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CLOUD COMPUTING FOR DUMMIES? IDENTIFYING MANAGEMENT ASSUMPTIONS OF CLOUD COMPUTING ADOPTION IN ORGANISATIONS

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Abstract

Cloud computing (CC) is nowadays a fashionable term that embraces ideas, concepts and technologies which, together, could help organisations improve their information processing capabilities at reduced costs. CC offers distributed, flexible and scalable computing environments for organisations. In times of economic recession and spending cuts, efficiency makings or expansion these features could be very attractive. There are many flavours and configurations of CC term in practice in infrastructure, hosting services and specialised applications. There is a common trend to get into the CC bandwagon which is being advocated by many information technology providers and end customers and recently by mobile telecommunication providers. However, CC seems to be assessed from a short-term and cost-based perspective which could in the long term deliver other benefits. Part of the confusion is also seen as an opportunity, as CC could help companies become flexible whilst reducing their energy consumption costs and investments and thus implement green government policies. There is then a need to clarify existing confusion as to how cloud computing could generate both business value and medium-term benefits beyond capital gains.

In this paper we aim to explore existing thinking about CC in order to identify and validate a number of assumptions from managers who are interested in it from different perspectives. We rank and test these assumptions to ascertain their importance and uncertainty, the latter in relation to how managers see their likelihood happening. Our insights indicate that the very same cost-related and short-term assumptions that could bring CC into further existence in organisations might hamper a wider understanding of its potential to address other business and environmental issues. In this regard, we see it as essential to translate government policy into specific action recommendations on how cloud computing can (and should) help companies meeting green targets.

Keywords: Cloud computing; Subjective Evaluation; Assumptions; Green IT; Strategic Assumptions Surface Testing;

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Introduction

Not long ago the spread of Internet and associated technologies offered organisations the possibility of network and communication with suppliers and end customers in a fast and reliable way. This possibility has been taken forward by many organisations to develop their e-commerce and e-business infrastructures to integrate their manufacturing, procurement, payroll, financial and service activities (Chaffey, 2009). With increasing demands on technological infrastructures to provide mobile, friendly and more interactive communication interfaces, and with the economic recession still affecting technology investment decisions, many organisations are turning their attention to what is being termed 'Cloud Computing' or CC. Generally speaking, this term includes a number of technologies and concepts that offer efficiency and transparency in the processing of electronic data as well as agility and flexibility to set up and run technological infrastructures 'on demand'. Businesses could in principle benefit by delegating their management of data processing infrastructures to third parties and at different levels: hardware and server maintenance, hosting services, network software applications and software as specialised services. By doing that, they can also gain agility and flexibility to face new demands from customers and markets (Hubert, 2010).

The interest in cloud computing has grown almost exponentially and now we see a vibrant community of technology suppliers, consultants and end users engaged in developing and improving a number of solutions that range from hardware hosting to specialised sales applications. In the UK alone, the second World Cloud Computing Forum took place in June 2010 and gathered over fifty (50) exhibitor companies and hundreds of participants who are already offering products and services (many to be) used in a cloud environment. A common perceived idea was that usage of CC is on the increase. However, end users and other potential customers (for instance outsourcing vendors or government) need to see more fully the benefits and tradeoffs that CC implies. With a new 'mobile' cloud computing forum that also gathers telecommunication companies and software developers, new plans of the UK coalition government to make efficient use of technology to better engage with citizens whilst reducing the deficit in public spending (Pullinger, 2010), and emerging interest in other countries on the topic of cloud computing, it is worth asking why cloud computing or CC is appealing, and how it can be better appreciated if not used more widely by different organisations in profit and non-profit sectors.

In this paper we aim to identify assumptions behind cloud computing (CC) that lead technology vendors, managers and potential users to turn their attention to it. We do so with the aim of assessing more fully the business value that CC can offer in the future. We validate these assumptions and identify a number of generic strategies that organisations could be using to support their decision to adopt CC. Our findings suggest though that short-term assumptions highlight key leverage points including government intervention that, adequately defined could be used to push more effectively for environmental compliance and thus to further reflection on how to make cloud computing more understandable and adopted by users.

The paper is organised as follows. We start by describing the basic features of cloud computing and how its assessment needs to consider perceptions and how to validate them. We then present a methodology to validate a number of assumptions from the

literature and practice on cloud computing that we consider relevant to currently drive decisions about it. Based on these preliminary findings we suggest a number of generic strategies that could guide future decisions to embark on CC adoption plans. Some of these strategies have to do with supporting both business plans and complying with 'green' policies.

