adapted rather than custom made.

Gallivan's six-stage assimilation framework has been used in IS studies that examine agile practice adoption in information systems development (e.g. Wang et al,

2012; Pikkarainen et al, 2007). We also believe it would also be an appropriate lens with which to examine challenges to adoption of cloud computing.

3. The Field Study

The objectives of this study are to examine the benefits of cloud technology adoption and also the challenges to (i) acceptance, (ii) routinisation and (iii) infusion of cloud technology. The study was categorised as exploratory due to the scarcity of empirical work in the area of cloud computing adoption. The researchers decided that a field study would be appropriate as it would facilitate the collection of data from a larger number of informants.

3.1 Selection of participants

For this study, we decided to use the perspectives of two different groups - (i) service providers who we believed could provide a better understanding of benefits and challenges of adopting cloud computing, based on their own interaction with, and feedback from clients, and (ii) organisations that have adopted cloud computing solutions who could provide us with information regarding benefits of adoption and potential challenges to acceptance, routinisation or infusion. A description of the cloud initiatives in each firm is outlined in Table 2.

	Description	Industry	Size of Co.
SERVICE PROVIDERS			
Co1	Management consultancy firm advising on environmental health and safety and information security management systems.	Consulting (SaaS offering)	12
Co2	Network and IT infrastructure provider and consultancy on IT managed services, networking and communication solutions.	IT and Networking Solutions (IaaS offering)	5500
Co3	Provides tools to evaluate new suppliers, cope with tender responses and implement best practice procurement processes.	Procurement software (SaaS offering)	21
Co4	An business technology consultancy that specialises in building solutions to help clients gain better value faster from investments in Microsoft technologies.	Business Technology Consultants (SaaS offering)	30
Co5	Provider of SaaS, IaaS and PaaS infrastructure and business offerings that span from handheld devices to supercomputer installations.	Information Technology (SaaS, IaaS, PaaS)	4000
Co6	Founded in 2010, this company specialise in providing cloud IT solutions and infrastructure.	Consulting (SaaS, IaaS)	10
CUSTOMERS			
Co7	A European based business unit of a larger multinational organization. Cloud software used for project management and reporting/communication across all 17 projects within business unit.	Consulting	112 in business unit
Co8	The company has adopted Co1 e-sourcing system in their procurement environment.	Public Sector Body (Food and Drink)	200
Co9	Public sector client of Co1. The company offer a number of clinical and diagnostic services to hospitals throughout the country	Public Sector Body (Health)	630
Co10	A customer of Co2, specializing in the delivery of customised and integrated GPS vehicle tracking systems and fleet management solutions for leading businesses in over 30 countries worldwide.	Electronics	16
Co11	A customer of Co2, this company provides modern, high volume software applications for middle office, back office and corporate actions automatioin within the global financial markets industry	Global Securities Processing	250
Co12	Engineering and construction project management company, also a customer of Co6	Engineering	50

Table 2: Description of Cloud Initiatives in each Company

4. FINDINGS AND ANALYSIS

4.1 Benefits of Cloud Computing

The benefits of adopting cloud computing, as perceived by study participants, are outlined in Table 3 and discussed in the following sub-sections.

Benefits of Cloud Computing	Description
Time Savings	Fast turnaround in terms of implementation; drives down administrative time
Cost Reduction	Reduces capital expenditure - lower hardware costs, license, maintenance, back-up and overhead costs (e.g. electricity, air-conditioning etc.)
Internal Process Improvement	Streamlines internal processes – can deploy environments for development, test or support functions instantly from templates
Increased Collaboration and Openness	Creates team spirit and involvement. More information is shared and employees are not working in silos on their own
Increased Scalability	Can provide services ad hoc on the scale that is needed any particular time
More Traceable and Transparent Audit Trail	Full documentation available and traceability from an audit point of view

