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Cloud computing as an innovation: Percepetion, attitude, and adoption

Angela Lin[a,*], Nan-Chou Chen[b]

[a] Information School, University of Sheffield, Regent Court, 211 Portobello Street, United Kingdom
[b] eBusiness Service Department, ASUSTeK COMPUTER INC., 5, Li-Te Rd., Peitou, Taipei 112, Taiwan

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ABSTRACT

Cloud computing is a current trend that reveals the next-generation application architecture and it is estimated that by 2013 the cloud market will have reached $8.1bn. While cloud services such as webmail, Flickr and YouTube have been widely used by individuals for some time, it not until relatively recently that organisations have began to use cloud services as a tool for meeting their IT needs. This study aims to investigate how cloud computing is understood by IT professionals and the concerns that IT professionals have in regard to the adoption of cloud services. The study was carried out in Taiwan and used a survey by interview approach to understand IT professionals' understandings and concerns about cloud computing. The findings of the study suggest that while the benefits of cloud computing such as its computational power and ability to help companies save costs are often mentioned in the literature, the primary concerns that IT managers and software engineers have are compatibility of the cloud with companies' policy, IS development environment, and business needs; and relative advantages of adopting cloud solutions. The findings also suggest that most IT companies in Taiwan will not adopt cloud computing until the uncertainties associated with cloud computing, e.g. security and standardisation are reduced and successful business models have emerged.

1. Introduction

Cloud computing is a current trend that reveals the next-generation application architecture (Hutchinson, Ward, & Castilon, 2009). While cloud services such as webmail, Flickr and YouTube have been widely used by individuals for some time, it is not until relatively recently that organisations have began to use cloud services as a tool for meeting their IT needs. It is estimated that by 2013 the cloud market will have reached $8.1 bn (BBC, 2010). Despite these trends cloud computing remains for many an unfamiliar concept. Therefore in order for cloud computing to grow it is important to understand the factors that can influence its rate of adoption by businesses. This study aims to investigate how cloud computing is perceived by IT professionals and the concerns that IT professionals have in regard to the adoption of cloud services. The study was conducted in Taiwan in 2009 when cloud computing was still a new phenomenon to most people. It was therefore a good opportunity to study how an innovation is perceived and what factors can encourage and prevent its early adoption. The study sought the views of IT professionals since it is IT professionals more than other professionals who are likely to experiment with, adopt, or otherwise promote the use of cloud computing. Diffusion of innovation theory is the theoretical basis used to underpin the identification of the factors encouraging and preventing its adoption (Rogers, 1995).

2. Cloud computing

Cloud computing, an emerging concept, has attracted much attention in both commercial and academic spheres. Strictly speaking cloud computing is not a new concept, it can be traced back to 1997 when the term was first mentioned but only recently it has become a fashionable term (Lijun et al., 2008). The use of the term 'cloud' is metaphorical and typically points to a large pool of usable resources such as hardware and software that are easily accessible via the Internet (Vaquero, 2009, Vouk, 2008). Characteristics of cloud computing are somewhat defined by the exiting computing concepts such as network computing, grid computing, utility computing, pervasive computing, and service computing (Voas & Zhang, 2009). Its notable features include its market-oriented architecture (unlike a traditional system-centric resource management architecture a cloud-based architecture is regulated by the supply and demand of cloud resources at market equilibrium, e.g. Buyya et al., 2008); its flexibility, i.e. a service can be easily scaled up and ramped down its resources for optimum utilisation (Vaquero, 2009); and its ability to charge consumers a fee for using the resources in the pool (Leavitt, 2009). Services are typically provided on the basis of service level agreements (SLAs) and, depending on a particular

* Corresponding author. Tel.: +44 0114 222 2634; fax: +44 01142780300.
E-mail addresses: a.lin@sheffield.ac.uk (A. Lin), nanchou_chen@asus.com (N.-C. Chen).

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customer's needs and expectations, can meet different quality of service criteria.