The basics of cloud computing

As the name suggests, 'cloud computing' (CC) is a form of computing based on the possibility of sharing processing and servicing capabilities and software applications. The term 'cloud' denotes that these capabilities can reside in remote (centralised) and often unknown geographical locations, making it easier for technology administrators to delegate planning their management to third parties. For the end user of computing applications and services there should not be —in principle, any difference accessing them in comparison with traditional access in his/her workplace.

There are many varieties of cloud computing, ranging from the provision of hardware and network capabilities to information management services and applications. Several companies provide cloud computing facilities in these areas. A basic diagram of cloud computing is provided in the following figure. It depicts a structure of communication that enables clients (users) access data, services and applications which reside in shared facilities (servers or other computer networks).

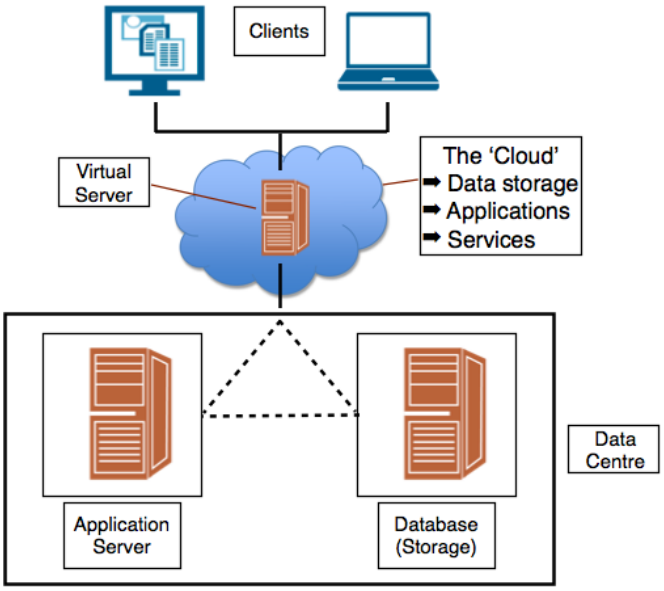

Figure 1. Basic operation of cloud computing.

Implementing cloud computing

In bringing the above infrastructure to implementation, information and communications technologies (ICT) providers are now offering different types of

‘cloud’ and with different types of services: the private cloud, which is contained within the closed infrastructure of one organisation or a group of organisations; the public cloud which operates via the Internet’s IP network and other peer-to-peer IP based networks; and the hybrid cloud which is a combination of the two. Services can be classified as software and utilities. The latter includes the management of hardware, communications and access to data. Cloud Computing, in its different configurations, is the sum of software and utility services (Armbrust, 2009), which provide services to users through different devices (personal computers, mobile phones, tablets).

A private cloud refers to internal data and its management, both belonging to a business and which are not made available to the public; because of its private nature and use, it is often not regarded as a cloud (Grossman, 2009). Marketing media that uses the words "private cloud" is designed to appeal to an organization that needs or wants more control over their data than they can get by using a third-party hosted service such as Amazon's Elastic Compute Cloud or Simple Storage Service. This can be achieved by developing a proprietary computing architecture that includes virtualisation and distributed computing techniques to provide hosted and efficient services to a limited number of people behind a firewall; these can be considered the internal ‘customers’ to serve.

When a cloud is made available in a pay-as-you-go manner to the public, it can be called a ‘Public Cloud’. The service being sold is ‘Utility Computing’, in other words a form of pay as you use computing power and data storage through a shared infrastructure that provides this service to different customer organisations. Current examples of public ‘Utility Computing’ include Amazon Web Services, Google AppEngine, and Microsoft Azure (Armbrust et al, 2009).

A variety of the type of public cloud is that of a community cloud. The term is used to denote an infrastructure of services is shared several organizations and which supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). This type of cloud may be managed by the organizations themselves or by a third party. It may exist on or off organisations’ premises. An example of a community cloud is that of Google's "Gov” Cloud, aimed at serving a group of government institutions.

When the cloud infrastructure is a composition of two or more clouds (private, community, or public) which remain as separate entities but which are bound together by standardized or proprietary technology to enable data and services portability (e.g., cloud bursting for load-balancing between clouds), it can be termed as hybrid (Williams, 2009). In a hybrid cloud environment an organization offers and manages some resources in-house and has others provided from the third party. For example, an organization might use a public cloud service, such as Amazon Simple Storage Service (Amazon S3) for archived data but continue to maintain in-house storage for operational customer data. A hybrid cloud could also enable organisations to take advantage of the scalability and cost-effectiveness that a public cloud computing environment provides without having to share mission-critical software applications or data to third-parties and hence become vulnerable in this front.