Table 3: Benefits of Cloud Computing

4.1.1 Time Savings

Faster implementation time is viewed as one benefit of cloud computing (Forbes, 2011; Goodburn and Hill, 2010), something that was also evident in this study. Study participants in Companies 8 and 9 who have adopted Company 3's e-sourcing system explained that the turnaround time in terms of implementing the system was viewed as extremely effective. These two companies were up and running on the system in 24-hours, which is beneficial when one considers that traditional IT systems implementation can take up to six-months. Additionally, there are no migration issues to worry about in implementing the system as, *"it is all cloud-based, so all you need to do is send them logins"* (CEO, Co.3). The Purchasing Manager at Co.9 also described how they were getting inundated with the amount of procurement they had to manage centrally and so the main reason for adopting a cloud based procurement system was to save time. The organisation was able to cut down on their administrative time by 65% as they now have

supplier online questionnaires for national and European tenders, which they can update or change as required. As the Purchasing Manager at Co.9 further added, *"it addresses the administrative elements which are resource hungry on organisations"*. Using Co.3 e-sourcing system, both study participants in Co8 and Co9 explained that they could eliminate the time spent searching, calling and qualifying potential suppliers and reduce the time spent with sales representatives. Additionally, having all the information stored centrally meant there was no need 'to go digging' through files for supplier correspondence.

4.1.2 Cost Reduction

The lower costs associated with cloud computing has been cited as a key benefit in the existing literature (see Farrell, 2010 Goodburn and Hill, 2010 and Geelan et al. 2008). The fact that users can pay-as-they-go, for what they need, rather than paying on an ongoing basis for excess capacity was something that was viewed as extremely beneficial by the majority of the study participants. Additionally, the move away from perpetual capital expenditure to operational expenditure was also cited as a cost benefit. For example, study participants in Co.11 explained how they were able to significantly reduce hardware costs. This company relies heavily on virtualisation to leverage the most out of their hardware. However, by adopting a cloud service, they found they were able to save money on servers, which cost in the region of €12,000-€13,000. Additionally, companies saves on license costs, maintenance costs, back-up costs of tapes, electricity bills and air-conditioning bills. As one manager explained, "*by putting some of our services on the cloud, we were able to leverage this data centre infrastructure without going to the added expense of upgrading our own data centre here"*.

4.1.3 Internal Process Improvement

The majority of the study participants also revealed that there is much value in the ability to streamline and improve internal processes as a result of cloud adoption. The IT manager at Co11 explained that with cloud adoption, they can instantly deploy new versions of applications and templates for test functions, development functions and support functions "*in a matter of minutes"* compared the "*three to four days*" prior to

cloud adoption. Similarly, the Executive Director at Co.3 explained that they build cloud-based templates for common spend areas, which customers find very valuable. Alternatively, their customers can choose to design their own templates if they wish, which again is viewed as something beneficial.

4.1.4 Increased Collaboration and Openness

The adoption of cloud was also found to enable collaboration and openness across organisational boundaries . All study participants explained that the adoption of cloud has resulted in more collaboration along their supply chain, improved team engagement and communication inside firms, more learning and information sharing. For example, several study partcipants described how it was crucial to actively engage with partners and customers in various cloud efforts and explained how they welcomed feedback from customers, as well as new ideas on how to improve their system. In terms of more team engagement and collaboration, the Purchasing Manager at Co.9 explained that they have a type of 'enterprise facebook' in place where,

> *"we can all go in and just see what's going on. Whereas before I might be doing something and I might not think to tell people. But they could literally go in now and see for themselves. When people feel that they are engaged with things and they know what's going on…like from a work point of view…you know, they feel they are part of something"*.

With the adoption of cloud computing, collaboration technologies are tools that enable employees in companies to operate on a whole new level. For example, the IT manager in Co11 explained how they run their internal operations regarding staff and projects via a wiki. This wiki includes user profiles and simple designed interface and employees can update their work and schedules whenever they want. Nonetheless, one manager in Co.4 argued that while cloud computing enables collaboration *"internally within organisations you do not need cloud to knowledge share, to have wikis, to have shared document bases. You know, Sharepoint, for example, as a product has been doing that for ten years"*. For this study participant, encouraging employees to use the collaboration technologies on a wider scale was key to effective communications and information sharing. Similarly, the CEO in Co.1 explained that while he was very happy with their cloud system and

believed it promoted collaboration in client organisations, it is "*still a database to me, not a collaborative tool*". However, going forward, this company wants to make the system more intuitive to user needs so that it will become an '*internal facebook*' of sorts.

Cloud computing also has the potential to offer different levels of business-to-business collaboration or community cloud-based models. For instance, both managers in Co.8 and Co.9 explained that migrating from a private to a community cloud-based model would enable public sector bodies to collaborate on different things and drive down costs. However, risks have to be measured, the impact likelihood and how to mitigate against these risks, should they arise. Once people are educated on how best to govern and manage the process, both managers revealed that public sector cloud computing would be more rapidly adopted.

