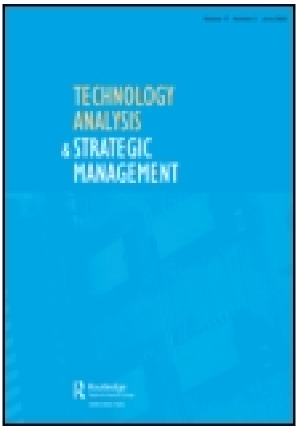

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Organisational culture and cloud computing: coping with a disruptive innovation

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Since 2007, cloud computing has emerged as a computing paradigm that is likely to change many of the traditional ways of delivering computing services to people and organisations. Many organisations, small and large, have embraced it because of the advantages it promises in terms of flexible cost structure, scalability and efficiency. However, is cloud computing the type of disruptive innovation that is likely to require a fundamental shift in the way supplying organisations view their delivery of computing services, and in the way consuming organisations perceive and use those services? This paper attempts to address this issue by reflecting on the developments of this emerging computing service modality and Christensen's theory of disruptive innovation. In doing so, the article highlights the implications of cloud computing for the future directions of organisations and their cultures.

Keywords: cloud computing; disruptive innovation; organisational culture.

1. Introduction

In the future innovations, especially technological, could have profound implications for the way organisations conduct their business and, indeed, for the wider community. This is particularly the case with disruptive innovations. Christensen (Christensen 1997;[1] Christensen and Raynor 2003; Christensen, Anthony, and Roth 2004) describes two types of innovations: sustaining innovations and disruptive innovations when he refers to his 'disruptive innovation theory'. Sustaining innovations, according to Christensen, are often innovations that occur frequently and are implemented by established large companies in order to improve the performance of some of their products that have strong market shares. Disruptive innovations occur less frequently and tend to have performance problems initially. However, they are likely to be less expensive, simple and more convenient to use. Most importantly, disruptive innovations can destabilise existing markets and may result in the failure of well established companies.

Despite the unmistakably disruptive nature of the Internet in terms of its ability to create new business models (e.g. e-commerce, e-advertising, e-learning) it is, if one is to apply Christensen's disruptive innovation theory, also a sustaining innovation. By the same token, one can also argue that cloud computing, despite its tangible disruptive qualities in terms of creating more business

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opportunities for delivering computing services over the medium of the Internet, is also a sustaining innovation. This area will be explained later, but a brief definition of cloud computing is warranted at this point.

2. Defining cloud computing

No common standard or definition for cloud computing seems to exist (Voas and Zhang 2009; Grossman 2009). However, the definition that describes it as clusters of distributed computers (largely vast data centres and server farms), which provide on-demand resources and services over a networked medium (usually the Internet) seems to be commonly accepted. The word 'cloud', a metaphor for the Internet, is likely to have been inspired by information technology (IT) textbook illustrations which often depicted remote environments (especially the Internet) as cloud images. Some sources also claim that the term 'cloud computing' was coined by Google's chief executive officer (CEO) Eric Schmidt during a search engine conference in 2006, when he described Google's software as 'cloud computing' (Willis 2009).

The services that can be offered by cloud computing can be listed in the following three main areas (Sultan 2011):

(1) Infrastructure as a Service (IaaS): Products offered via this mode include the remote delivery (through the Internet) of a full computer infrastructure (e.g. virtual computers, servers, storage devices). Some of the most notable vendors under this category include Amazon's EC2, GoGrid's Cloud Servers and Joyent;
(2) Platform as a Service (PaaS): Services provided by the traditional computing model, which involves teams of network, database and system management experts to keep everything up and running (e.g. operating systems, databases, middleware, Web servers and other software), are now provided remotely by cloud providers under this category. Some of the early market leaders in this field include Google's App Engine, Microsoft's Azure, Amazon Web services, and Force.com (supplied by Salesforce.com);
(3) Software as a Service (SaaS): Under this, layer applications are delivered through the medium of the Internet as a service. Instead of installing and maintaining software, one can simply access it via the Internet; thus freeing oneself from complex software and hardware management. This type of cloud service offers a complete application functionality that ranges from productivity applications (e.g. word processing, spreadsheets) to programs such as those for Customer Relationship Management (CRM) or Enterprise-Resource Management (ERM). Products under this category include Yahoo mail, Google Apps, Saleforec.com, WebEx and Microsoft Office Live.

A cloud provider maintains a number of data centres (possibly scattered in different parts of the world and inter-connected), stocked with servers that provide the three types of cloud services listed above. Cloud users access and interact with those services through the cloud (i.e. the Internet). Typically, users do not have to worry about the location of their data. In some cases, however, they could be presented with an option to choose the preferred locations of the data centres that will host their data. This would be particularly useful for organisations that are legally required to maintain their clients' personal data in certain geographical locations.