Despite the diversity of cloud computing types and potential configurations, in principle, the type of operation that it offers is no different from others. Companies set up their own networks (intranets or private clouds) and services in web servers (i.e. email, specific purpose applications). They also integrate data and software applications if not implement comprehensive software suites (i.e. enterprise resource planning systems or ERP). They could decide what to have 'in the cloud' as services on software and utilities. The different types of clouds offer possibilities and constraints. What are the benefits that they can generate overall?

Benefits of Cloud Computing (CC)

The common thinking behind many business managers is that cloud computing offers financial benefits which also can translate into business flexibility and agility (Hubert, 2010). First, there is no capital investment in technology infrastructure, as cloud computing providers are in charge of it whenever it is deemed necessary; capital expenditure is shifted to operational expenditure. Second and in line with operational expenditure, services can be bought (rented) on demand, when companies or individuals require an increase in computing power, so they only pay for what they use and when they use it. Third, the infrastructure of cloud computing offers flexibility and agility so that new services (a new network, or a new software application) can be quickly set up, run and accessed from different places and devices. This feature has been seen positively by telecommunication and software companies which can facilitate capture of users' profiles (i.e. in terms of their usage of information services) according to their location. The data obtained can be appropriately mined, so that organisations and software developers can design tailored information services to groups of users according to their geographical location.

With these financial and operational benefits, cloud computing infrastructures can be thus designed in centralised or distributed ways, with data, communications or applications residing anywhere. Infrastructures can also provide mobile services, so that applications can be used in mobile phones or tablets. There is though an emerging issue of concern: that of reducing energy consumption not only by organisations but by cloud computing infrastructures. In the next section we explore it in more detail and in relation to increasing demands for organisations to become more environmentally friendly.

Organisations going green

Within the last five years, there has been greater political, scientific, economic, social and moral consciousness and action on the topic of climate change and unsustainable growth. The physical and natural environment has become a priority for governments, scientists, academics, businesses and consumers. Esty & Winston (2008) regard the existence of a 'Green Wave' of environmentally driven issues that have challenged the existing order of the business world. These issues vary from compliance with new and emerging policies on climate change to the adoption of day-to-day practices in organisations and by individuals in order to ensure that future generations can benefit from growth and development as it has been the case for many so far (UNCED, 1992).

Governments are currently acting on this front to encourage individuals and organisations to reduce their energy consumption practices. The UK government for instance has pledged its commitment to reducing the carbon emissions to both public and private sector. A new regulation, the CRC Energy Efficiency Scheme (CRC) in April 2010, has mandated that qualifying businesses in the country submit their annual carbon emissions report and participate in a trading scheme where performance in carbon reduction is incentivised and polluters are taxed (Department of Energy & Climate Change, 2010).[2] In Europe, broad-ranging targets have been set for EU (European Union) member states to reduce fine particle emissions in urban areas by 20% by 2020 (EUROPA, 2010).

Within the information and communication technologies (ICTs) industries there have been similar calls for change. Around 2% of greenhouse gases worldwide have been emitted by the information technology industry alone– a figure comparable to that of the entire aerospace industry (Banerjee, et al., 2009). Anderson, et al. (2009) notes that businesses affected by these new policies have begun to recognise that reducing ICTs' carbon footprint and have begun to engage in forms of 'green' computing. The exponential growth of computing power, storage, cooling, complex software programmes, e-commerce, and mobile computing within the past 10 years has contributed to greater carbon emissions and greater electricity bills for businesses. A study by Credit Suisse showed that 50% of its total electricity bill was generated by ICTs (Crooks and Hopton, 2010). Can cloud computing respond to environmental policies and demands?

Cloud computing could offer 'green' benefits

As a first response to the above question in relation to energy consumption and sustainability of CC infrastructures, Sobota (2010: 65) states that the 'direct, indirect and systemic effects' of Cloud Computing has the ability to reduce carbon emissions. By making use of the Cloud, companies minimise hardware and software inefficiencies and reduce the power consumption of their ICT infrastructures. By doing so, there could be several benefits.

