OBSTACLES TO THE ADOPTION OF CLOUD COMPUTING: BEST PRACTICIES IN TECHNOLOGY AND COMMUNICATION

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ABSTRACT

This paper details some of the obstacles to cloud computing that have been identified in recent literature, grouping organizational concerns into four categories, namely security, organizational resistance, performance, and lack of economic gains. Following an analysis of concerns, we recommend a set of best practices for cloud providers. Technological measures include identifying and addressing potential flaws in data security, drafting policies for data responsibility, and increasing server space and contracting with multiple Internet providers in order to improve performance. Communicative measures include communicating with all stakeholders in order to mitigate against organizational resistance and outlining security and performance mechanisms in place to potential adopters in order to assuage their concerns about adopting cloud solutions.

Keywords: Cloud Computing, Technology Adoption, Change Communication

INTRODUCTION

Ever since its appearance in 2006, cloud computing has seen an expansion in interest and use, both by individuals and organizations. Its growing popularity is not surprising, considering the benefits it offers to adopting organizations. As Udoh notes, "The cloud concept offers infrastructure, platform and software as a service to users, and eliminates the need to install and run middleware and applications on a user's own computer, thus easing the tasks of software/hardware maintenance and support" [23].

Traditionally, companies have had to maintain their own IT systems on their premises, requiring not only the requisite infrastructure to handle all of their organizational requirements but also skilled IT professionals to maintain the infrastructure, develop necessary organizational software, create and manage email accounts, develop and maintain websites, and handle organizational and customer data. Obviously, the capital layout for infrastructure and human resources is considerable. Cloud computing, with its available online services (PaaS, IaaS, SaaS) provides a means for organizations to focus on their business goals with less time and effort required for maintaining IT infrastructure.

In 2006, Amazon became the first company to implement and capitalize on cloud computing. At that time, the company had enough capacity to handle the demands of Christmas shoppers but found that its system was underutilized at other times of the year. By offering cloud services, they were able to put their capacity to work outside of peak season [8]. In doing so, they created a revolutionary new platform that allows organizations to rent capacity instead of owning underutilized equipment. Furthermore, with cloud computing, fewer resources have to be dedicated to the maintenance of legacy infrastructures, ongoing training to support those infrastructures, security audits, and so on.

Because many organizations still manage their own, in-house IT infrastructure, there is considerable growth potential for cloud providers. However, there are also numerous barriers to the adoption of cloud computing. This paper will reiterate some of the barriers that have been pointed out in cloud research and suggest best practice solutions to overcome them.

REVIEW OF RELATED LITERATURE

In the following sections, we will have a look at some of the obstacles to the adoption of cloud computing that researchers have identified, which fall into four categories, namely security, organizational resistance, performance, and lack of economic gains.

Security

Security is perhaps the most serious concern for organizations considering adoption of cloud services. Weldon reported on the results of a survey conducted at the AWS re:Invent 2013 conference, which found that security was a concern for 60% of participants [24]. A number of other sources have also identified security as a concern to potential cloud service adopters [1, 2, 6, 14, 16, 17, 18].

Cohen, addressing the issue of control of data, notes that some organizations feel more secure knowing that their data reside in-house [5]. While security is important to all organizations, it is particularly of concern to the banking and health care sectors. For example, Chaptal [2] notes that between 2009 and 2012, interest in cloud computing by French banks was becoming more common, yet their two biggest concerns were security and the related issue of regulations (i.e., what a bank's regulatory responsibilities are when the data do not reside with them). Iyer and colleagues found that security was also a top concern to the banking sector in India [10, 11]. The fact that security would be a highly ranked risk factor for banks should come as no surprise. A bank losing assets in the event of a security breach is bad enough, but a bank's reputation could also suffer, which in turn could have an effect on investors' willingness to work with it.

Kuo, Kushniruk, and Borycki [16] found that security and privacy were the greatest sources of resistance to cloud adoption in the health care sector. As Iyer and colleagues note, patient health confidentiality is a moral and legal obligation [10], so it is not surprising that security is a high-ranking factor in the health sector.

While security is clearly on the minds of organizations considering adoption of cloud products, resistance may largely be a matter of perception. In fact, Morgan and Conboy found that the term "cloud" itself could constitute a potential barrier to adoption, and that providers might be well advised to consider alternative terminology, such as "new service delivery model" [17]. Yet despite the notion that some potential adopters have about the nebulous (and therefore, potentially unsecured) nature of the cloud, Cohen notes that cloud providers typically have fairly advanced security measures. Indeed, as Kuo, Kushniruk, and Borycki point out in an article about cloud computing in the health care industry, companies like Google and Microsoft have greater resources to devote to security than individual hospitals. Furthermore, they warn of potential loss of physical records, as occurred in New Orleans during Hurricane Katrina [16]. Still, the risks are not imaginary. Groß and colleagues warn that existing cloud infrastructures are vulnerable to man-in-the-middle and flooding attacks (leading to denial of service), as well as attacks on users' accounts [14].