4.1.5 Increased Scalability

Scalability, another cited benefit of cloud computing (see: Forbes, 2011; Armbrust et al., 2009; Iyer and Henderson, 2010), was viewed by most study participants as being extremely valuable with the adoption of cloud solutions. For example, the managers in Co.11 explained that they had gone through a large growth pattern in the last year and were continually absorbing the resources available to them in-house. This Product Manager further elaborated,

> *"the trouble with that is we would find that every few months we would literally have to go and buy one or two large capacity servers, which has quite an impact on our finances. Now when moving to a cloud infrastructure we have this sort of elastic resourcing in which we can provide services ad hoc on the scale that we need for that particular time. So realistically being able to have an infinite base of resources that we can call on at any particular time is probably the major value that we get out of the cloud solution"*

Likewise, the manager in Co.4 agreed that the cloud gives companies scalability insofar that they can just start out with one server and *"then if it proves to be popular you can keep going and going and going"*.

4.1.6 Traceable and Transparent Audit Trail

According to researchers such as Armbrust, 2009 and Iyer and Henderson (2010), cloud capabilities such as traceability enables the usage of every information service within an organisation to be tracked. The ability to trace the history, location, or application of an item through recorded documentation is vital for ensuring that companies conform with internal and external constraints. Internally, compliance rules may require companies to audit the use of their data from other parts of the world (Iyer and Henderson, 2010). Many of the study participants need to show an audit trail of where data is stored for regulatory and legal purposes. Thus, the ability of vendors to provide a traceable and transparent audit trail demonstrates compliance and data integrity. As the Executive Director in Co.3 pointed out *"transparency and integrity are very important with public and private sector bodies…for both sectors we need to demonstrate that we are doing things properly"*. Study participants Co.8, Co.9 and Co.12 further explained that with their respective cloud systems, they have full documentation and traceability from an audit point of view, which is extremely beneficial.

4.2 Challenges to Cloud Computing Assimilation

The study revealed many challenges around cloud computing that are further discussed in the following subsections. As is shown in Table 4, each of these challenges impact various stages of assimilation.

Challenges of Cloud Computing	**Obstacle to Acceptance (OA)**	**Obstacle to Routinisation (OR)**	**Obstacle to Infusion (OF)**
Perceptions of the Term 'Cloud'	✔ Co.4, Co. 6, Co.10, Co.1, Co.9, Co.2, Co.5)		
Convincing IS/IT Management	✔ (Co.4. Co. 6, Co.10, Co.1, Co.9, Co.8, Co.7, Co.5, Co.3)	✔ (Co.4, Co.7, Co.8, Co.9)	
Persuading employees to use cloud systems			✔ (Co.1, Co.3, Co.9, Co.8, Co.5, Co.11, Co.4)
Security and privacy issues	✔ (All study participants)		✔ (Co.10, Co.9, Co.8, Co.4, Co.12)
Integration	✔ (Co.3)		

Bandwidth and Connectivity	✔ (Co.10, Co.11)	✔ (Co.10, Co.11)	✔ (Co.10, Co.11)

Table 5: Challenges of Cloud Computing by Assimilation Level

4.2.1 Perceptions of the Term 'Cloud'

Interestingly, the study revealed that a significant barrier to cloud acceptance is people's perception of the word 'cloud'. Several of the study participants (e.g. Co.5, Co.1, Co.4) mentioned that while people are comfortable 'banking online, passing around hard drives and USB keys or leaving laptops on trains', once the word 'cloud' is mentioned, this evokes a negative reaction (OA). As one study participant pointed out, *you know sometimes you would wonder if the word 'cloud' hadn't been around, would we be better off?"* (CEO, Co.1) while another admitted that, *"the word cloud scares some people"* (Practice Director, Co.4). Several other study participants (e.g. Co.10, Co.5) believed that while the term became fashionable rapidly, it became tainted just as quickly. As a result, when dealing with customers, service providers such as Co.2 and Co.4 purposely tend not to talk about 'cloud' per se, but rather a new service delivery model.

