FACTORS AFFECTING THE ADOPTION OF CLOUD COMPUTING: AN EXPLORATORY STUDY

Morgan, Lorraine, Lero, National University of Ireland Galway, Ireland, Lorraine.morgan@nuigalway.ie

Conboy, Kieran, National University of Ireland Galway, Ireland, Kieran.conboy@nuigalway.ie

Abstract

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. Drawing on three case studies of service providers and their customers, this study will contribute to the existing cloud technologies literature that does not address the complex and multi-faceted nature of adoption. The findings are analyzed using the adoption of innovation literature as a lens to reveal how technological, organizational and environmental factors impact cloud adoption. Our conclusions reveal that factors impacting cloud adoption tend to be psychological as well as technical, and some recommendations are put forward for future research.

Keywords: Cloud Computing, Technology-Organization-Environment Adoption Framework, Challenges, Case 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 Chief Technology Officers (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". However, there is currently no single, universally accepted definition of the term "cloud computing" (Foster et al. 2008; Vouk 2008; Yang and Tate 2009; Iyer and 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 and 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, 2012)), 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 (e.g. Brohi and Bamiah, 2011; Forbes, 2011; Guilbert, 2008; Channel Insider, 2010; Dialogic, 2010; Farrell, 2010 Goodburn and Hill, 2010; Geelan et al., 2008). Therefore, the objective of this study is to investigate the factors that impact cloud adoption. To achieve the objective, three research questions were formulated:

1. What technological factors impact the adoption of cloud computing?
2. What organizational factors impact the adoption of cloud computing?
3. What environmental factors impact the adoption of cloud computing?

We begin by describing the theoretical background to the study (Section 2). This is followed by a discussion of the research design (Section 3) and the findings (Section 4). Finally we conclude by discussing the implications of our work (Section 5).

2 Theoretical Background

There are weaknesses in innovation adoption research in its failure to take adequate consideration of the business context and its integration with the overall environment (Swanson, 1994). Moreover, there has been an excessive focus on adoption at the individual level and not enough on the organizational level (Eveland and Tornatzy, 1990). It is therefore evident that the theoretical

foundation for our study needs to take into consideration specific factors such as the technological, organizational and environmental circumstances of the organization. We thus begin by drawing on the work of Tornatzky and Fleischer (1990). Their model consists of three elements that influence the process by which innovations are adopted – the technology, organization and environment. This framework has been elaborated on in relation to IS adoption studies carried out by Morgan and Finnegan (2010), Dedrick and West (2003) and Chau and Tam (1997).

The technological context relates to the technologies available to an organization and focuses on how certain technology factors influence the adoption process (Tornatzky and Fleisher, 1990). According to Rogers (2003), five technology factors influence the likelihood of adoption - relative advantage, compatibility, complexity, trialability and observability. Relative advantage refers to the level to which an advantage is perceived as better than the idea it supersedes. Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of potential adopters. Complexity relates to the perceived difficulty of understanding and using the innovation while trialability refers to the degree to which the innovation can be tried and tested in small chunks over time. Finally observability refers to the level to which the results of an innovation are visible to the technology adopter (Rogers, 2003). The organizational context looks at the structure and processes of an organization that constrain or facilitate the adoption and implementation of innovations (Tornatzky and Fleischer, 1990). Additionally, Tornatzky and Fleischer (1990) propose that the external environmental context, i.e., the industry, competitors, regulations, and relationships with governments, in which an organization conducts its business, presents constraints and opportunities for technological innovations.

3 Research Design

Given the scarcity of empirical work in the area of cloud computing adoption and the need to obtain rich data, the study was considered exploratory in nature, and therefore, a case study approach was considered appropriate (Yin, 2003; Marshall and Rossman, 1989). Case studies are useful for exploring areas where existing knowledge is limited (Eisenhardt, 1989) and are also valuable in generating an understanding of a particular situation (Yin, 2003). Our research method involves three case studies representing service providers (SourceDogg, AD Networks and Almir) and their customers in a network (see Table 1). The decision to use the perspectives of these two different groups was based on the belief that services providers could offer a better understanding of benefits and challenges of adopting cloud computing based on their own interaction with, and feedback from clients, while those customers that had adopted cloud computing solutions could provide us with information regarding benefits and potential challenges they experienced. Interviewees were senior decision-makers with experience of assessing cloud-computing adoption.