There are mainly two technologies that underpin this new computing paradigm, namely 'virtualisation' and 'grid computing'.

Virtualisation is a technology that masks the physical characteristics of computing resources (e.g. a PC or a server) in order to simplify the way in which other systems, applications, or end users interact with them. For example, a PC running Windows can use virtualisation to enable another operating system (e.g. Linux) to run alongside Windows. Furthermore, the technology also enables single physical resources (e.g. a server, an operating system, an application, or storage device) to appear as multiple logical resources.

Grid computing involves the use of software to combine the computational power of many computers, connected in a grid (hence the term 'grid'), in order to solve a single problem (often one that requires a great deal of computer processing power). Furthermore, grid computing also uses software that can divide and farm out pieces of a program to as many as several thousand computers. Grid technology, therefore, can be thought of as the technology that enables the establishment of network-distributed parallel processing and distributed and large-scale cluster computing. These two innovations have become the most fundamental technologies that underpin cloud computing (Carr 2009).

A public cloud (also referred to as a commercial cloud sometimes) is a term used to describe a computing service provided by a third party, i.e. a cloud vendor. Interestingly, there are also two additional types of clouds: private and hybrid. In a private cloud, the business or organisation takes the role of the third party and implements a cloud infrastructure in-house. This arrangement may be suitable for organisations that desire (possibly due to the sensitive nature of their business) to take overall control of how they manage and secure their data and IT infrastructure. However, the disadvantage of this arrangement is that organisations take responsibility for managing their hardware, software and the people (e.g. technicians, developers) who run those assets. Whereas a hybrid cloud involves outsourcing some aspects of an organisation's IT operations to a public cloud provider while maintaining an in-house private cloud. BAE Systems (see below) is an example of a hybrid cloud user.

3. Increasing interest in and impact of cloud computing

The high rate at which IT technology changes will continue to place a great deal of pressure on organisations' budgets. Continuous upgrades of software and hardware have become important items on many of those organisations' agenda meetings. These budgetary constraints are likely to be made worse in the current difficult economic conditions following the near collapse of the world's financial systems in 2008.

Budgetary constraints

Cloud computing services could provide many of those companies with the opportunity to continue to take advantage of new developments in IT technologies at affordable costs. Organisations that adopt this service model will be able to access the latest technology in terms of software and hardware (on a pay-as-you-go basis) without having to spend great sums of money on software licenses and upgrades and expensive hardware. Cloud computing is likely to be particularly attractive (from an economic viewpoint) to start-ups, small to medium enterprises (SMEs) and educational establishments, which have demonstrated increasing interest in this computing service (Sultan 2010a, 2010b, 2011).

Environmental factors

Most interestingly, cloud computing has the potential to reduce companies' carbon footprints and, at the same time, reduce their electricity bills. It is estimated that the world's 1.5 billion computers consume about 90,000 MW of electric power, which is about 10% of global consumption (Lefèvre and Pierson n.d.). Subscription to public clouds will enable organisations to spend less money on electricity for powering and cooling their computing hardware. It will also enable those organisations to devote less space to house their IT infrastructures and resources (an advantage where square foot rent is at a premium). There is increasing government pressure on companies in the UK and elsewhere to reduce their carbon footprints. For example, the UK's Carbon Reduction Commitment (recently renamed the CRC Energy Efficiency Scheme) is aimed at reducing carbon emissions within the UK by 60% by 2050, in comparison to 1990 levels. On a regional level, the Eureopean Union (EU) Energy Using Products Directive is aiming to reduce the environmental impact caused during the manufacture, use and disposal of a very wide range of products (except vehicles for transport). Consumers of cloud services will find themselves in an advantageous position with regard to this issue in a more environmentally friendly and greener future with more ethically conscious consumers.