Cloud services delivery models can be broadly categorised into four types: Software-as-a-service (SaaS), Service, Platform-as-a-service (PaaS) and Infrastructure-as-a-service (IaaS). Each of the service types serve different purposes and target different customers however they share a common business model that is that they 'rent' the use of their computing resources including services, applications, infrastructures, and platform to customers. This model is similar to the application service provider model (ASP) in which a service provider provides software, infrastructure, people, and maintenance to run in a customized fashion for the customer (Wang et al., 2010). Thus SaaS and Service models can be understood as the variation to ASP where customers pay, rent, or subscribe to applications or services from the cloud providers to access applications or services such as online storage and database capabilities via the Internet (Leavitt, 2009). Both SaaS and Service models aim to provide trouble free operation for the end users and allow corporate customers to free up their IT resources (Pearlson & Saunders, 2009). Cloud computing has gone beyond the basic SaaS and Service provision and provides IaaS and PaaS. *PaaS* provides a full or partial application development environment that enables developers to access resources for application development and to collaborate with others online (Mathur & Nishchal, 2010). Amazon's Simple Storage Solution (S3) and Microsoft Azure Service Platform are the known PaaS solutions. *IaaS* provides customers with a large set of computing resources for example virtual machine to deliver a computing infrastructure to customers via the Internet. IaaS targets IT organisations and software developers to allow them to increase or decrease the number of virtual machines running depending on their workload to promote efficiency in the use of IT resources, examples include Amazon's Elastic Compute Cloud (EC2) and Mosso Hosting Cloud. From the above it is evident that cloud computing challenges the existing understanding of IT resources. IT resources are no longer regarded as products rather thy are understood as services which can be rented and subscribed from the providers and accessed via the Internet. It is therefore argued that cloud computing presents a computing paradigm shift to virtualisation of IT provision and management (Armbrust et al., 2010; Buyya et al., 2008).

The potential benefits of adopting cloud computing can be assessed from both the financial savings and resource management perspectives. One obvious financial benefit of cloud computing, especially for small to medium size companies, is the savings made from buying, running, and maintaining their own hardware and software infrastructures (Miller, 2008). Reduction in capital investment in hardware and software infrastructures cloud therefore provides companies with the opportunity to acquire IT capacities that they may not have been able to afford in the past (Grossman, 2009). Universal access to software (SaaS) and services (Services) can also bring financial benefits by not needing to pay for software licensing fees. The elasticity of cloud services also means more flexible resource management which can also lead to cost savings. In other words, with cloud services companies can scale up and ramp down capacity on demand and only pay for the actual usage. PaaS offers an agile development environment that makes it easier for IT professionals to develop applications quickly and to adopt them instantly because it eliminates the wait for deployment of suitable hardware and software for the applications (Greer, 2009; Vile & Liddle, 2009). In short, cloud computing enables businesses, particularly SMEs, and consumers to access resources from a resource pool on-demand; the latter benefiting from greater flexibility and the lower costs of managing computer resources.

Despite the promise of cloud services, there are also obstacles to their growth and adoption. The lack of constant and high-speed Internet connections is a significant obstacle for cloud computing as it relies on the Internet to deliver its services (Miller, 2008). The lack of standardisation of application program interfaces and platform technologies means that interoperability among platforms is poor and companies will not be able to transfer easily from one cloud provider to another. Consumers hence face vendor and data lock-in. This perceived lack of control can discourage companies from adopting cloud computing (Armbrust et al., 2010). Companies can also be concerned that their IT performance is controlled not by their own staff but by off-premises cloud providers; and that they may not be able to make necessary changes in application features easily and when needed (Leavitt, 2009; Miller, 2008). Security to concerns, in particular privacy and data confidentiality, is one of the most cited objections to cloud computing (Armbrust et al., 2010; Zhang, Cheng, & Boutaba, 2010). It is argued that most of the security and privacy issues in cloud computing are due to a lack of control over the physical infrastructure. In other words, companies are wary of who controls and monitors the data centre in the cloud. The risks of using cloud computing can be grouped into four categories (Khajeh-Hosseini et al., 2012): policy and organisational risks (e.g. vendor and data lock-in, loss of governance), technical risks (e.g. data leakage, loss of data), legal risks (e.g. data protection and software licensing), and risks not specific to the cloud but to the infrastructure on which it is dependent (e.g. network problems). Uncertainty of service availability and reliability especially the concern over unexpected system downtime and disruption could deter companies from adopting cloud computing because it increases project and business risks. For example it has been reported that the customers of Salesforce.com were left without service for six hours due to system upgrade; and Amazon's EC2 service experienced an outage in one of the East Coast availability zones in the United States because of power failure in a data centre in northern Virginia. IT professionals' existing knowledge and skills will be challenged by cloud computing (Khajeh-Hosseini et al., 2012; Hutchinson et al., 2009); therefore whether having relevant IT professionals in companies to manage cloud computing will be a further issue of concern (Tsai, 2009).

In summary cloud computing poses both opportunities and challenges for companies in general, and IT professionals in particular. Some of these challenges are technical, which can be solved over time, while some are related to the uncertainties derived from engaging with a recent innovation. An objective of this study was to identify some of uncertainties that IT professionals may have and which may discourage them from adopting cloud computing.

3. Theoretical framework

"An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1995, p. 11). Although the novelty of cloud computing is debatable there is no doubt that its introduction challenges our conventional understanding of the location and management of IT infrastructure, the nature of product and service and, business processes and practice (both from IT professionals' and cutomers' point of views). While individuals may actively use cloud services offered on the Internet (Horrigan, 2008) cloud computing remains an unfamiliar concept to businesses and even to IT professionals.