SourceDogg, a sourcing software provider, was founded in 2009 and presently has 21 employees (although they have recently announced 80 new jobs due to customer numbers expanding rapidly). They offer a cloud-based e-sourcing service (also called SourceDogg.com), provided on a subscription basis,, that allows users to find and evaluate new suppliers with an easy-to-use approach to quotations, tenders and other aspects of the procurement process. The company has an extensive list of clients from both the public and private sectors based in five different countries, who use the SourceDogg system to deliver cost and time savings and transparent sourcing in their procurement processes. Both IBTB and APM are early-adopter public sector clients of SourceDogg and have adopted their e-sourcing system in their respective procurement departments.

AD Networks, founded in 1992, provides major organizations, midsize businesses and wholesale customers with resources that combine network and IT infrastructure and possess expertise in IT managed services, networking and communication solutions. AD Networks has 5,500 employees and operates a 21-country, 35,000km network that includes metropolitan area networks in 39 major European cities. Their cloud infrastructure service provides businesses with a modular IT infrastructure provided on a subscription basis, covering networking, storage, a systems and software

catalogue, backup service and self-service portal. Information Mosaic, one of AD Networks customers, is a global leader in providing modern, high volume software applications for middle office, back office and corporate actions automation within the global financial markets industry. They leverage AD Networks infrastructure service only in their development environment.

Almir is a management consultancy of 12 experienced professionals that work extensively in a consulting capacity with companies in the area of business improvement and techniques including implementation of proven international best practice management standards such as Quality, Environmental, Health & Safety and Information Security management systems. Their complimentary software as a service offering includes a suite of management system on-line tools around continuous improvement, training, asset management and documentation. NDC is a customer of Almir and specialize in the delivery of customized and integrated GPS vehicle tracking systems and fleet management solutions for leading businesses in over thirty countries worldwide. This company use Almir's continuous improvement tools to manage their ISO systems.

Firm	Industry	Interviewees
Case Study I - SourceDogg (SaaS)		
SourceDogg (Service Provider)	Procurement software	Chief Executive Officer (1 interview) Executive Director (2 interviews) Chief Technology Officer (1 interview)
IBTB[1] (Customer)	Public Sector Body (Health)	Purchasing Manager (1 interview)
APM* (Customer)	Public Sector Body (Food and Drink)	Procurement Officer (1 interview)
Case Study II – AD Networks (IaaS)		
AD networks* (Service Provider)	IT and Networking Solutions	Chief Technology Officer (1 interview)
Information Mosaic (Customer)	Global Securities Processing	Product Management (2 interviews) IT Manager (1 interview)
Case Study III - Almir (SaaS)		
Almir (Service Provider)	Consultancy	Managing Director (2 interviews) Developer (1 interview)
NDC* (Customer)	Electronics	IT Manager (1 interview)

Table 1. Data Sources for the Study

3.1 Data Collection and Analysis

Data collection took place between October 2011 and April 2012 and was primarily personal face-to-face interviews, a technique well suited to exploratory research such as this because it allows expansive discussions to illuminate factors of importance (Yin, 2003). To improve the reliability and repeatability of the research, a traceable, 'audit trail' of the research process, from data collection through to the drawing of conclusions, was sought. Kirsch's (2004) model was followed; this model defines a set of procedures to (i) identify and selecting project cases, (ii) determine who to interview and (iii) how the interviews were to be conducted. Interviewees were senior decision-makers with experience of assessing cloud-computing adoption. A common interview protocol was prepared. Each interview was structured around three issues, with the interviewers asking probing questions based on responses. These three issues were: (i) the level of adoption, (ii) perceived benefits of cloud computing, and (iii) perceptions of technological, organizational and environmental challenges to adoption. The interviews lasted between 50 and 120min. The questions were largely open-ended, allowing respondents freedom to convey their experiences and views, and expression of the socially complex contexts that underpin cloud technology adoption (Oppenheim, 1992; Yin, 2003). In order to aid analysis of the data after the interviews, all were recorded with each interviewee's consent, and

[1] IBTP, APM, AD Networks and NDC are pseudonyms used to protect anonymity

were subsequently transcribed, proof-read and annotated by the researcher, and then coded using nVivo. Also, venting was used, whereby results and interpretations are discussed with professional colleagues to avoid the problem of what Kaplan and Duchon (1988) call multiple realities. Findings were continuously presented and discussed with colleagues and practitioners informally. In any cases of ambiguity, clarification was sought from the corresponding interviewee, either via telephone or e-mail. Supplementary documentation relating to the cloud technologies and their use were also collected. These included a comprehensive review of publicly available documents including websites of firms, company brochures, white papers etc.