First, there is the benefit of power consumption in managing services and utilities. The premise and development of cloud computing is derived from the growth and maturation of data centre technologies. Data centres consume large amounts of electricity for powering the devices and cooling. The group IDC estimates that power and cooling amounts to 50% of the cost of hardware over its operational lifetime (IDC, 2008). A data centred offered as a cloud platform can have combined state-of-the-art cooling systems, power management systems, efficient and powerful servers, and virtualisation technologies to make it more efficient and 'greener' than ever before. Because having these facilities is expensive, if a company moves to the cloud they can rent or share these services from data centre specialists. If power consumption is reduced in the cloud, it is also lowered in the organisation. Furthermore, data centres servers can be optimised run high loads and capacity, reducing idle time.

[2] The new UK coalition government formed in mid-2010 has announced plans to review the CRC. New terms and conditions will be set out by the first quarter of 2011.

Secondly, there is the benefit of computing equipment manufacturing and disposal. Organisations participating in the cloud require fewer servers to run the same operation via virtualisation technologies. Companies that use software as a service 'in the cloud' do not require physical installation and upgrading of their desktops or laptops saving hardware cost. Other additional costs that could be reduced include transport, packaging or procurement of CDs, DVDs or storage devices. Organisations could then have less to worry about the lifecycle of their hardware and software as the cloud computing provider can take care of these issues. In cases of larger organisations reductions of energy in these activities including software applications 'in the cloud' can be of the order of 30% (Accenture and WSP, 2010).

Thirdly, cloud computing (CC) offers the potential to change the behaviour of humans in workplaces. The approach 'anywhere and anytime' that has been promoted by cloud computing advocates in particular in offering software as a service enables telecommuting, work from home, and more flexibility to access information and services. This can reduce needless travel by car or public transport that contributes to carbon emissions. These forms can also contribute to improve the quality of life of employees, giving companies a good step in the direction of acting more responsibly.

Given these benefits as well as the ones offered by cloud computing in terms of business flexibility and agility, one might think that it is just a matter of time and of conveying these benefits to organisations for them to adopt cloud computing. As mentioned before, the long term operation of cloud infrastructures lead us to think that not everything is clear cut. A report by Greenpeace (2010) predicts that carbon emissions from data centres worldwide, —many of which will offer cloud services will increase by 5% to 7% annually. If many companies decide to reduce their own carbon footprint by offsetting it to the cloud infrastructures, these would require more electricity from electricity grids, increasing the potential for imbalances in grids. CC designers should not only consider this, possibly by distributing energy consumption in federated or distributed cloud infrastructures (Yapp, 2010). Moreover, if companies decide to become more flexible and responsive to their markets, it might be difficult for them to chance their ICT infrastructures, given that their design is based more on control (Ciborra, 2001).

The above issues should make managers more conscious about the potential benefits of cloud computing in the short-term but also of medium-term implications and potential short-comings. It becomes necessary then to build some flexibility in the thinking behind decisions to adopt cloud computing as a way of operating ICT infrastructures in organisations, so that flexibility also considers concerns beyond organisational realms. To contribute to flexibility, we propose to help managers identify and understand a number of assumptions that are used to decide on CC. These assumptions could then be used to address potential impacts of CC in the short and medium-term. To begin our identification of assumptions, in the next section we explore the notion of value attributed to ICT and how it relates to management assumptions about it.

The notion of value of ICTs revisited

Since information systems and technologies (IS and ICTs) became tools to achieve and sustain competitive advantage in the mid 90s, we as technology and strategic managers have had the responsibility to assess how their implementation and use could contribute to generate value. Value is a concept that is difficult to be defined. Drucker (1968) situates the generation of value as a contribution to meeting the objectives of an organisation, to which individuals should continuously look to do. Information systems and technologies are commonly understood as generators of value in terms of cost reduction, efficiency, better service/product experience for customers and the opening of possibilities for the future in organisations (Chaffey, 2009; Hammer and Champy, 1995). With its emphasis on cost, business flexibility and agility to respond to customer demands at low cost, cloud computing (CC) as a configuration of systems and technologies fits well within this notion of value.