Factors that potentially affect IT professionals' intention of using cloud computing to provide products and services to their customers are taken primarily from the diffusion of innovation theory (Rogers, 1995). The theory identifies five variables that have a profound influence on the rate of an innovation adoption including: perceived attributes of innovation, type of innovation decision, communication channels, nature of social system, and change agents' promotion efforts. Among these Rogers (1995) argues that perceived attributes of innovation is an important predictor of innovation adoption intention. Perceived attributes of innovation

form part of individuals' or organisations' perceptions of an innovation. The attributes identified as being important in influencing the intention to adopt are relative advantage, compatibility, complexity, observability, and trialability.

Relative advantage is the degree to which using an innovation is perceived to make one better off than otherwise. Organisations are likely to adopt an innovation when they believe that it will aid increase in efficiency and effectiveness, and economic gains. The relative advantage of cloud computing includes capital costs, capacity, agility of implementation, reliability, compatibility, ease of use, and flexibility (Grossman, 2009; Leavitt, 2009; Melvin & Greer, 2009; Miller, 2008). The evidence suggests that compared to grid desktops cloud computing is more cost effective in terms of performance and the resources required for it (Kondo et al., 2009); as well as allowing agile distribution of resources (Vouk, 2008). Therefore, perceived relative advantage of cloud computing both technically and economically should encourage IT professionals to consider using cloud computing to provide products and services to their customers.

Compatibility is the degree to which an innovation is perceived to be consistent with internal organisational and information systems environments. The internal organisational environment considers business structures in organisations (e.g. primary and support activities), business strategy in general, existing values, experience, work practice, and organisational needs. The internal information systems environment includes capability, infrastructure (e.g. operating environments including hardware and software infrastructures), domain technology, and implementation technique (Kang et al., 1998). Grandon and Pearson (2004) find that compatibility between e-commerce and a firm's culture, value, and work practices is an influential factor that determines mangers' intentions to adopt e-commerce. In a study of the adoption of web technology it was found that early adopters appear to place more emphasis on the perceived benefits of the technology and its compatibility with the organisation's existing norms and technology infrastructure than do later adopters (Beatty, Shim, & Jones, 2004). Hence compatibility with existing values, experience, business needs, and technological infrastructure is important to IT professionals' intention of using cloud computing to provide products and services to their customers.

Complexity is the degree to which using an innovation is perceived to be a difficult task. A general consensus is that a complex innovation that requires greater technical skills and greater effort to implement will reduce the likelihood of adoption (Cooper & Zmud, 1990; Teo, Tan, & Wei, 1995). This can also be applied to cloud computing as the complexity of the underlying infrastructure and middleware can impact on the wider adoption of a cloud solution (Vouk, 2008). This, according to Vouk (2008), is a lesson learned from grid computing. Hence, IT professionals are more likely to consider using cloud computing if it does not require more technical skills and greater efforts to implement use it.

Trialability is the degree to which, prior to adoption, an innovation can be experienced in a limited way. It is understood that it will increase the likelihood of adoption if users and organisations can experience an innovation before adoption. Teo et al. (1995) argue that the importance of trialability depends on the complexity of the financial impact of an innovation and whether it relates to the company's current or future intention to adopt. They suggest that if the financial impact is complex, trialability will not be a strong predictor of current intentions because the management does not see trialability as useful. Hence trialability can increase the likelihood of using cloud computing because IT professionals may feel more comfortable with it after having used and handled it.

Observability is the degree to which the impact of an innovation is observable to and can be communicated to others. The greater the perceived observability of an innovation the more likely an organisation will be to adopt. Like trialability observability is not a strong predictor of current intentions to adopt; management may be more willing to adopt an innovation if they can see others in particular their business partners benefit from it (Bouchard, 1993; Teo et al., 1995). Therefore the IT professionals are more likely to use cloud computing if the benefits of using cloud computing are obvious and being communicated to them.

This study investigates the impacts of these five attributes on IT professionals attitudes towards cloud computing and their intentions towards its adoption. It is important to note nevertheless that intention does not always lead to adoption but is significantly related to adoption and is perhaps the best measure of the likelihood of implementing a given innovation at the early stage of its lifecycle (Morrison, 1979; Teo et al., 1995).

4. Research methodology

This is an exploratory study which used a survey by interview approach to explore IT professionals' understandings and concerns about cloud computing. A survey by questionnaire survey approach was also considered as many studies based on diffusion of innovation in the IS domain have used this approach to identify the factors influencing the rate of adoption (Premkumar & Roberts, 1999; Teo et al., 1995; Teo, Lim, & Fedric, 2007; Thong, 1999). After careful consideration however the study identified a number of potential issues associated with using a questionnaire to collect data at this stage of an innovation, in this case at the early stages of adopting cloud computing. First, the concept of cloud computing was new to many at the time that the research was carried out, and there was no agreement on a definition of cloud computing. Therefore it is not possible to generate questions and key statements regarding cloud computing. In addition to this, the study takes the stance that the decision to adopt and use a given innovation is dependent on how the innovation is understood and constructed by individuals. Therefore it is important to understand peoples' perceptions and understandings of cloud computing in their own words. Second, as a new concept, many of the features, benefits, and challenges of cloud computing are not well understood and it is difficult to generate key statements on the basis of common understandings and practices. Third, it was felt that it is important for respondents to be able to interact with the researchers when answering the questions in order to clarify their understandings of cloud computing.