Data analysis used Strauss and Corbin's (1998) open coding and axial coding techniques. This approach encourages researchers to be flexible and creative (Sarker et al., 2000) while imposing systematic coding procedures (Strauss and Corbin, 1990). This form of analysis facilitates the development of substantive theory without prior hypotheses, and can be utilized in the absence of, or in conjunction with, existing theory (Strauss and Corbin, 1990; Urquhart, 1997). In the initial phase, 'open coding' was used to determine the main ideas in each transcript. These ideas were then grouped by significant headings (technology context, organizational context and the environmental) to reveal categories and sub-categories. The next step involved 'axial coding' which is the process of relating categories to their sub-categories. As a list of codes began to emerge, the analysis moved to a higher level of abstraction, looking for a relationship between the codes. Once a relationship had been determined, the focus returned to the data to question the validity of these relationships. Additional follow-up interviews were arranged with all of the original interviewees to elicit further, richer, more focused information. This was done to confirm, extend, and sharpen the evolving list of categories.

4 Findings and Analysis

4.1 Technological Factors Impacting Adoption

Four technological characteristics were evident in this study as influencing the adoption decision: trialability, relative advantage, compatibility, and complexity. Given that the extent of cloud adoption among customers was only moderate or at pilot phase, observability was not seen as relevant. The *relative advantage* was seen in terms of savings on software and hardware costs. 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 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 Information Mosaic explained how they were able to significantly reduce hardware costs. This company relies heavily on virtualization 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, the company saved on license costs, maintenance costs, back-up costs of tapes, electricity bills and air-conditioning bills. As the product manager further 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*". Additionally, study participants in IBTB and APM explained that traditionally they would only get three or four quotes from suppliers, which was too narrow in terms of a market sample. With the SourceDogg system, they could increase the number of quotes threefold, which resulted in significant cost savings. Scalability, a 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 and had a positive impact on relative advantage. For example, the managers at Information Mosaic 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. The 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".

Likewise, the Project Manager at NDC 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".*

Relative advantage was also seen in terms of time-savings. Faster implementation time is viewed as another benefit of cloud computing (Forbes, 2011; Goodburn and Hill, 2010), something that was also evident in this study. Both study participants in IBTB and APM that adopted the SourceDogg.com 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, Sourcedogg). The Purchasing Manager at IBTB 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 organization 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 IBTB further added, *"it addresses the administrative elements which are resource hungry on organizations"*. Using the SourceDogg system, both study participants in APM and IBTM 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.

The *compatibility* of cloud technologies was found to be consistent with the technologies, skills and tasks of various adopters in the study. For example, the majority of the customers in the study 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 Information Mosaic 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 Sourcedogg explained that they build cloud-based templates for common spend areas, which their customers in general find very valuable. Alternatively, their customers can choose to design their own templates if they wish, which again is viewed as something beneficial. Nonetheless, this same service provider (i.e. SourceDogg) revealed that integrating cloud systems with existing organizational IT systems, e.g. ERP systems, could pose a challenge to long-term adoption and acceptance of cloud computing. As cloud computing adoption becomes more popular, integration may become more complex, and so SourceDogg are 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 SourceDogg 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".

In terms of compatibility, issues around bandwidth and connectivity are concerns for adopters. From a business point of view, organizations have to rely on connectivity to the network or data centres. For example, the study participants in Information Mosaic 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. 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 pointed out 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. Presently, this firm is piloting this phase with AD Networks who, according to the Product Manager at Information Mosaic, *"are uniquely positioned whereby they can provide an SOA around bandwidth or a leased line to the AD Networks cloud infrastructure. And as I said that is quite unique because some of the other providers don't seem to have this capability"*.

In terms of *complexity*, the real issue was in relation to staff who resist or are uncertain as to how to use the cloud system. The Procurements Officer at APM explained that for somebody working in procurement, it's very straightforward for them using the SourceDogg system but for the non-procurement people, it can be quite challenging. Presently APM 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 IBTB using the system, but again they are investigating how best to roll it out across the organization. The Procurements Officer at APM pointed out that *"some training and handholding"* is necessary at the start while the Purchasing Manager at IBTB 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 SourceDogg and Almir believed that it is important to build a system that is intuitive to peoples needs. The Project Manager at NDC explained that while the underlying workflow engines of AlmirLive 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 service providers like Almir that lack the resources to recruit developers who can work on different functions of the system.