4. Cloud computing and the theory of disruptive innovation

According to Christensen (see Christensen and Raynor 2003; Christensen, Anthony, and Roth 2004), the disruptive innovation theory is a useful tool to explain how organisations cope with innovation. Innovation, according to this theory, is either sustaining or disruptive. Sustaining innovations are what move companies along established improvements trajectories. These are improvements to existing products, e.g. airplanes that fly farther, faster-processing computers, cellular phone batteries that last longer and televisions with improved quality pictures. Disruptive innovations, in contrast, introduce a new value proposition. They either reshape existing markets or create new ones. Hence, there are two types of disruptive innovations: low-end and new-market. Low-end disruptive innovations can occur when companies offer 'good-enough' products and services to 'overshot' customers (i.e. customers content with those products and services) at much lower prices. Wal-Mart's discount retail store and Dell's direct-to-customer models are examples of low-end disruptive innovations. New-market disruptive innovations can occur when characteristics of existing products and services (e.g. size, price, complexity) limit the number of potential consumers or force consumption to take place in inconvenient or centralised settings. Bell's telephone, Sony's transistor radios, Apple's personal computers and eBay (among others) are examples of new-market disruptive innovations. They all created growth by making it easier for people to do something that historically required a great deal of expertise or great wealth.

Cloud computing has been promoted by some authors and analysts during the last few years as, potentially, the new fifth utility after telephony, water, gas and electricity. However, its fundamental concept (using other organisations' IT resources on a per-use basis to process business-related data) may be traced back to the practice of 'timesharing' during the 1970s when small companies relied on other companies (which had access to mainframe computers) for processing some of their data (e.g. payrolls) for a fee (Campbell-Kelly 2009). One author refers to this practice as 'Timesharing 2.0' (Campbell 2009). Furthermore, cloud computing also relies on existing innovations, e.g. the Web, virtualisation and grid computing. Some of these innovations are both sustaining and disruptive if one is to employ the criteria of the disruptive innovation theory proposed by Christensen. The Web, for example, is fundamentally a sustaining innovation. It is an improvement on the Internet which existed initially as a means of connecting US government establishments and universities, a kind of large wide area networking (WAN) system. The only difference with this sustaining innovation from that advanced by the theory of disruptive innovation is that it was not created by a company wanting to produce a better product, but by British scientist

Tim Berners-Lee. The Web did not displace WAN. Many organisations still communicate and exchange data with their geographically distant branches and business partners through this mode of communication, but at the same time, the Web is also both a low-end and new-market disruptive innovation. It has allowed many companies to capture a much larger consumer base through the provision of their goods and services at much-reduced prices. Furthermore, consumers are also provided with feedback from past satisfied or dissatisfied customers on products and sellers before their purchase. It also enabled the creation of new markets, such as when sellers can select a product and invite suppliers to submit their best prices, or when sellers invite bids from buyers on products whose prices will ultimately depend on the number of interested buyers. This mode of trading has become known as consumer to business (C2B), a type of inverted business model.

The same applies with relation to virtualisation and grid-computing. Virtualisation is a fairly well-established innovation. According to Barb Goldworm, president of Focus Consulting, about 75% of large enterprises use virtualisation for some aspects of their businesses (Shavit 2008). Virtualisation can be described as an approach to pooling and sharing technology resources to ensure supply can readily meet business demands. With servers, storage, or networks, virtualisation is used to take a single physical asset and make it operate as if it were many separate, smaller assets. This process improves asset utilisation and efficiency, and decreases costs by reducing the need for physical assets. Additionally, with storage or networks, virtualisation is used to combine multiple assets and present them to servers and applications as if they were a single, larger asset. This dramatically simplifies server and application architecture and reduces costs.

The emergence of virtualisation can be traced back in history to the mainframe era when it was first introduced. It began with ‘virtual memory’ which dates back to the late 1950s. Virtual memory is a process that increases the actual amount of memory available to a computer by allocating it space on that computer’s hard disk. This idea was quite radical at that time and advantageous due to the fact that computer memory was extremely expensive during the 1950s and 1960s (see Dandamudi 2003). This concept of creating ‘virtual’ resources was developed further in the 1960s in order to partition large mainframe hardware for better hardware utilisation. The term virtual machine (VM) dates back to that era. IBM became the pioneer of VM systems when it introduced the System/360 (model 67) in 1967 with its integrated virtual memory, which allowed the creation of multiple virtual memory address spaces for different users, thus potentially permitting each user to have a private virtual machine.

In the late 1990s, interest in virtualisation grew owing to a sudden increase of the number of servers used throughout the enterprise which created a major issue of hardware redundancy. This redundancy was due to the conflict between the software installed on servers, which necessitated acquiring and assigning servers with specific tasks in order to avoid that conflict. This resulted in servers only using a fraction of their resources. Organisations soon realised that this large abundance of servers had a high maintenance cost, especially when those servers were not being utilised to their full capability. This issue increased the appeal of virtualisation. Software vendors saw in this situation a new market opportunity (Campbell and Jeronimo 2006). As well as being an improvement of an existing technology (i.e. a sustaining innovation), server virtualisation was also a new-market disruptive innovation. It enabled consumers to make better use of their IT resources in a very affordable and efficient way. A number of emerging and large companies specialised in this area and became major players such as VMware (which began operating in 1998 with just 20 employees), Citrix Systems (founded in 1989) and Microsoft (founded in 1975).