However, the notion of value in terms of costs and benefits has been reviewed in depth in the realm of information systems and technologies. Information systems (IS) evaluation as a process that involves pre (ex-ante) and post implementation assessment of value of information systems has moved beyond a central focus on cost / benefit analysis (Avison and Horton, 1992; Farbey, Land, and Targett, 1999; Hirschheim and Smithson, 1988; Walsham, 1999). There are several reasons for that. First, it is difficult to estimate costs on complex infrastructures of systems and technologies let alone exactly planning how their dynamics will unfold (Ciborra, 2001). A great deal of detail is required to estimate units of analysis and gather data related to their associated costs (Laudon and Laudon, 2009). Second, the attribution of value is *subjective*, in particular in terms of intangible benefits that people attribute to systems before these systems are implemented, and even after they are implemented, there are differing perspectives on the systems' perceived outcomes (McAulay, Keval, and Doherty, 2002; Robey and Boudreau, 1999). Thirdly, evaluation works best when it is continuous, so that issues that are identified as relevant in systems planning and implementation processes could be addressed promptly (Doherty and King, 2001).

A type of interpretive (subjective) evaluation about cloud computing could help us identify and understand assumptions and perceptions about it that could go beyond financial considerations, so that a wider understanding of expectations about CC and its context could be drawn, in particular in terms of current benefits and implications that managers and specialists see. In the next section we detail a methodology to conduct an exploratory form of interpretive ex-ante evaluation (prior to decisions), which we see as relevant in helping managers better understand cloud computing.

Methodology

Interpretive information systems (IS) evaluation aims to understand how groups of people perceive systems according to how useful they see them for their work and the overall value they (could) offer to their organisations (Symons and Walsham, 1988; Walsham, 1999). A variety of meanings are to be identified and shared, so that those involved can see themselves and others and in particular the issues that they would like or are committed to act upon with systems. This type of evaluation involves

qualitative research, where interviews are carried out and captured in a story-like and holistic context (Merriam, 2009; Stake, 2010), so that interpretations about people's perceptions can be drawn and validated with them. Marshall & Rossman (2011) note that qualitative research is useful for multiple modes of inquiry and understanding complex values in a given situation. We use qualitative research to identify and integrate a number of managerial, technical and environmental assumptions held by different individuals in relation to cloud computing as a form of information processing and management.

We structure the identification and validation of assumptions by relating to Mason and Mitroff (1981)'s approach on strategic assumption surfacing and testing (SAST). According to Mason and Mitroff, the thinking considered essential for people for a strategic decision can be 'surfaced' in terms of assumptions that describe how things will work out if a decision is supported or rejected. In people's minds, these assumptions carry a degree of certainty and importance which can be subjected to scrutiny or testing to challenge assumptions' validity. With assumptions supporting or rejecting a decision debate can be organised and those assumptions still being held as valid in terms of certainty and importance can offer managers firm grounds to proceed with strategies or plans. The assumptions that are perceived as important but not very certain can then be investigated furthers and revisited at a later time by managers. The assumptions with a low degree of both importance and certainty can be discarded (Mason and Mitroff, 1981).

In our approach we identified, validated and interpreted with groups of managers and cloud computing experts a number of assumptions supporting the adoption of cloud computing. We did not identify assumptions that could contribute to its rejection as we assumed that CC is still a novel and often untested form of computing. Instead we have taken forward some assumptions that did not carry a considerable degree of certainty to suggest a number of exploratory strategies in the medium term to organisations. Since the time of identification of 'favourable' assumptions about CC, we have also engaged in further discussions to subject them to further scrutiny with a view of integrating these and new ones future evaluations of cloud computing where debate could take place.

To initially identify assumptions we reviewed existing literature on cloud computing and talked informally to experts in a cloud computing forum during August 2010 and in subsequent weeks. Our literature review focused on understanding how CC works as well as how it could benefit organisations. During and after the forum, we asked experts questions about how they perceived the evolution of CC in the short and medium term as well as how they conveyed benefits to potential CC clients. With the compiled list of assumptions we prepared an online questionnaire and sent its link to various electronic lists whose members had a general interest in information technology or a more specific interest in cloud computing (CC). We sent the questionnaire to approximately one hundred and fifty (150) individuals. Fifteen (15) completed questionnaires were returned and their answers checked. A summary of the findings and their interpretation are presented in the following section.

Interpreting the findings

TABLE 1: To what extent do you agree that the following statements are *important* for your organisation or business?