Semi-structured qualitative interview was the primary data collection method used in this study. Using an interview instrument enabled us to understand the statements provided by the participants in their social context (Neuman, 2006). We were therefore able to comprehend participants' thoughts on cloud computing and sympathise with their experiences and concerns about cloud computing. The interview method also provides an opportunity for interviewer and interviewees to interact directly. Real-time interaction also means that both parties are able to clarify each others' statements immediately. This is particularly important in this study since because of the novelty of cloud computing the interviewees may need help from the interviewer to understand the concept and questions. A further reason for using interviews is to enable interaction and dialogue between the interviewees and interviewer that can be used to clarify, explore, and raise new issues (Bryman, 2004).

A form of convenience sampling, snowball sampling, was used in the study, so described because of the similarity of the method to a snowball. Neuman (2006) describes snowball sampling "which begins small but becomes larger as it is rolled on wet snow and picks up additional snow." (Neuman, 2006, p. 223) Hence snowball sampling is a method that can be used to access a representative sample through an interconnected network of people or organisations (Bryman, 2004, p. 100). This study targets IT professionals

in organisations in Taiwan. The study began with a small circle of IT professionals who were ex-colleagues of one of the researchers. The researcher was then referred and introduced to other IT professionals through the ex-colleagues. The study focused on people who had at least three years experiences of being an IT professional at the time the study was carried out.

A total of 19 IT professionals were interviewed. All interviewees were in full time employment and had had at least three years experience in the IT industry at the time of the study; this is because it is assumed that they would have more experience and therefore provide better insights and evaluations into cloud adoption. All interviewees either worked either for IT companies or for the IT department in a large company. All interviews were conducted and digitally recorded via the Internet using Skype. All interviewees received a copy of the questions prior to the interviews so that they could decide whether they would like to continue to take part in the study. Table 1 summarises the profiles of interviewees. The study groups the interviewees into two categories: management and engineers because it assumes that individuals occupying different positions in a company will affect the way in which they understand and perceive an innovation.

5. Findings

This section presents the findings of the analysis of the interview data. The findings are organised under the following headings: compatibility, relative advantage, complexity, trialability, and observability.Compatibility

Compatibility refers to the consistency between a previously mooted idea and the perceived innovation. When an innovation is more compatible with the existing values, past experiences and needs of potential adopters, uncertainty will decrease. Also, the rate of adoption will increase (Rogers, 1995, p. 224). It is apparent that compatibility was the major concern that the interviewees had in mind regarding adopting cloud solutions in their companies. The issues raised can be broadly categorised into two groups: the business model and the internal IS environment. Business model refers to products and services to their customers; while internal IS environment refers to the existing IS development environment.

Almost all of the interviewees were from software companies therefore their concern with compatibility was mainly about whether a cloud solution can meet their customers' needs and demands. The terms 'customer demand' and 'customer needs' were mentioned often during the interviews and the interviewees expressed that they would not use the cloud for projects or provide cloud solutions if customers did not ask for it.

> Usually we do not adopt new technologies, only when our customers demand us to use them (M6)

> Currently our customers do not demand us to use cloud technologies to develop solutions for them (E10)

In most cases the interviewees said that they would not use the cloud to develop software but would use existing technologies. The reasons for this include: stability and reliability of cloud, learning curves of using the cloud, and time pressure of project development. They saw that the cloud is new and immature and that therefore using it for project development is risky.

> [. . .] from the project management perspective we would not use new technology for the project if the project time is short because a new technology usually involves learning costs (M1).

> [. . .] although we would like to try new technologies we do not always have opportunities to do so because not all projects require using new technologies. In fact, in practice we tend to use the existing technologies because of time pressure (M5).

Compatibility with a company's products and services is a concern especially for those whose companies develop systems for the banking and aerospace sectors. Usually the systems for these sectors must be robust therefore the uncertainties associated with using cloud technologies (e.g. PaaS, IaaS) should be eliminated. In addition to this the issues of security and privacy are also particularly important to these two sectors. As for the banking sector the integrity and privacy of customers' data is critical and using a cloud service such as IaaS was perceived by the interviewees as unsafe and incompatible with the security requirements of any product for the banking sector. Similarly, IaaS would not be considered by the aerospace sector because system security and data confidentiality are important to them especially when the Ministry of Defence is their customer. The interviewees from the company that specialised in anti-virus software however saw that providing cloud services to their customers fits with their business model and in fact they had already begun developing web-based products when the interviews were conducted. In general companies' decisions about the cloud will have to be agreed by their customers and if the solutions conflict with the contracts with the customers' the companies are unlikely to adopt the cloud as a solution.