As with the Web, grid computing was an improvement on an existing innovation, namely ‘clustering’ which was developed during the 1980s by companies like Digital Equipment Corporation (now part of Hewlett Packard). Clustering allowed two or more computers to appear as if they were just one computer to the end-user, thus enabling load-balancing and hot standby. (Load-balancing is a technique to distribute workload evenly across two or more computers. Hot standby (also known as hot spare) is a data-recovery method which allows the primary and secondary (i.e. backup) systems to run simultaneously so that data is mirrored to the secondary server in real time as a safety procedure for system failure.)

Oracle used load-balancing and hot standby in its database management systems (starting with Oracle 9i), which avoided the need to manually switch users from one database instance to another in cases of failure and the need for applications to be cluster-aware. That was the start of an evolutionary process for grid computing. Companies such as Sun Microsystems extended the concept of clusters to include a variety of computers from different vendors running different operating systems in a 'pool' of computing resources that can be made available as and when required to serve peaks in the demand for those resources.

However, the term 'grid' was coined in 1997 following a workshop entitled 'Building a Computational Grid' organised by two researchers (Ian Foster and Carl Kesselman) at Argonne National Laboratory (a research facility operated by the University of Chicago for the United States' Department of Energy). The workshop was followed in 1998 by the publication of a book entitled *The Grid: Blueprint for a New Computing Infrastructure* authored by the same researchers. Foster and Kesselman became known as the fathers of grid computing and their book (which was republished in 2003 after undergoing substantial re-editing) was considered the 'Grid Bible' (Antognini 2004).

As with virtualisation, the motivation for the development of grid computing grew out of a desire to improve the efficiency of using computer resources. For example, research has shown that the average central processing unit (CPU) usage is only 15–20%, and storage usage is only 50% (Smart Soft Computing n.d.). Having resources dedicated to run each major application also means that there can be a large number of systems to maintain. The solution to this problem necessitated the creation of a grid – a pool of low-cost servers and storage that can be allocated to applications to meet peak loads. However, as with the Web, it took (in this case) two scientists to catapult grid computing into the next stage of its evolution. As well as being a sustaining innovation, grid computing is also a new-market disruptive innovation. It opened a new market composed of governmental and scientific institutions with huge and frequent computational requirements for data processing. It made it possible to use a huge computational power without having to spend great amounts of money in expensive hardware and setup costs. Most importantly, however, grid computing is becoming part of cloud computing and is serving a much larger pool of enterprises with small or occasional computational needs.

As is the case with the main innovations (i.e. virtualisation and grid computing) that underlie it, cloud computing is both a sustaining and disruptive innovation. As a business model, cloud computing is a huge improvement on timesharing, a case of sustaining innovation. Unlike timesharing, cloud computing allows organisations to remotely buy a variety of computing services at a click of a button, and to scale their needs of those services up or down as and when required in real time. It has created opportunities to economically deliver a range of 'good-enough' computing services (a case of low-end disruptive innovation) that historically required consuming companies to devote large expenditures in terms of hardware, software and labour, and, in the process, benefited many companies with humble resources. It has also created a new market where organisations can make 'pain-free' use (at affordable prices) of a range of historically expensive and hugely complex technologies (a case of new-market disruptive innovation).

5. Cloud culture

The notion of providing a wide array of computing services on the fly on a pay-as-you-go basis opens many opportunities for the providers of those services to exploit this expanding market which, according to Gartner (the global IT research and advisory company), will generate revenues that could reach US$150 billion by 2014 (Hickey 2010). At the same time, it increases the options available to policy makers entrusted with the job of ensuring the efficient functioning of the IT resources of their consuming organisations. Consuming organisations need not waste resources by over-provisioning for a service whose popularity does meet their predictions or under-provisioning for one that becomes wildly popular, thus missing potential customers and revenue. The elasticity of using IT resources in this way, without having to undergo large scale investment, is unprecedented in the history of IT (Armbrust et al. 2009). On that basis, cloud computing represents a paradigm shift in the way IT (in its all aspects) is being sold to, and consumed by, clients (Sultan 2011). Consequently, there are bound to be cultural issues with those organisations that provide this innovation as well as the organisations that are affected by it.