1 = strongly disagree; 7 = strongly agree

	1	2	3	4	5	6	7
Reduce capital expenses on IT and maintenance costs	1 (5%)	0 (0%)	1 (5%)	***3 (15%)***	***4 (20%)***	***5 (25%)***	***6 (30%)***
Spend less time addressing IT systems and focus on business tasks	1 (5%)	1 (5%)	1 (5%)	1 (5%)	***6 (32%)***	***5 (26%)***	***4 (21%)***
Achieve greener credentials	1 (5%)	***4(21%)***	3(16%)	2 (11%)	***5 (26%)***	1 (5%)	***3 (16%)***
More flexibility and agility to business and customer needs	0 (0%)	0 (0%)	2(11%)	1 (5%)	***7(37%)***	***4(21%)***	***5(26%)***
IT is a strategic way to achieve my organisation's mission and objectives	0 (0%)	0 (0%)	2(11%)	***3(16%)***	***4(21%)***	***5(26%)***	***5(26%)***
Provide IT system backups and disaster recovery	2(10%)	0 (0%)	***3(15%)***	0 (0%)	***7 (35%)***	***5 (25%)***	***3 (15%)***

TABLE 2: What is your degree of *certainty* regarding the following statements about Cloud Computing?

1 = strongly disagree; 7 = strongly agree

	1	2	3	4	5	6	7
Cloud Computing reduces capital expenses on IT and maintenance services	0(0%)	1(5%)	1(5%)	***3(15%)***	***4(20%)***	***4(20%)***	***7(35%)***
Spend less time addressing IT systems and focus on business tasks	0(0%)	1(6%)	2(11%)	1 (6%)	***4(22%)***	***5(28%)***	***5(28%)***
Helps businesses to achieve greener credentials	***3(16%)***	1(5%)	2(11%)	***4(21%)***	***6(32%)***	1 (5%)	2(11%)
Gives more flexibility and agility to business and customer needs	0(0%)	***3(17%)***	1 (6%)	***3(17%)***	2(11%)	***4(22%)***	***5(28%)***
A strategic part of IT to achieve my organisation's core mission and objectives	0(0%)	2(11%)	***4(21%)***	***3(16%)***	***3(16%)***	2(11%)	***5(26%)***
Provides business continuity and disaster recovery	0 (0%)	***3(15%)***	2(10%)	***3(15%)***	***6(30%)***	***4(20%)***	2(10%)

Tables 1 (importance) and 2 (certainty) above provide a summary of the findings of the online questionnaire. Each column indicates the degree of agreement and disagreement to the statement (assumption) with the percentage of respondents in each column of the total in the sample (15). As it can be seen, CC is best seen as an alternative to reduce capital expenses and maintenance costs, with accumulated degrees of certainty and importance above 90% (total respondents that ranked assumptions with a value of 4 or more). This assumption supports the existing literature and marketing arguments used by CC vendors to put forward their case. It is generally assumed that CC's importance resides in reducing expense and maintenance by offering to take responsibility on ICT infrastructures and its management, leaving businesses to do what they are good at. Also, the assumption

on less time on IT and focus on the business showed strong correlation between its degree of importance (79%) and certainty (78%).

However, on closer examination of the strategic factors there is a corresponding drop in certainty on the assumptions of flexibility and agility, IT strategy, and business continuity. The cloud provides flexibility and agility to businesses – an assumption that 84% of respondents agree on its importance, but only 61% are certain. The assumption that CC is a strategic part of IT similarly shows an agreement of 73% of respondents, but only 53% are certain. The assumption on business continuity and disaster recovery receives 75% agreement, but only 60% certainty when comparing the tables. The drop in certainty in these 3 assumptions show that as much as the cloud provides potential cost and time saving abilities, respondents are still wary as to how the cloud fits into the bigger picture of their own organisation's IT structure and strategy, including its contribution to keep the business going. This means that managers do not find it clear yet how CC is to support business strategy beyond reducing operating costs; security issues are in need of being more fully addressed. We will take these findings further when we discuss two possible strategies to move CC forward.

The green nature of cloud computing

When asked about ranking the degree of importance of assumptions related to how CC can help companies become 'greener', the results indicate that CC is better perceived as a vehicle for reducing power consumption and lower energy cost as shown in the following table.

TABLE 3: To what extent do you agree that the following statements are *important* for your organisation or business in terms of the environment?

	1	2	3	4	5	6	7
Reduce power consumption and lower energy cost	1 (6%)	0 (0%)	1 (6%)	1 (6%)	***4(22%)***	***8(44%)***	***3(17%)***
Comply with government regulations on reducing carbon emissions	2(11%)	1(6%)	2(11%)	***5(28%)***	***4(22%)***	***3(17%)***	1 (6%)
Achieve green branding and better competitive advantage	0 (0%)	3(17%)	1 (6%)	***4(22%)***	***5(28%)***	***4(22%)***	1 (6%)
Green/ Sustainability is a part of Corporate Social Responsibility (CSR) Strategy	***3(17%)***	0 (0%)	1(6%)	2(11%)	***5(28%)***	***5(28%)***	2(11%)
Meet partner/supplier/customer requirements on sustainability	***3(17%)***	1 (6%)	**3(17%)**	1(6%)	***6(33%)***	*1(6%)*	**3(17%)**
Employees expect their organisation to be green	2(11%)	***3(16%)***	1 (5%)	2(11%)	***5(26%)***	***3(16%)***	***3(16%)***

Table 4

What is your degree of certainty regarding the following statements about Green Computing?