Compatibility with a company's current policy is also important and companies are less likely to adopt a cloud solution if it conflicts with company policies.

> We don't encourage our employees to use Google Documents. Because being able to have an overall control of our documents and resources is important to us and it is the company's policy not to put important documents on the Internet (M1).

> We can update the documents and share with our colleagues immediately using the share function in Google Documents. It is good because we can discuss the project having everyone looking at the same document. But we cannot use this officially because it is against company policy (Eng 7).

> At the team level employees can try out SaaS but not at the organisational level. This is because we need to consider whether using SaaS in the company as a whole would undermine the integrity, security and confidentially of our customers' data (M7).

With regard to the internal IS environment, including the existing IS usage within a company and the development environment, the interviewees pointed out that their companies will continue to use the current software such as Microsoft Office applications rather than using cloud office applications, e.g. Online Office or Google Documents. The sunk cost of the existing software package is the reason.

> The company will not adopt cloud such as office application. Because we have already paid for the license for desktop and there is no reason for us to disregard what we have already paid for. Unless the products that we are using now are at the end of their lifecycle (M7)

Using a non-desktop package may run the risk that the document format is incompatible with others and therefore causing problems, e.g. whether their customers are able to read the documents if they use Google Documents.

> The format of the documents often becomes very messy when converting Google documents to PDF or RTF; but I don't have this problem when I use Microsoft Office applications (Eng 5)

It was pointed out that there will be a learning curve for all users if a company is considering switching to cloud office applications.

Table 1
Interviewee's profiles.

Code	Job title	IT seniority	IT service type	Responsibilities
M1	Senior manager	27 years	Software	• Managing the company • Developing business strategy
M2	Middle manager	19 years	Software	• Managing system development
M3	Senior manager	16 years	Software	• Managing projects • Managing system development • Developing business strategy
M4	Middle manager	11 years	Transportation	• Managing projects • Managing system development
M5	Middle manager	9 years	Software	• Managing projects • Managing system development
M6	Middle manager	9 years	Software	• Managing system development
M7	Middle manager	7 years	Banking	• Managing projects • Dealing with system design
M8	Middle manager	6 years	IT security	• Managing projects • Managing system development
E1	Senior engineer	20 years	System integration	• Dealing with system design • Dealing with system integration
E2	Senior engineer	7 years	Aerospace	• Dealing with system design • Developing applications
E3	Senior engineer	6 years	Telecommunication	• Dealing with system integration
E4	Senior engineer	6 years	IT security	• Dealing with system design • Developing applications
E5	Senior engineer	6 years	Banking	• Dealing with system design • Developing applications
E6	Senior engineer	5 years	Telecommunication	• Dealing with system design
E7	Senior engineer	5 years	Aerospace	• Dealing with system design • Developing applications
E8	Engineer	5 years	Software	• Developing applications
E9	Senior engineer	4 years	Software	• Dealing with system design • Managing projects
E10	Senior engineer	4 years	System integration	• Dealing with system integration
E11	Engineer	3 years	Software	• Developing applications

> Once users are familiar with an office package they are likely to resist to other office packages because the way of doing things are different (M2).

> Since I have been using Microsoft Office in the past I naturally expected that Google Documents would have the same or similar functions (Eng 8).

In terms of IS development environment this study focuses on the interviewees' perceptions of possible impacts and changes induced by adopting cloud technologies in the existing IS environment from four perspectives: capabilities, operating environments, domain knowledge, and implementation techniques. The underlying assumption is that the more compatible the cloud solution is with the existing development environment the less effort will be involved in adopting it. From the management point of view capabilities such as the existing knowledge and skills among personnel and company's experiences are the keys when considering cloud computing. As for the management the gap between the existing knowledge, skills, and experiences and cloud computing will affect the costs (e.g. training and education costs, recruitment) and quality of projects (e.g. time management, system design, system reliability and stability). Most software engineers' agreed that the concept of cloud computing is different from the client–server computing but since they have heard or learned about grid, network, cluster, distributed, and utility computing in the past they did not perceive cloud computing as something totally new to them. The interviewees although were not familiar with cloud computing they did not see learning about and acquiring skills of cloud computing is 'incompatible' to their current work rather they saw that as part of their job, as an IT professional, to be interested in technology innovations.

Both managers and engineers interviewed perceived that adopting cloud computing will only have impact on their technical know how; and even so the impact would be limited to the extent that they only need to 'upgrade' their know how. They believed that business domain knowledge such as their own and their customers' business models and operations will remain the same regardless of the cloud adoption. Operation environment both hardware and software were expected to change significantly by the engineers. Because of perceived significant changes in operations environment and required capabilities for cloud computing the engineers expected that they will have to put in more effort to use and implement cloud solutions. However it was believed that the extent of efforts to use the cloud depends on the development tools by API providers. The interviewees believed that good development tools will save time and efforts to develop software.