The analysis reveals that *trialability* is also an important factor impacting cloud adoption. All of the adopters in the study have carried out various trials and experimentations with their respective cloud systems. For example, the Procurements Officer at APM explained that they carried out some trials with the SourceDogg system and came up with an action plan of 20 improvements to the system. This manager further elaborated "some of these changes were not so small. I mean with some of them I was very surprised at how quickly they [SourceDogg] turned them around. So they are eager to keep the clients that they have now very happy". Prior to adoption, all of the customers in the study also participated in various feasibility studies around cloud adoption and pilot studies.

4.2 Organizational Factors Impacting Adoption

The analysis revealed that one organizational factor impacting customer adoption was the desire to *improve collaboration* and promote openness both inside and outside organizations. All of the customers in the study 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. In terms of more team engagement and collaboration, the Purchasing Manager at IBTB explained that,

"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 at Information Mosaic 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. From the perspective of the service providers in this study, the CTO at Almir described how it was crucial to actively engage with partners and customers in various cloud efforts while the managers at SourceDogg explained how they welcomed feedback from customers, as well as new ideas on how to improve their system. Similarly, the CEO at Almir explained that while he was very happy with the AlmirLive system and believed it promoted collaboration in client organizations, 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.

Another organizational factor impacting adoption included *increased traceability and auditability*. 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 organization 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). All of the customers in the study need to show an audit trail of where data is stored for regulatory and legal purposes. Thus, the ability of service providers to provide a traceable and transparent audit trail demonstrates compliance and data integrity. As the Executive Director at Sourcedogg 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 at NDC, APM and IBTB further explained that with their respective cloud systems, i.e. SourceDogg.com and AlmirLive, they have full documentation and traceability from an audit point of view, which is extremely important. In terms of the managed service option that Information Mosaic offers their own clients, the Product Manager there explained that they undertake a heavy audit each year where auditors come in and audit all their controls around security, around segregation of duties, etc. He further explained that the physical and logical access is controlled - developers in the organization are not permitted access onto the hosted environment in case they should insert some transactional information or modify it. Thus, the audit that they provide is a very important part of the sales message that they give to clients. Long-term clients often demand annual audits and want to see proof of infrastructure set-up or even proof that the company can meet customer requirements around data availability in case of a disaster. As the IT manager pointed out, *"it's really a cost of doing business. What it means is that existing clients will demand it and new clients will expect it"*.

Adopting cloud systems represents a shift in organizational norms and culture. One organizational factor that impacts cloud adoption is the *IT managers' fear of 'losing control of their IT environment'*. For example, the project manager at NDC 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 adoption. Similarly, the CEO at Almir pointed out, "*IT managers in a company tend to be very protective and sometimes overly protective of what's there. And in some ways you know over-protective but there isn't an ounce that you can do about it"*. According to several study participants, the massive transition to cloud may result in many IT managers' jobs becoming obsolete in a few years. Nonetheless, service providers in this study believed that there are still tremendous opportunities for IS/IT managers, if they adjust their skills and capabilities to suit the cloud landscape.

4.3 Environmental Factors Impacting Adoption

Our analysis revealed that *security and legal issues* was the main environmental factor impacting cloud adoption. For example, adopters such as IBTB, APM, NDC and Information Mosaic referred to issues around data jurisdictions, data confidentiality and security risks. For example, both managers in Information Mosaic explained that with the AD Networks offering they feel safe in the knowledge that