4.2.2 Convincing IS/IT Management

In identifying challenges to overall adoption and acceptance of cloud computing, the study revealed that one such challenge was reassuring and convincing IS/IT managers to move through the various stages of cloud computing assimilation. Regarding initial acceptance, it was clear that this was an issue. For example, the project manager at Co.10 explained that IS/IT managers like to be in control of data and services, thus there is a perception among them that 'if it ain't broke, don't fix it' in terms of cloud acceptance (OA). Similarly, the CEO at Co.1 pointed out, "*IT managers in a company tend to be very protective and in some ways you know over-protective but there isn't an ounce that you can do about it"* (OA). In Co.7, some of the managers refused to adopt the technologies available in any form, and even refused to participate in a pilot phase. This also caused issues in terms of routinisation, in that, while over 90% of the 112 members of Co.7 routinely used the cloud features as planned, *"it was inevitably the senior managers that did not"* (Developer). Also, there were inconsistencies and duplication in effort across the projects, caused by the fact that some mangers instructed their staff to

use certain cloud based tools and others did not (OR). Similarly, the Practice Director at Co.4 explained that *"there's an element of 'turkeys voting for Christmas' in relation to this, in that the IT departments, especially the guys who are actually in charge of the physical boxes- they don't like this idea of cloud"* (OA).

According to several study participants, the massive transition to cloud may result in many IT managers' jobs becoming obsolete in a few years. Nonetheless, the majority of study participants believed that there are still tremendous opportunities for IS/IT managers, if they adjust their skills and capabilities to suit the cloud landscape. The Practice Director at Co.4 further explained that the way they try to sell cloud computing to IT managers, is to be as inclusive as possible. He further elaborated, "*so we sell to them by saying, you know instead of administering the kit that's physically within your four walls, you are just now being the administrator of something that exists somewhere else. But you are still an important part of the picture. You still need to be an administrator on the system, just not locally"*.

4.2.3 Persuading Staff to Accept and Employ Cloud Systems

While convincing IT managers is one potential barrier to cloud acceptance and routinisation, the analysis revealed that another significant barrier to actual infusion of cloud computing is staff who resist or are uncertain as to how to use the cloud system. The Procurements Officer at Co.8 explained that for somebody working in procurement, it's very straightforward for them using the Co.3 system but for the non-procurement people, it can be quite challenging (OF). Presently Co.8 have nine procurement staff using the system but eventually want to increase usage to thirty employees in the Dublin offices and also staff based in their overseas offices. Similarly, there are seven people in Co.9 using the system, but again they are investigating how best to roll it out across the organisation. The procurement manager at Co.8 pointed out that *"some training and handholding"* is necessary at the start while the Purchasing Manager at Co.9 argued that, *"give it six months or a year, it definitely is going to show true value to employees in what it's costing us and what it will deliver"*. In persuading employees to use cloud systems, study participants in Co.3 and Co.1 believed that it is important to build a system that is intuitive to peoples needs. The Project Manager at Co.10 explained that

while the underlying workflow engines of their sysem are quite rigorous, the system still needs more work in terms of user-related features, i.e. how employees consume or interact with the workflow in terms of retrieving summarised data. However, this takes time, especially for small and medium sized enterprises that lack the resources to recruit developers who can work on different functions of the system.

4.2.4 Security and Privacy Issues

Similar to the existing literature, issues round security and privacy were found to be a major concern among all study participants to cloud acceptance and infusion. For example, the Purchasing Manager at Co.9 explained that in accepting cloud computing, *"there are issues for cloud computing in the public sector. Who owns the information? Where is it stored? These types of things"*(OA). Similarly, the project manager in Co.10 stressed that a company's data can be its 'baby'. Thus, regular meetings take place prior to cloud adoption with service providers to ensure that proper data protection or governance procedures are in place and that systems are implemented in a risk free environment. To overcome security and privacy concerns with cloud acceptance, the providers in the study, e.g. Co.3 and Co.2, explained that they have 'locked-down processes' on data confidentiality and information repositories are outsourced to secure datacentres. Interestingly, the Executive Director at Co.3 pointed out that the biggest risk to security is staff in an organisation, "*people dealing with a favourite supplier all the time, telling their friends about them and not bothering to go beyond three quotes"*. Similarly, the Senior Manager at Co.5 argued that, *"our generation didn't worry about CD disks or didn't worry about stolen laptops and things like that..you know if you build a bigger safe, there is always going to be somebody who wants to crack the safe. So you will always have security and you will always have that problem"*. The Practice Director at Co.4 also pointed out that while security is and will continue to be a concern to cloud acceptance and infusion, (OA, OF) *"clients need to examine exactly what they are doing now to see if it is any more secure that what vendors are proposing in relation to cloud technologies. I guarantee it's not"*. Additionally, both managers in Co.10 and Co.4 advised that for those firms thinking about implementing a cloud system, but not entirely sure of it should start with a lightweight application or something that is non-mission