> The tools can help us save some development efforts because we don't need to learn and code everything from scratch but use the API directly. These tools will speed up the development cycle (Eng 7).

Relative advantage

Relative advantage is taken as a significant indicator of whether the benefits of the adoption of an innovation to individuals or organisations exceed those of the previous idea. Generally speaking, before potential adopters decide to adopt an innovation, they tend to analyse what specific type of relative advantages are important to them (Rogers, 1995, p. 216). The relative advantages of using cloud solutions that IT professionals perceived here can be examined at two levels: personal and organisational. At the personal level all the interviewees have had experience of using webmail, some have also use other services such as Google Documents, Flickr and YouTube. The main advantage of the cloud is its accessibility and convenience which means that they can access the applications and data on any desktops via the Internet and mobile devices. The better performance speed and storage space were mentioned as important reasons for the interviewees to consider using the cloud. Being able to share files with others anytime and any place was identified

as an advantage by those who use Google Documents and Flickr. Another important advantage of using the cloud is that because users no longer need to install some resource consuming software on their desktops and that they do not need to frequently upgrade their personal computers.

> The advantage of cloud-based applications is convenience. You do not need to install software on your own computer and you do not need to update applications. Taking Google Mail as an example; you can access your emails anywhere via the Internet because you save your mails on the Internet rather than downloading them onto your desktop. It is quite convenient. (Eng 6)

> My experience with Flickr is that I can share my photos with friends and family regardless of time and place. In the past in order to access these photos I have to use the specific computer where they were stored. Besides these services are free and easy to use (Eng 10).

At the organisational level the relative advantages of cloud computing are not obvious to the interviewees. This is partly because their products and services do not require using the cloud currently and there is no demand from their customers to use the cloud. In this sense the immediate commercial benefits are not apparent to the companies. However it was pointed out that the benefit of the cloud can be realised when the number of users or volume of the data increases. Some also saw that the cloud can speed up the development cycle and save costs because developers can take advantage of tools and platforms provided by the cloud providers instead of working on them from scratch.

> The cloud will have a positive impact on our product development (aeroplane). The whole operation process will speed up. Using the cloud can speed up the time spent on locating the correct information in our inventory database which is enormous because what we are doing involves a lot of parts (Eng 8)

Although the interviewees cannot see the relative advantage of the cloud to their company and products and services, they identified some issues associated with the cloud which may have a negative impact on their companies and products. First, despite it is argued that cloud solutions can save costs the interviewees believed that there may be hidden costs which will only become apparent after adopting the cloud. These hidden costs may involve human resources (e.g. recruitment and re-training the existing staff), software and hardware upgrade in order to accommodate the cloud, maintenance (e.g. additional hardware to maintain, more dedicated personnel involved to maintain the hardware and software). Compared with in-house hardware and software the interviewees perceived that they would lose overall control of the resources which may put them into a disadvantageous position because of the poorer quality of the services provided to their customers. That leads to concerns about the security measures in place when using the cloud

> . . .you cannot have overall control over the providers. What would when problems occur in your system? You cannot fix them immediately because you rely on the provider to fix the problems. This is a serious problem because in the banking sector the system has to be 24×7 without interruption. The cloud has to satisfy this basic requirement (M2).

Complexity

Complexity is relative to the degree to which cloud computing is difficult to use, recognise and realise. According to Rogers (1995, p. 242) the complexity of an innovation is not positively related to the rate of adoption. Although complexity is not a decisive factor, data analysis still suggests the potential effort required to adapt to cloud computing. Most engineers thought that a cloud environment will be more complicated than the current local client–server environment especially from the point of view of developing programming codes that have to consider parallel computing. However they believed that if the service provider can provide easy to use development tools, learning about and working within the cloud should not be an issue for them. On the other hand some felt that cloud computing can be difficult to learn because it covers a wide range of techniques and therefore more parameters need to be taken into account.

> I think that it may be difficult to acquire the techniques of cloud computing. This is mainly because it covers a wide range of IT techniques and concept making it difficult to understanding cloud computing (Eng 4)

> From the user point of view the cloud is easy to use but from the developer's point of view cloud is very complicated. This is because you have to ensure the integrity of each layer and the links between the layers. . . The complexity however can be reduced if some basic layers [lower end] are already available to developers (Eng 3).

One interesting point made by an engineer who stated that using the cloud could complicate the existing dynamics between different developers. This issue could be escalated when problems arise and no one would want to take responsibility.

> The most difficult part is to debug the system because there are so many layers that you have to take into account. For example some may focus on developing front ends while some focus on the backend, and when problems arise people who develop front ends would blame the backend which failed to support the user interface, and vice versa.