An increasing number of historically successful IT vendors are beginning to realise that a cultural change is engulfing the IT landscape that requires a cultural overhaul of the way they used to do business. Larry Ellison, the founder of Oracle, once criticised the rash of cloud computing and described it as ‘fashion-driven’ and ‘complete gibberish’, and commented that it would be hard to make money from this technology, which he saw as ‘lacking a clear business model’ (Johnson 2008; Hasson 2008), but he soon realised the danger of dismissing emerging innovations in this way. Oracle has finally acknowledged the power of the cloud and is trying to do some catching-up. The same also applies to SAP (Systems, Applications, and Products in Data Processing), which is in a similar position (Williams 2010). One IT analyst commented:

> I believe that cloud is a revolution for Oracle, IBM, SAP, and the other big vendors with direct sales forces (despite what they say). Cloud computing has the potential to undermine the account-management practices and pricing models these big companies are founded on. (Rymer 2010).

History has proved to be unkind to technology companies that ignored the signs of disruptive innovations. Kodak, once market leader in the film and camera market, is a recent example. Kodak’s middle managers were unable to make a timely transition to digital technology. The consequences were dramatic. Kodak experienced a nearly 80% decline in its workforce, loss of its market share, a tumbling stock price and significant internal turmoil as a result of its failure to take advantage of the new digital technology (Lucas and Goh 2009).

Many other software vendors are also finding the switch to cloud computing culturally challenging. Their main problem is finding a way to offer cloud-based applications without having to undermine their existing revenue streams according to Bailey (2010a), who quotes a director at Quocirca (a research and analysis company) as saying that many of those are still sitting there with a ‘maintenance for life’ business model and that moving to a cloud subscription model is ‘stressing their brains quite heavily’.

Consumers of cloud computing should also be prepared to implement cultural changes in the way they view their IT resources and infrastructures.

Cloud computing, as indicated earlier, is an emerging computing service paradigm and, like other services of this scale, complexity and novelty, there are likely to be some issues associated with this innovation. Loss of control, vendor lock-in, security, privacy and reliability are examples of those issues.

IT departments and organisations are likely to be wary of surrendering control of their resources to outside providers who can change the underlying technology without customers' consent. The European Network and Information Security Agency (ENISA) survey showed that 29 out of 62 small- and medium-sized enterprise (SME) responses saw 'loss of control of services and/or data' as being 'very important' (ENISA 2009). Issues relating to performance (evidenced by the temporary run-outs of capacity by some providers) are also problematic.

Furthermore, there are also valid security concerns. A survey of chief information officers and IT executives by IDC (International Data Corporation) rated security as their main cloud-computing concern and almost 75% of respondents said they were worried about security (see Leavitt 2009). Moreover, various governments, such as those in the EU, have privacy regulations that prohibit the transmission of some types of personal data outside the EU. These regulations have prompted companies such as Amazon and Microsoft to develop offerings using data centres located in the EU, and to provide users with the option to choose the geographical locations of the data centres that will host their data.

Another concern is vendor lock-in and failures. Currently many cloud providers offer their services through proprietary interfaces as there are no cloud-computing standards for elements and processes such as APIs (application programming interfaces), the storage of server images for disaster recovery, and data import and export. This means that cloud users could find it difficult to switch cloud suppliers without too much pain and expense. Portability is likely to be increasingly important as the number of cloud providers increases. Furthermore, failure of a cloud provider that owns data centres can have serious repercussions for end users who trusted their data with such a provider. However, there are some efforts to address issues relating to the portability and security of cloud computing by bodies such as the Cloud Computing Interoperability Forum (www.cloudforum.org), whose purpose is to promote the creation of a common cloud computing interface, and the Cloud Security Alliance (www.cloudsecurityalliance.org), which was created to promote security best practices in a cloud computing environment. Moreover, there are currently efforts to base vendors' APIs on open source messaging standards such as simple object access protocol (SOAP) or representational state transfer (REST) to overcome this interoperability problem. Companies such as Amazon and Microsoft are moving in this direction. For example, Amazon is making its S3 storage cloud available through both SOAP and REST, and Microsoft's Windows Azure cloud also supports those standards.

Lastly, reliability can also be a serious problem for cloud users. Salesforce.com, for example, left customers without service for 6 hours in February 2008, while Amazon's S3 and EC2 suffered a 3-hour outage a few days later. In July 2008, an 8-hour outage was caused by Amazon's S3 (Leavitt 2009). In early 2009, Google's Gmail (its Webmail service) went down for 3 hours, thus preventing its 113 million users from accessing their emails or the documents, which they store online as 'Google Docs' (Naughton 2009).