critical, "*so in other words if it did actually crash for a week, would your business crumble? And if the answer is no, then listen, why don't we just see? Let's put that on the cloud, we will show you the benefits of it. We will show you what it's all about. And if that goes well, then we do a second one. And then all of a sudden you know the issues just go away"* (Practice Director, Co.4).

The study also found that as there is huge risk averseness in the public sector, this presents many challenges in extensive adoption of cloud. For example, the Purchasing Manager at Co.9 explained that, *"if we go out on a limb to try something innovative and it doesn't work, what will happen is you end up in the newspapers. And nobody wants this corporate image of inefficiency"*(OA). In adopting the e-procurement system, both managers in Co.9 and Co.8 added that there were a lot of hurdles to jump through in terms of getting approval and support from senior management (OA, OF). In terms of cloud infusion, both of these managers explained that is necessary to create an environment or structure whereby public sector bodies could engage in pilot projects around cloud in a risk free environment. There would still have to be audit trails and essentially a case of value for money. However, the majority of study participants revealed that there are no real issues around cloud computing routinisation once it is implemented within a controlled environment. In terms of public sector community cloud-based systems, the challenges are much more substantial. As one manager noted *"it's the fear of loss of control and the risk of it…do you want to be first one to do it?* (OA) (Purchasing Manager, Co.9).

4.2.5 Bandwidth and Connectivity

Reliability of the cloud has been referred to as another major issue in the literature (see McAfee, 2011; Ingthorsson, 2010 and Sun, 2010). Those managers at Co.10 and Co.11 revealed that one constraint considered a challenge at all stages of cloud computing were issues around bandwidth and connectivity (OA, OR, OF). From a business point of view, organisations have to rely on connectivity to the network or data centres. For example, the study participants in Co.11 explained that bandwidth and connectivity to the cloud is as much of a concern as the actual performance and the facilities that are on offer from the cloud provider. One of this company's major concerns was with the large amount of

data that had to be moved to servers hosted in the cloud (OA). For example, the IT manager in this company explained that moving a database could be in excess of 100GB, which would take up a huge amount of time. As he further explained *"that can be the bottleneck in the process. So from a proof of concept point of view we took the long view on that. We were able to take our time to upload the necessary files and what not, to actually prove that we can run servers up there, that they are performant"*. Nonetheless, the adoption of cloud computing in this company is very much at pilot phase in their development environment. Production applications like payroll, source controls etc., are not hosted in the cloud but this is something the company is presently considering. The IT manager further explained that when moving forward to this next phase of adoption in their production activities, they are going to need decent bandwidth, which has a cost attributed to it (OF). Presently, this firm is piloting this phase with Co.2 who, according to the Product Manager at Co.11, *"are uniquely positioned whereby they can provide an SOA around bandwidth or a leased line to the Co.2 cloud infrastructure. And as I said that is quite unique because some of the other providers don't seem to have this capability"*.

4.2.6 Integration

The analysis revealed that integrating cloud systems with existing organisational IT systems, e.g. ERP systems, could pose a challenge to long-term adoption and acceptance of cloud computing. Study participants in Co.3 explained that as cloud computing adoption becomes more popular, integration may become more complex (OA), and so this company is working on ways to improve integration. Nonetheless, they stressed that generally cloud computing companies do not aim to directly integrate with existing IT systems because once you do, you move away from what your core offering is, to get companies up and running in the cloud very quickly. The Executive Director in Co.3 further explained that,

> *"If you try to make an ERP system manage your entire business, it's a very expensive process for development and for licensing and all that. Whereas if you get various tools to manage the bits of your business…especially a business that's*

developing quickly, you know, a lot of the online and cloud tools are much easier to bespoke yourself and to continually update as you change your business".