Ease of maintenance was mentioned several times during the interviews. It was pointed out that ease of maintenance was also an important criterion other than reliability, stability, and interoperability when a new technology is considered. Ease of maintenance refers to the efforts including time and personnel that companies have to put in to maintain the technology.Observability

Observability is relative to the visibility of successful cases and practices. When an innovation is visible to others, it will help raise the rate of adoption (Rogers, 1995, p. 244). All interviewees claimed that their companies will not adopt a new technology unless the technology can demonstrate a relative advantage in comparison to existing technologies and commercial benefits (e.g. increase in revenue and faster systems development lifecycle). A few pointed out that 'cloud computing' is still a concept, therefore its commercial value and the costs of using the cloud are still not clear. Besides this because most companies are small to medium size companies they are unlikely to take risks to use the cloud if its benefits are not clear. Thus providing successful business cases and models to demonstrate the worth of the cloud adoption is a "must have" when cloud providers promote the concepts and technologies.

> Currently there are not enough commercial applications based on cloud computing. Advertisement is still the main source of the revenue (M2).

> In order for me to consider the cloud the providers have to offer reliable and better solutions than the ones that we are using now. I would also like to know the actual numbers that show actual costs involved and savings of adopting the cloud. Case studies to demonstrate successful business models and applications of the cloud will help me make adoption decision (M6).

> It is important for us to know how successful cloud adoption is especially by those large companies. We usually check with other banks to see if they have used similar technologies and

their experiences of using them. We only consider adopting a technology when others are happy with it (Eng 5).

Businesses are very programmatic, they won't invest in something where its benefits are not apparent or measured. That is why cloud computing still not taking off big time even it has been discussed several years ago. (Eng 2).

Trialability

Trialability means that potential adopters can experiment with cloud services on a limited basis (Rogers, 1995, p. 243). According to the theory of diffusion of innovations, trialability of an innovation will lead to an increase in the rate of adoption. From the interviews, it is clear that all the interviewees have used cloud services in their daily lives and they are aware of the benefits of using the services. However cloud computing is not widely adopted at organisational level even through grassroots (bottom up). In terms of adopting SaaS Google Documents has been used informally in a couple of companies but not formally. Although the interviewees could not see the benefits of using the cloud office applications they agreed that the current desktop office applications are superior in terms of their functions and speed. In terms of IaaS and PaaS interviewees did not have first hand experience of using the technologies, therefore they were not sure if these two types of the cloud will benefit their work.

6. Discussion

The findings of the study suggest that in order for cloud computing to take off in the IT sector in Taiwan cloud service providers and other stakeholders such as government and leaders in IT sector need to do more. More papers and examples have been published in the past years to identify and illustrate the potential financial benefits offered by cloud solutions however these benefits are not widely realised in practice and there is a lack of sufficient evidence to support the claims. According to the literature cloud solutions can help companies, especially small to medium size companies to make savings from buying, running, and maintaining their IT infrastructure. However the interview data of this study suggests that such cost savings can only be realised for the new companies. This is because the existing companies would have invested in the infrastructure (sunk cost) already using the cloud solutions; indeed will incur costs unless the existing infrastructure has come to the end of its lifecycle and requires a replacement. On the other hand sunk costs may be incurred when companies want to adopt a cloud service because they may have to first upgrade their infrastructure in preparation for cloud adoption. In addition to overlooking the sunk cost the current literature also underplays the transaction costs associated with using the cloud services provided by the third party. The transaction costs involved here are: bargaining costs which incur when level of service (SLA) is formally defined and agreed in the service contract between companies and cloud providers; and policing and enforcement costs which are the costs of making sure cloud providers stick to the terms of the contract. The transaction costs can be overwhelming depending on the complexity of the agreements. In this sense companies are often better off using their own resources rather than relying on third party providers. Other costs such as the cost of learning is considered by the existing literature. Cost of learning is the cost of learning new knowledge and skills. The findings of this study indicate that it is a major concern for managers when considering using the cloud. Although most engineers interviewed were willing to acquire cloud computing skills they and the companies will have to invest time and money for training. The cost of time and training spent on learning about cloud computing will depend on how steep the learning curve is.

Compatibility with company policies is also a significant factor in the adoption decision. Company policies that most interviewees referred to were mainly the quality and security measures that companies take to ensure the integrity of their services to customers. Interviewees pointed out that using the cloud such as IaaS means that companies will lose governance of the infrastructure. An implication for this is that companies may be able to overall control when problem situations arise such as systems downtime and have to rely on cloud providers' services. This, they believe will have an impact on their overall service quality to customers. In terms of security measures companies were most worried about data leakage, loss of data, and data protection; and this explains why they discourage employees from putting company documents on the Internet. This policy according to the interviewees is reinforced by the customers as their businesses require better security measures (e.g. data protection on individuals' bank accounts). Indeed policy and organisational risks (e.g. loss of governance), technical risks (e.g. data leakage, loss of data), and legal risks (e.g. data protection) have been identified in the literature as possible obstacles for cloud adoption (Khajeh-Hosseini et al., 2012).