they are aware of where their datacentres are actually hosted, as well as the legislation around the jurisdiction in which they are hosted. The Product Manager in this company further revealed that, *"certain datacentres are scattered across the world and sometimes you can specify which datacentre you are going into. But with regard to disaster recovery they have to fail over to other data centres around the world and that may mean that some very pertinent information or data will end up in a jurisdiction where it shouldn't be for legal purposes"*. The analysis also revealed that there is huge risk averseness in the public sector and this presents many challenges for widespread adoption of cloud. For example, the Purchasing Manager at IBTB 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"*. In adopting the e-procurement system, both managers in IBTB and APM added that there were a lot of hurdles to jump through in terms of getting approval and support from senior management. As the Purchasing Manager at IBTB further elaborated *"there are issues for cloud computing in the public sector. Who owns the information? Where is it stored? These types of things"*. The project manager in NDC also 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 adoption, two the service providers (i.e. AD Networks and SourceDogg), explained that they have 'locked-down processes' on data confidentiality and information repositories are outsourced to secure datacentres. Interestingly, several of the study participants in the study referred to people's perception of the word 'cloud' as being a potential barrier to cloud adoption. For example, the CEO at Almir, the Procurements Manager at APM and the CTO at AD Networks 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. 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, Almir) while one customer in the study admitted that, *"the word cloud scares some people"* (Project Manager, NDC). Several other study participants believed that while the term became fashionable rapidly in the market, it became tainted just as quickly. As a result, when dealing with customers, service providers in the study purposely tend not to talk about 'cloud' per se, but rather a new service delivery model.

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 IBTB and APM 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. The Purchasing Manager in IBTB noted that senior managers in the public service would like to see more real world examples of successful community clouds. This acts as a safety net for managers, because as the Purchasing Manager at APM pointed out, *"it's the fear of loss of control and the risk of it…do you want to be first one to do it?* However, it was found that once people are educated on how best to govern and manage the process, public sector cloud computing would be more rapidly adopted.

5 Discussion and Conclusion

As discussed earlier, while some existing research has examined the benefits and challenges of cloud adoption, this research is largely based on anecdotal evidence and generally focused on technical issues. Additionally, no previous research has drawn on innovation adoption theory that considers the technological, organizational and environmental factors that impact cloud adoption. It is evident that this study adds empirical weight to support previous findings. For example technological factors included relative advantage in terms of time savings (i.e. fast turnaround in terms of implementation) cost savings (i.e. reduced capital expenditure) and increased scalability (i.e. provision of ad hoc services on a scale that is needed). In terms of compatibility, customers in the study referred to the need for better bandwidth and connectivity for more widespread adoption in their respective

organizations while service providers pointed out the need for better integration. Technological complexity in the case of persuading employees to use cloud systems was also a factor deemed important as well as the ability to carry out trials and pilot phases in risk free environments. The study also identified previously undocumented factors. For example, one of the organizational factors that emerged was the desire to improve collaboration inside and outside organizations. It was evident from the study that the cloud introduces a shift in the way companies interact with external sources and even in the way employees interact with each other inside the organization. This has the potential to leverage more innovation and facilitate engagement and collaboration along a company's supply chain. Nonetheless issues surrounding security and legal issues highlight the need for educational awareness of security and regulations in various jurisdictions in which data centres are hosted.

There are a number of themes crossing these challenges, which emerged during the analysis of the findings and warrant further research. 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, perceptions of the term 'cloud' was one psychological factor that negatively impacts adoption, so much so that service providers avoid using the term in some cases. Additionally, cloud technology may not bode well with IT managers who may view it as something that will eventually kill their profession. Thus, further research should consider the role of the IT manager and changing skill-sets in the future cloud landscape. Similarly, another challenge to widespread adoption of cloud computing is the 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 organizations need to prepare employees for this new learning curve by providing training and communication in advance of cloud implementation. Additionally, there has to be an awareness of what is actually being introduced and people need to know what the benefits are. The study provides empirical support for theories associated with traditional adoption of innovation (i.e. Rogers, 2003; Tornatzky and Fleischer, 1990) in better explaining the adoption of cloud computing. Additionally, the results of the study are useful in providing a better understanding of how certain challenges impact adoption which may in turn lead to more informed managerial decision-making processes regarding adoption of cloud systems. To conclude, our research design was exploratory, and further research should go deeper into each factor and level of analysis, as well as focusing on consistent theoretical lenses that consider technological, environmental and organizational factors, so that a more integrated perspective on the complexities surrounding the adoption of cloud computing may be achieved. Furthermore, identifying correlating best practices to resolve these challenges would be beneficial.

References

Armbrust, M. et al., 2009. "Above the Clouds: A Berkeley View of Cloud Computing", EECS Department, University of California, Berkeley. Available at: http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.html

Banker, J. 2012. "Traceability Benefits Can Extend Far Beyond Better Recall Capabilities", Available at: http://logisticsviewpoints.com/2012/06/11/traceability-benefits-can-extend-far-beyond-better-recall-capabilities/.