Notwithstanding these important issues and concerns, using cloud computing has many operational benefits. One such benefit is efficiency. It is a service that matches computing supply to demand, thus providing instant scalability. Furthermore, the virtualisation technology that cloud computing relies on can help reduce redundancy. For example, companies requiring access to hardware (e.g. servers) can rent rather than buy these (virtualised) resources from cloud providers. Even where cloud computing is thought to be giving rise to concerns about security and reliability, there are some analysts and cloud users who think that cloud computing can still provide better security and greater reliability than those provided in-house (see Ashford 2009; Linthicum 2009; *The Financial Times* 2009). According to Eran Feigenbaum, Google's enterprise security director, most businesses do not have the security intelligence gathering capabilities and resources that are available to his company. The following is a collection of quotes Feigenbaum made on a visit to London that reflects his views on this issue:

> Cloud computing can be as secure, if not more secure, than what most organizations do today in the traditional environment. . .. Data is typically lost when laptops and USB [universal serial bus] memory sticks are lost or stolen, but local storage is no longer necessary if a company uses cloud-based apps. . .. Statistics show that 66% of USB sticks are lost, and around 60% of those lost contain commercial data. (Ashford 2009)

On the issue of security patching, a common problem with many organisations, and cyber attacks, Feigenbaum explains how this issue is handled by his company:

> Research shows most organizations take between 25 and 60 days to deploy security patches, but CIOs [chief information officers] admit it can take up to six months. . .. Google is able to patch systems rapidly and efficiently as it has a homogenous IT environment across the organisation, unlike most other businesses. . .. Google is able to gather security intelligence from billions of transactions a day and apply that intelligence in real time throughout the organisation. (Ashford 2009)

Reflecting on the security concerns expressed by companies contemplating moving to the cloud, Green, from Trustmarque Solutions (a UK software solutions provider based in York), asks:

> . . .how many of those companies can truly say they have an internal data policy that is more rigorous than that of a third party? And is duly enforced. How many of those companies strictly govern their staff's training to ensure they understand security policies and their importance and the consequences when they fail? (Green 2010)

The aforementioned views on cloud vs in-house security are shared by Field, director of Parsec Systems, a London-based IT solutions provider, who says:

> There is a tendency to assume data is safer in-house because we have control. However, large cloud providers can generally fund more significant security measures. They do that because they hold a goldmine of digital information and will be attacked regularly and assiduously by well funded cyber-criminals. This has to be factored into the cost/benefit analysis. Unemotional thinking will be necessary when comparing in-house security to that of an external provider. (Field 2010)

Despite some highly publicised system 'glitches' (such as those mentioned above) by a small number of the big cloud players, some analysts also argue that cloud computing has, thus far, a good uptime record. Linthicum (2009), a technology consultant, asserts that cloud computing providers understand the sensitivity of their customers towards downtime, and that most of them have built distributed failsafe features into their offerings. This, according to him, means that when a cloud provider's primary data centre goes down, another data centre is ready and waiting to pick up the load, typically invisible to the cloud-computing consumer. When there is a catastrophic failure, most cloud providers often have procedures in place to resume a service very quickly.

While acknowledging that cloud computing has teething problems, such as the aforementioned, efforts are underway to address those issues as many of the big cloud players are throwing their weight behind this new business model.

The disruptive nature of cloud computing requires a radical response from organisations that deliver 'traditional' IT services as well as consuming organisations that either embraced this innovation or are still considering its implications for their businesses, and therefore have not yet made the move.

Organisations develop their own cultural identity as they grow. This cultural identity of organisations is their own way of conducting their business, epitomised in the values exhibited by their employees when they decide which orders are more important, what type of customers should have priority, and whether an idea of a product is attractive. As well as defining what an organisation can do, it also defines what an organisation cannot do. Culture is therefore a double-edged sword. When great changes such as disruptive innovation occur, cases studies have shown that organisational culture generates cultural inertia, which is so difficult to overcome directly. It is often a key reason why managers fail to introduce timely and substantial change, even when they know that it is needed (Christensen and Raynor 2003; Henderson 2006; Yu and Hang 2009). This issue was echoed by another author (Bailey 2010b) who commented that one of the problems for companies considering making the transition to cloud computing is lack of appetite for change within the enterprise. Dan Scarfe, a CEO of Dot Net Solutions (a British SME), commented during an interview with the lead author of this article in 2010 that 'the main challenge is that companies will see their IT departments resisting the move to the cloud and turkeys don't vote for Christmas'. A study conducted by GFI (a software vendor) indicated that many senior business managers had little or no understanding of the concept of cloud computing (Bailey 2010a).