Customer needs are the key to cloud adoption. All interviewees referred to this as the most important parameter when considering the cloud. That is, unless there is a specific request from customers for using the cloud the companies are more likely to use the existing technologies that they are already familiar with. In so doing the companies can shorten the developing time comparing with using a new technology, e.g. cloud and ensure the quality of the product which is reliable and compatible with other products in the market. "We do not use the cloud just because it is the cloud" is a general remark made by interviewees on different occasion during the interviews. This clearly reflects the fact that companies' attitudes towards adoption is market oriented which is demand-pull rather than technology push. While the literature is promoting the computation power of the cloud it overlooks the actual needs of consumers. The interviewees in this study clearly stated that computational power can only be realised if scalability is required. In this sense using the cloud does not necessarily give companies or consumers any advantage.

From the point of view of end users, most interviewees in this study believed that the cloud, especially SaaS and Service, will be the trend in the future. They also believed that mobile devices, especially smart phones, can take advantage of the benefits offered by the cloud in order to develop better services to mobile users. From a business point of view the interviewees argued that viable business models, which are built on cloud computing, are more important than cost reductions through the cloud. The interviewees argue that they would like to know how using the cloud can help them increase revenues and improve and differentiate their product and service offerings when making adoption decisions. And companies are said to hold back from adopting cloud because of the lack of examples of successful adoption and innovative business models (Tsai, 2009). Leavitt (2009) also noticed that best practices can reduce uncertainty and fear in potential adopters which explains why most companies are having wait-and-see attitude towards cloud adoption.

It is apparent from the interviews that there is a lack of understanding of cloud computing (Buyya et al., 2008; Vaquero, Rodero-Merino, Caceres, & Lindner, 2009; Voas & Zhang, 2009). Currently the Internet is the main source of information about cloud computing and many interviewees found that although there are various views of cloud computing there is no unified definition of the concept. The lack of a clear definition may prevent IT professionals from exploring the cloud (Vaquero et al., 2009) and at worst it may prevent companies from adopting it. This is because it can lead to a lack of standardisation between application program interfaces and hence interoperability, thus preventing companies

from switching easily from one platform to another and from one cloud provider to another (Greer, 2009; Grossman, 2009). As stated by the interviewees in this study, the lack of a standard can prevent companies from adopting the cloud and that also explains why companies are waiting for a widely agreed and used standard before they decide to adopt.

7. Conclusion

This paper investigates IT professionals perceptions and attitudes towards adopting cloud computing in Taiwan. Despite the efforts made by providers such as HP and IBM the interview data suggests that many IT professionals do not have an in-depth understanding of the cloud nor are they aware of its benefits to businesses. Their main concerns revolve not around the complexity and effort that will be required but around the business applications of the cloud. Companies will wait until more sustainable business models and more successful cases of cloud adoption emerge before they make their decision.

The implications of the findings of this study for practice are these. First, in order to promote cloud computing among commercial companies cloud service providers should provide successful case studies and statistics in order to help companies realise the applications of the cloud. That is, to make the benefits of adoption more observable to companies will help companies understand the concept and realise the potential benefits. Second, like web services SLA is also important to cloud services as companies will likely be put off when SLA is clear. Third, to achieve agreement on an industry standard perhaps is the priority in the sector. The standardisation will reduce uncertainties and hence encourage adoptions. Fourth, like other information technology adoptions in businesses there are issues other than the technology that need to be taken into account for example compatibility of the technology with organisational policy, structure, value, and most importantly products and services. Companies will have to assess the necessity of cloud computing to their business first and then its compatibility. Further research on cloud computing should focus on investigating how businesses are using the cloud to create advantage. Further research also needs to identify the issues faced by organisations when adopting the cloud. Since cloud computing is still new to both academia and commerce the outcome of these studies will help academics and practitioners alike assess the actual uses of the cloud in practice and the business benefits and challenges of adopting it.

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Angela Lin is a lecturer of Information Systems at the University of Sheffield. Her research takes a socio-technical view of organisational process of information systems implementation and adoption. She is particularly interested in the social and political environments in which information systems are implemented and adopted and the changes brought by the information systems to those environments. Another research area that Angela works on is business as well as consumer adoption of information technologies in the digital economy.

Nan-Chou Chen is a project leader in Asus, a global computer company. He holds an MSc degree in Information Management at the University of Sheffield. Prior to joining Asus he was a system manager responsible for Product Lifecycle Management system at Compal Electronic Company Taiwan and before that he worked as a software engineer specialized in developing banking systems. He is interested in the topics of the diffusion of cloud computing in business sectors and implementing and adopting cloud computing in businesses to deliver products and services to customers.