	1	2	3	4	5	6	7
Green computing reduces power consumption and lowers cost	0 (0%)	1(6%)	1(6%)	2(11%)	***5(28%)***	***3(17%)***	***6(33%)***
Helps businesses comply with government regulations to reduce carbon emissions	1 (6%)	***4(22%)***	0 (0%)	***3(17%)***	***4(22%)***	2(11%)	***4(22%)***
Achieve green branding and better competitive advantage	2(11%)	2(11%)	2(11%)	2(11%)	***3(17%)***	***4(22%)***	***3(17%)***
Green computing should be a part of my organisation's Corporate Social Responsibility (CSR) Strategy	0 (0%)	2(11%)	1 (6%)	2 (11%)	***5(28%)***	1(6%)	***7(39%)***
Helps businesses meet partner/supplier/customer requirements on sustainability	1(6%)	2(11%)	3(17%)	1 (6%)	***7(39%)***	1(6%)	***3(17%)***
Employees expect their organisation to utilise Green computing	2(11%)	***3(16%)***	1 (5%)	2(11%)	***3(16%)***	***7(37%)***	1(5%)

From Tables 3 (importance) and 4 (certainty), the highest scoring assumption is reducing power consumption and energy cost with over 78% (total respondents that ranked assumptions with a value of 5 or more), which validates that cost is the most important value for consideration. This is followed by the assumptions on corporate social responsibility (CSR) strategy with 67% and employees expectations at 58%. This means that cost is the overwhelming factor in consideration - shown in the large gap between the answers of reducing power consumption and CSR strategy. This further reinforces the overall perception that the 'cloud' is mostly about cost-saving compared to other factors, and that wider issues (for instance electricity consumption of CC infrastructures) are not yet considered at the level of organisations.

The above also contrasts with a low degree of awareness of how environmental regulations are going to impact on organizations, and how cloud computing can help in this regard. Only 45% (importance) and 55% (certainty) of participants responded in that compliance with government regulation on carbon emissions was important. We interpret these findings in two ways. First, there needs to be a more proactive stance by both governments and organisations on how ICT and cloud computing are to meet environmental policies and regulations. When interviewed, one participant mentioned that 'unclear standards' is a key reason for a lower degree of importance noted. Secondly, there is scepticism or lack of certainty that the cloud can actually provide a 'green' solution, or that 'green' computing (whatever form it might take) can help with carbon emissions reductions. Another interviewee mentioned that there is 'Green branding' adopted by cloud computing providers, whereby ICT companies jump onto the 'Green bandwagon' to improve sales without actually considering if their products/services has an actual benefit to the environment. This generates scepticism regarding '*if green is really green*', or if we extend this further, '*if cloud is really green'*. This scepticism contrasts with regulations in countries like the UK, where governments are planning to implement tax policies on carbon emissions, something that could generate more awareness and somehow forced action by organisations and individuals.

The above findings suggest that cost-related assumptions currently drive the possible adoption of cloud computing in organisations and could then support managers in the

short-term in some organisations (those mostly concerned with costs). However, how to make CC respond to other business strategies and environmental demands beyond cost remains an issue. It might be a case of explaining CC better, or it might be a case of exploring it further. In relation to the second possibility, in our study we see that there are other assumptions whose degree of certainty needs to be further investigated and which should be integrated in the medium term; these include how CC can reduce carbon emissions, how it can really help organisational strategy, or how, if it CC a form of 'green' computing (this term can also require further explanation), how it is going to support 'green'. In the next section we propose two strategies based on these assumptions which aim to guide future thinking and research on cloud computing.

Moving CC forward: Two strategies

With the current pace of technological change and economic climate, cloud computing could be a solution for organisations that are starting-up or those that want to reduce their maintenance and capital expenses. The degree of certainty and importance given to assumptions supporting CC to address these demands can be taken forward by some organisations. A first strategy to adopt CC is to do so, on the grounds that CC can let organisations focus on other issues rather than technology. If organisations adopt this strategy of 'quick' adoption, they should focus on making sure that they have a business strategy in place, so that CC does not conflict but rather supports it. Subsequent or complementary strategies based on cost reduction, enabling capital to be reallocated and improving ICT services could then be better defined and supported by CC.