In another article, Bailey (2010b) focuses on the experience of three British companies that embraced cloud computing. One of those is BAE Systems (a leading British aerospace and defense company) which, with the help of cloud providers (e.g. Camwood and CSC[2]), has implemented a hybrid cloud managed by its IT department and other cloud service providers. The move of his company to the cloud, according to its Chief IT Strategist (Charles Newhouse), required a change in outlook arguing that they began to see their infrastructure as a commodity service and not as a strategic asset, which was a considerable change. One of his colleagues compared the situation to being 'professionally emasculated'. Newhouse acknowledges the cultural changes that befell his company's IT department by arguing that: 'The 'noise' associated with managing an infrastructure has gone, and the IT team is delivering better services as a result'. He claimed that his company had reduced its total cost of IT ownership by 20%, and improved site provisioning cycles by 90%. He indicated that it used to take up to 6 weeks to set up a project, whereas now it takes just 72 hours thus allowing projects to be created on the fly 'to see if they have legs'. The set-up also prevented painful financial decisions around capital investment and hardware refresh cycles and made BAE more efficient in using its IT infrastructure. The company moved from using 10% of its server capacity to an almost optimum level of use.

BAE is in a sensitive industry and has the resources to opt for a private or a hybrid cloud implementation. However, companies and organisations endowed with less resources and which operate in less sensitive sectors are likely to consider full open cloud implementations as the most economically viable option.

Whether opting for a private, hybrid, or an open cloud implementation, consuming organisations will need to reconsider how they deliver their products and services, view their IT resources and roles, evaluate and calculate their expenditures, value and manage their security, and how they foresee themselves in a, potentially, more environmentally friendly future environment with ethically conscious consumers.

6. Conclusion

This article has focused on the issue of cloud computing within the context of Christensen's theory of disruptive innovation. As well as being a disruptive innovation, cloud computing, as portrayed in this paper, can also be regarded a sustaining innovation, i.e. an improvement over a computing service paradigm (namely 'Timesharing') that existed in the early 1970s. Like many other disruptive innovations, cloud computing has enabled the provision of 'good-enough' and affordable computing services to a much wider market and also made it easy to access useful technologies that are essentially expensive and more complex to use.

Many vendor and consuming organisations have embraced this new innovation which is not without its own set of problems. However, dismissing this new innovation as 'fad' or 'hype' could be a costly mistake. Current evidence suggests that this innovation is likely to grow in popularity, especially in the present global economic environment of budgetary cuts and austerity. Most importantly, implementing this innovation is likely to require a fundamental and cultural change in how organisations view their IT resources, conduct their business and prepare for the future.

These are indeed both challenging and exciting times. However, before hailing cloud computing as the innovation that saved organisations from the dire consequences of the global financial crisis, more and continuous future research will be required to monitor and investigate the extent to which this innovation has delivered the desirable changes which many believe it is capable of.

Notes

1. In his 1997 book Christensen used the term 'disruptive technology' which he changed to 'disruptive innovation' in his subsequent publications.
2. BAE contracted Camwood to help it migrate its business applications to a private cloud and also contracted CSC to implement identity federation as a way of managing identity-related risks.

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References

Antognini, C. 2004. Is oracle database moving toward grid computing? http://antognini.ch/papers/GridComputing_20040723.pdf.

Armbrust, M., A. Fox, R. Griffith, A.D. Joseph, R.H. Katz, A. Konwinski, G. Lee et al. 2009. Above the clouds: A Berkeley view of cloud computing. Electrical Engineering and Computer Sciences, University of California at Berkeley. http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28.pdf.

Ashford, W. 2009. Cloud computing more secure than traditional IT, says Google. *Computer Weekly*. http://www.computerweekly.com/Articles/2009/07/21/236982/cloud-computing-more-secure-than-traditional-it-says.htm.

Bailey, D. 2010a. Firms fail to see cloud's silver lining. *Computing*, 10 June: 11.

Bailey, D. 2010b. Are you up to the cloud challenge? *Computing*, 24 June: 9.

Campbell, S. 2009. Timesharing 2.0. *HPC Wire*. http://www.hpcwire.com/specialfeatures/cloud_computing/features/Timesharing-20-66169142.html.

Campbell, S., and M. Jeronimo. 2006. Virtualization White Paper – An introduction to virtualization. http://www.dabcc.com/downloadfile.aspx?id=455.

Campbell-Kelly, M. 2009. The rise, fall, and resurrection of software as a service. *Communications of the ACM* 52, no. 5: 28–30.

Carr, N. 2009. *The big switch: Re-wiring the world, from Edison to Google*. New York: W.W. Norton.

Christensen, C.M. 1997. *The innovators dilemma: When new technologies cause great firms to fail*. Boston, MA: Harvard Business School Press.