5. DISCUSSION AND CONCLUSION

5.1 Benefits of Cloud Technology Assimilation

As discussed earlier, while some existing research has examined the benefits of cloud adoption, the research is largely based on anecdotal evidence and is generally focused on technical issues regarding adoption (e.g. Armbrust et al., 2009, Brohi and Bamiah, 2011; Forbes, 2011; Guilbert, 2008; Channel Insider, 2010; Dialogic, 2010; Farrell, 2010 Goodburn and Hill, 2010; Geelan et al., 2008; Iyer and Henderson, 2010). This study identified a number of key benefits, with supporting empirical evidence of each. These are (i) time savings, (ii) cost reduction, (iii) internal process improvement, (iv) increased collaboration and openness, (v) increased scalability and (vi) a more traceable and transparent audit trail.

While this study adds empirical evidence to support some of these findings, it also identifies previously undocumented benefits, in particular the potential that cloud computing provides to facilitate more collaboration and openness. It was evident from the study that the cloud introduces a shift in the way companies interact with external sources such as customers and even in the way employees interact with each other inside the organisation. This has the potential to leverage more innovation and facilitate engagement and collaboration along a company's supply chain. Indeed, cloud computing offers a way of collaborating with different partners in the same industry, whereby users can share information and knowledge, co-create services and products and hence, reduce costs. Additionally, we believe that community-based cloud models have the potential to accelerate and enable what Chesbrough et al., (2006) refers to as open innovation, where firms search outside their own boundaries for the best ideas, seeking input from other companies, as well as from customers, suppliers and vendors.

5.2 Challenges to Cloud Computing Assimilation

Cloud computing is not without its drawbacks. In this study, security and privacy proved to be one of the biggest sources of unease. This study identified some key

challenges including (i) perceptions of the term 'cloud', (ii) convincing IS/IT management, (iii) persuading employees to use cloud systems, (iv) security and privacy issues, (v) integration and (vi) bandwidth and connectivity.

There are a number of themes crossing these challenges, which emerged during the analysis of the findings. Firstly, previous research highlighted the need for studies of more user related challenges as opposed to technical issues (Iyer and Henderson, 2010). This research shows that this should be taken further, examining psychological issues. For example, there were many examples where the very existence of the issue only occurred when the term 'cloud' was used. Technologies may have been in use without concern but were not labeled as 'cloud' technologies. As a further example, cloud technology may not bode well with IT managers who may view it as something that will eventually kill their profession.

Secondly, it was clear that assimilation of the cloud technologies studied was not binary. As is clear from Table 4, no technology was implemented fully across all stages of assimilation within any organisation. Furthermore, there is only one instance of a barrier that impacted all stages of assimilation within a company studied (bandwidth and connectivity) within Co.10 and Co.11.

Thirdly, it was clear that assimilation across phases was not sequential. For example, a simple assumption may be that a technology is accepted, then routinely used across all members of the organisation, and then instances of infusion would start to appear. Instead, we see that there were instances of infusion for example, without routinisation.

As was evident in this study, cloud computing has the potential to streamline internal processes and hence productivity. Thus, the role of IT managers in the future is likely to change, along with their skill-sets. Similarly, another challenge to further infusion of cloud computing adoption is uncertainty and resistance that may exist among employees. It is widely known that introducing a new innovation can result in employee resistance, particularly if there is a lack of understanding of the change or indeed a lack of knowledge on how it will affect their work, e.g. may be fear of eventual downsizing. Thus, senior decision-makers in organisations need to prepare employees for this new learning curve by providing training and communication in advance of cloud

implementation. Additionally, there needs to be an awareness of what is actually being introduced and people need to know what the benefits are.

Overall, the results of the study are useful in providing a better understanding of how perceptions impact adoption which may in turn lead to more informed managerial decision-making processes regarding adoption of cloud systems. In terms of future research, while this study examines the challenges to various stages of assimilation, there is an underlying assumption that reaching deeper levels of assimilation is something that may be beneficial. However, this may not be always correct, and further research will examine levels of assimilation achieved, and more importantly the costs associated with overcoming the barriers to further assimilation, with the return on investment of achieving the higher level. In addition, given the exploratory nature of this research, future explanatory research could be carried out to determine the prevalence and impact of these challenges, and to identify correlating best practices to resolve these.

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