Brohi, S.N. and Bamiah, M.A. 2011. "Challenges and Benefits for Adoption the Paradigm of Cloud Computing", International Journal of Advanced Engineering Sciences and Technology, 8(2), pp. 286-290.

Buyya, R., Yeo, C.S. & Venugopal, S., 2008. "Market-Oriented Cloud Computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities", In HPCC '08: Proceedings of the 2008 10th IEEE International Conference on High Performance Computing and Communications. Washington, DC, USA: IEEE Computer Society, pp. 5–13. Available at: http://dx.doi.org/10.1109/HPCC.2008.172

Channel Insider. 2011. "Businesses Indecisive on Cloud Computing Benefits: Report", Available at: http://www.channelinsider.com, 15th July.

Chau, P.Y.K. and Tam, K.Y. 1997. "Factors affecting the adoption of open systems: An exploratory study", *MIS Quarterly* (21:1) 1997, pp. 1-24.

Cooper, R.B. and Zmud, R.W. 1990. "Information technology implementation research: a technological diffusion approach", Management Science, 26, 123-39.

Dedrick, J. and West, J. 2003. "Why Firms Adopt Open Source Platforms: A Grounded Theory of Innovation and Standards Adoption", *Proceedings on the Workshop on Standard Making: A Critical Research Frontier for Information Systems,* Seattle, Washington, 236-257.

Dialogic, 2011. "An Introduction to Cloud Computing: A White Paper". Available at: https://www.dialogic.com/.../Cloud.../12023-cloud-computing-wp.pdf.

Eveland, J. and Tornatzky, L. 1990. "The deployment of technology", in Tornatzky, L. and Fleisher, M. (eds) The Processes of Technological Innovation, Lexington Books, MA.

Eisenhardt, K.M. 1989. Building Theories from Case Study Research, Academy of Management Review, 14(4), 1989, pp. 532-550.

Farrell, R. 2010. "Securing the Cloud: Governance, Risk and Compliance Issues Reign Supreme", Information Security Journal: A Global Perspective , 19, pp. 310-319.

Federico, E, 2009. "The Economic Impact of Cloud Computing on Business Creation, Employment and Output in Europe, An application of the Endogenous Market Structures Approach to a GPT innovation". Available at: http://www.techrepublic.com/

Fichman, R.G. 1999. The Diffusion and Assimilation of Information Technology Innovations. In R.W. Zmud (Ed.), *Framing the Domains of IT Management: Projecting the Future...Through the Past,* Cincinnati, OH: Pinnaflex Educational Resources, Inc.

Forbes, 2011. "The Economic Benefit of Cloud Computing". Available at: http://www.forbes.com/sites/kevinjackson/2011/09/17/the-economic-benefit-of-cloud-computing/

Foster, I. et al., 2008. "Cloud Computing and Grid Computing 360-Degree Compared" In Grid Computing Environments Workshop. IEEE, pp. 1–10. Available at: http://dx.doi.org/10.1109/GCE.2008.4738445.

Gansen Zhao,, Jiale Liu, Yong Tang, Wei Sun, Feng Zhang, Xiaoping Ye, and Na Tang. "Cloud Computing: A Statistics Aspect of Users", South China Normal University, China , Sun Yat-sen University, China, 2009, Springer- Verlag, Berlin- Heidelberg.

Goodburn, M.A. and Hill, S. 2010. "The Cloud Transforms Businesses". Financial Executive, December.

Guilbert, B. 2010. "Understanding Cloud Computing: Benefits and Challenges for Investment Firms". Available at: http://www.finalternatives.com/node/14728

Hayer, L. 2011. "Lack of Standards in the Cloud". Available at: http://www.telecomreseller.com/2011/06/22/lack-of-standards-in-the-cloud/

IEEE. 2011. "Cloud Computing Interoperability Presents a Greater Challenge to Adoption Than Security, Say IEEE Cloud Experts". Available at: http://www.ieee.org/about/news/2011/28_june_2011.html

Ingthorsson, O. 2010. "Cloud Computing – barriers for faster adoption". Available at: http://cloudcomputingtopics.com/2010/01/cloud-computing-barriers-for-faster-adoption/

Iyer, B. and Henderson, J.C. 2010. "Preparing for the Future: Understanding the Seven Capabilities of Cloud Computing". MIS Quarterly Executive 9(2), pp. 117-131.