Christensen, C.M., and M.E. Raynor. 2003. *The innovator's solution: Creating and sustaining successful growth*. Boston, MA: Harvard Business Press.

Christensen, C.M., S.D. Anthony, and E.A. Roth. 2004. *Seeing what's next: Using theories of innovation to predict industry change*. Boston, MA: Harvard Business School Press.

Dandamudi, S.P. 2003. *Fundamentals of computer organization and design*. Heidelberg: Springer.

ENISA. 2009. An SME perspective on cloud computing. http://www.enisa.europa.eu/act/rm/files/deliverables/cloud-computing-sme-survey/?searchterm=survey.

Field, P. 2010. Get more from the cloud. *IT Now*, May: 18–19.

Green, K. 2010. Embrace the cloud. *IT Now*, March: 6–9.

Grossman, R. 2009. The case for cloud computing. *IT Professional* 11, no. 2: 23–7.

Hasson, J. 2008. Cloud computing is for the birds. *FierceCIO*. http://www.fiercecio.com/story/cloud-computing-birds/2008-10-11.

Henderson, R. 2006. The innovator's dilemma as a problem of organizational competence. *The Journal of Product Innovation Management*, no. 23: 5–11.

Hickey, A. 2010. Cloud computing, SaaS boom fueled by recession. http://www.crn.com/software/225701016;jsessionid=RYE3URCMO12QVQE1GHPSKH4ATMY32JVN?queryText=boom.

Johnson, B. 2008. Cloud computing is a trap, warns GNU founder Richard Stallman. *The Guardian*. http://www.guardian.co.uk/technology/2008/sep/29/cloud.computing.richard.stallman.

Leavitt, N. 2009. Is cloud computing really ready for prime time? *Computer* 42, no. 1: 15–20.

Lefèvre, L., and J. Pierson. n.d. Energy savings in ICT and ICT for energy savings. *Ercim News*. http://ercim-news.ercim.eu/en79/special/introduction.

Linthicum, D. 2009. Should failures cast shadows on cloud computing? *Intelligent Enterprise*. http://intelligent-enterprise.informationweek.com/blog/archives/2009/09/should_failures.html.

Lucas, H.C., Jr, and J.M. Goh. 2009. Disruptive technology: How Kodak missed the digital photography revolution. *The Journal of Strategic Information Systems* 18, no. 1: 46–55.

Naughton, J. 2009. There's silver lining to Google's cloud computing glitch. *The Observer*, 1 March 2009. http://www.guardian.co.uk/technology/2009/mar/01/gmail-outage-cloud-computing.

Rymer, J.R. 2010. Oracle likes cloud computing after all. http://blogs.forrester.com/application_development/2010/03/oracle-has-a-cloud-strategy-after-all.html.

Shavit, Y. 2008. Advantages and disadvantages of server virtualization. http://searchsystemschannel.techtarget.com/generic/0,295582,sid99_gci1307133,00.html.

Smart Soft Computing. n.d. Oracle training – Tips and tricks to improve your oracle systems' reliability, availability and scalability: Oracle 10g and grid computing. http://www.smart-soft.co.uk/Oracle/oracle-10g-and-grid-computing.htm.

Sultan, N. 2010a. Cloud computing for education: A new dawn? *International Journal of Information Management* 30: 109–16.

Sultan, N. 2010b. Cloud computing and SMEs: A match made in the recession! Paper presented at the 33rd Annual ISBE Conference, 'Looking to the Future: Economic and Social Regeneration through Entrepreneurial Activity', London, 3–4 November 2010.

Sultan, N. 2011. Reaching for the 'cloud': How SMEs can manage. *The International Journal of Information Management* 44: 272–78.

The Financial Times. 2009. Getting to grips with the cloud. *The Financial Times*. http://podcast.ft.com/index.php?sid=21&pid=621.

Voas, J., and J. Zhang. 2009. Cloud computing: New wine or just a new bottle? *IT Professional*. 11, no. 2: 15–17.

Williams, A. 2010. Will SAP CEO shakeup lead to a unified cloud computing strategy? http://www.readwriteweb.com/cloud/2010/02/will-sap-ceo-shakeup-lead-to-a-unified-cloud-computing-strategy.php.

Willis, J. 2009. Did Google's Eric Schmidt coin 'cloud computing'? *Cloud Computing Journal*. http://cloudcomputing.sys-con.com/node/795054.

Yu, D., and C.C. Hang. 2009. A reflective review of disruptive innovation theory. *International Journal of Management Reviews* 12: 435–52.