The first type of strategy proposed does not contemplate directly the provision of agility and flexibility to organisations as this benefit is not certain to be accrued with CC. It does not guarantee either that CC infrastructures are to be integrated with existing ones or that they are to meet all environmental requirements either. Still, it could be an adequate strategy to help organisations 'kick off with', or 'let off' from their information infrastructures if that is seen as an urgent requirement. If this is the case, we suggest that organisations should then consider operating in two fronts: a) In defining how different types of CC services are to meet flexibility and agility needs (if any). Second, organisations should then work on ensuring that their information is integrated regardless of where it resides (in the cloud or elsewhere). Information and knowledge are still considered strategic assets that could offer organisations competitive advantage. Making sure that these assets are *exploited* rather than managed continuously and that customers benefit from that exploitation (for instance by accessing information online) could be key in helping organisations make the most of their technological infrastructures. This guarantee also means that issues of security of the cloud are dealt with, and that organisations know the implications of signing up to the cloud. In a recent mobile cloud computing forum, Bradshaw (2010) reported on the results of research conducted on cloud computing contracts. Many of existing contracts exclude liabilities to cloud computing providers in relation to the loss of data. It is important to clarify different roles in cloud computing (client, controller, processor) and their own responsibilities and liabilities if things go wrong. Managers need to understand the terms and conditions of what they sign up for when they CC.

Once the above issues of flexibility, agility and security are better studied or dealt with (which could also mean that organisations might not get into the cloud at all!), a second type of strategy could then be adopted in the medium term to make sure that organisations adopt and use the cloud to meet all environmental requirements, and that by doing so they also contribute to wider environmental concerns (energy consumption). This is a medium-term strategy, given that there is still uncertainty about the policy and regulatory environment in which organisations are to operate, and also the degree of scepticism by many organisations about it; furthermore, with different CC configurations and services, it may well be that not all of them prove to be sustainable or useful in the medium term. With this degree of uncertainty it could be more adequate to develop joint thinking between organisations, cloud computing providers, energy providers and governments than simply developing a market for CC services. More research is needed to continue exploring how CC unfolds, as well as on how the joint management of CC infrastructures by organisations, providers and governments as well as the joint definition and translation of policy into practical action.

With these strategies we hope that CC could go beyond its apparent benefits and organisations make more conscious and relevant use of it for their benefit and that of the wider environmental environment they are part of. We also hope that CC providers and governments take a more proactive stance in dealing with emerging issues and in facilitating use or transition to CC by different types of organisations (for example small and medium enterprises).

Conclusion

In this paper we have explored in more depth the meaning of cloud computing (CC) so that its features, configurations, potential benefits and tradeoffs are better understood. We have used ideas on finding the value of CC to identify and validate a number of current assumptions that managers and experts in CC hold about it so that its possible adoption can be taken gradually in consideration of what CC can certainly offer now and what it needs to offer in the medium term. Our findings suggest that CC can offer cost-related benefits but its adoption needs to widen strategic thinking by managers about how CC can offer flexibility, agility, continuity and compliance with emerging environmental demands.

Based on the identification and validation of assumptions we have suggested short-term and medium-term strategies that managers and organisations should pay attention to in order to make the most of CC. Short-term strategies involve finding out how organisations can make CC part of their strategic thinking and objectives by possibly exploiting CC's features of flexibility and agility and by ensuring that information plays or continues playing a strategic role in organisations. Medium-term strategies involve exploring how different CC's configurations and services can help organisations and governments address environmental issues, and how organisations and other stakeholders in this area can better address or jointly define policy and regulation and its implementation.

However, the long term strategies regarding CC are subject to debate. Much of the focus on CC is related to "quick wins" such as cost-reduction without understanding the long-term significance of adoption. It is conceivable that CC is a trend that may be

obsolete in due course. In the future, organisations may reverse their policies towards shared services and outsourcing. Nevertheless, the intertwining of environmental degradation and explosive technological growth illustrates the value of CC as a long term strategy. Clearer government policy guidelines and more awareness building by IT companies will help to enhance the case for the green aspects of CC.

In this regard, further research is needed to continue exploring the dynamics of CC, its implementation in different types of organisations and its implications for policy and management.

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