Iyer, B. and Henderson, J.C. 2012. "Business Value from Clouds: Learning from Users", *MIS Quarterly Executive*, 11(1), pp. 51-60.

Javan, M.S. and Akbari, M.K. 2011. "Cloud Computing Issues and Challenges for Ultimate Interoperability", 1st CSUT Conference on Computer", Communication and Information Technology, University of Tabriz, November.

Khajeh-Hosseini, A., Sommerville, ILango Sriram, I., 2010, "Research Challenges for Enterprise Cloud Computing", 1st ACM Symposium on Cloud Computing, SOCC 2010.

Lawton, G. 2009. "Addressing the Challenge of Cloud-Computing Interoperability". Available at: http://www.computer.org/portal/web/computingnow/archive/news031.
Leimeister S, Riedl, K., Krcmar H; 2010. The Business Perspectives of Cloud Computing: Actors, Roles and Value Networks", Proceedings of 18th European Conference on Information Systems (ECIS), 2010.
Lewin, K. 1952. "Group decision and social change", in Readings in Social Psychology, Swanson, G.E., Newcomb, T.M. and Hartley, E.L. (eds), pp. 459-473.
Luftman, J. and Zadeh, H.S. 2011. "Key information technology and management issues 2010-11: an International study", J Inf technol, 26(3), pp.193-204.
Marshall, C. and Rossman, G. 1989. "Designing Qualitative Research", Sage Publications, California.
McAfee, A. 2011. "What every CEO needs to know about the Cloud" Harvard Business Review, pp. 124-133, November.
Mell, P. and Grance, T. 2009. "The NIST Definition of Cloud Computing", National Institute of Standards and Technology.
Meyer, A.D. and Goes, J.B. 1988. "Organizational assimilation of innovation: a multilevel contextual analysis" Academy of Management Journal, 31, 897-923.
Motahari-Nezhad, H.R., Stephenson, B., and Singhal. S. 2009. "Outsourcing Business to Cloud Computing Services: Opportunities and Challenges", Technical Report HPL-2009-23, January.
Morgan, L. and Finnegan, P. 2010. "Open Innovation in Secondary Software Firms: An Exploration of Managers' Perceptions of Open Source Software", The DATA BASE for Advances in Information Systems 41 (1).
Orlikowski, W.J. and Hofman, J.D. 1997. "An improvisational model for change management: the case of groupware technologies", Sloan Management Review, 38, 11-21.
Pikkarainen, M.; and Wang, X., Conboy, K. 2007, Agile Practices in Use from an Innovation Assimilation Perspective: A Multiple Case Study (2007). ICIS 2007 Proceedings.
Rogers, E. 2003. *Diffusion of Innovations*. 5th Edition, Free Press, New York.
Saga, V.K. and Zmud, R.W. 1994. The nature and determination of IT acceptance, routinisation and infusion", Proceedings of the IFIP TC8 Working Conference on Diffusion, Transfer and Implementation of Information Technology, Levine, L. (ed.,) pp. 67-68, Elsevier, Amsterdam.
Sriram,I. and Khajeh-Hosseini, A. (2010) Research Agenda in Cloud Technologies. Proceeding of IEEE CLOUD 2010: Miami, FL, USA
Strauss, A. and Corbin, J. 1990. Basics of Qualitative Research: Grounded Theory Procedure and Techniques, Sage Publications, Newbury Park, CA.
Sun, Ray. 2008. Cloud Computing: Looking for Security, Reliability and Resiliency. Available at: http://www.baselinemag.com/c/a/Utility-Computing/Cloud-Computing-Looking-for-Security-Reliability-Resiliency-466013/
Swanson, E.B. 1994. "Information Systems Innovation Among Organisations", *Management Science* (40:9), pp. 1069-1092.
Tornatzky, L.G. and Fleischer, M. 1990. *The Processes of Technological Innovation*. Lexington Books, Massachusetts, USA.
Wang, X.; Conboy, K.; Pikkarainen, M. 2012 "Assimilation of Agile Practices", Information Systems Journal, Blackwell Publishing.
Yin, R. 2003. Case Study Research: Design and Methods, London, Sage.

Acknowledgement

This work was supported, in part, by Science Foundation Ireland grant 10/CE/I1855 to Lero, the Irish Software Engineering Research Centre (www.lero.ie).