Related to security are concerns about data responsibility. In the event that business data (particularly customer data) that reside on the cloud are compromised, the question arises as to whether the cloud provider or the organization itself bears responsibility [5]. This is, of course, by no means a trivial issue. Consider the 2013 breach of Target's customer data. The credit card information of up to 40 million customers may have been compromised during the 2013 holiday shopping season [15]. This kind of breach affects an organization in two ways. First, it is on the hook for whatever damage may have been done to customers. A major retailer like Target is likely to be financially well covered (insured) for this sort of eventuality, but the damage to the store's reputation will be harder to remediate. Similarly, any organization considering a cloud migration will want to know beforehand if the organization itself or the cloud provider is responsible for guaranteeing that data are kept safely, and for remediating any damage caused in the event of a data breach. Stieninger and Nedbal, in a study about attitudes toward cloud computing, found that organizational leaders were concerned, among other things, about "too little contractual agreements concerning data security" [21]. Additionally, a recent data breach, in which several well-known actresses' personal pictures were posted publicly online, may have been partly due to a hacker attack on Apple's iCloud [13]. It is thus likely to damage both user and organizational trust in cloud systems.

One final security concern involves vendor risk. Iyer and colleagues found that, because cloud computing is a rather new technology, organizations may not be familiar with vendors, and are concerned about vendor lock-in [10]. Although this is not a security concern in the way the word is typically used in IT, it is one in the broader sense of the word, because organizational leaders want to be secure from having to enter into a long-term contractual relationship with still unknown actors. Stieninger and Nedbal found, perhaps surprisingly, that small cloud service providers were perceived as more trustworthy than large corporations [21].

Organizational Resistance

Organizational resistance may be an inevitable part of the introduction of any new initiative, whether technology-related or not. Weldon found that it was a concern for 53% of participants in the AWS survey mentioned above [24]. In this section, we will consider a few findings about organizational perceptions and attitudes, as well as factors that may mitigate against organizational resistance.

In general, attitudes toward cloud computing are mixed. According to a study of German organizations, these attitudes may, in fact, be becoming somewhat polarized. In its "Cloud Monitor 2013" study, KPMG found that organizations remaining undecided toward cloud computing were becoming less common (dropping from 33% in 2011 to 20% in 2012). Those organizations with positive attitudes toward cloud computing (*eher aufgeschlossen und interessiert* 'more open and interested') climbed from 28% to 35% between 2011 and 2012. However, during the same period, those organizations whose attitudes were more negative (*eher kritisch und ablehnend* 'more critical and disapproving') grew from 38% to 44% [4].

In a survey of staff at a university on the verge of a migration to cloud computing, Furner found that perceptions of quality of service provided by, along with trust in, the university's Office of Information Technology were the strongest predictors of pre-adoption attitudes toward the pending migration to the cloud [12]. He also found that attitudes toward the new technology, namely perceived degree of individual control and perceived usefulness, influenced users' intent to use the new system [12]. Park and Ryoo, in a study of university students in Korea, found that the two strongest enablers of positive associations with a switch to cloud computing (Google Apps) were the widespread presence of cloud services and support for collaboration. The greatest obstacles were satisfaction with current IT services and their breadth of use [19].

In any discussion of organizational resistance, it is important to consider what will be best for the organization long term. Employees are more likely to get on board with a new initiative if it is in the organization's and their own best interests. In the case of cloud computing, this entails that organizations consider their business needs, rather than moving to the cloud blindly [5]. As Cohen notes, the cloud is better suited for some purposes than others. For example, he suggests that off-site backup is an area where cloud providers can provide a cost-effective service to guarantee business continuity. It is quicker to recover data from the cloud than from, for example, magnetic tape [5]. The AWS survey also identified disaster recovery (and thus, business continuity) as advantages to cloud computing [24].

Organizational resistance sometimes abates once individuals realize the benefits of a new technology. A survey of 121 students found that the cloud-based service Dropbox was rated highly for perceived usefulness and ease of use [20]. Udoh [23] also suggested that perceived usefulness and perceived ease of use [7] could be facilitating factors in the adoption of cloud services.

Perhaps the greatest source of organizational resistance comes from employees concerned about losing their jobs as new technologies are adopted. However, a survey of 3645 IT professionals [9] found that only 14% of organizations that adopted cloud solutions downsized their IT departments following adoption. By contrast, 20% hired additional employees with cloud expertise. Thus, there is likelihood in some organizations of job creation, rather than job loss, following the adoption of cloud services. It is prudent for cloud providers to include this kind of data in advertising to potential adopters, in order to assuage employees' fears.

Performance

Any organization preparing to spend money on a technology initiative will want good performance from the new system. In fact, performance issues were cited as an obstacle to cloud adoption by 29% of those in the AWS survey [24]. Individuals in the health and baking sectors identified performance issues as a top concern [10]. As Iyer and colleagues note, given the speed with which financial transactions take place, performance is paramount to banks. Similarly, medical professionals rely on readily available, updated data to perform their duties. If a system were to crash at a critical moment (e.g., during surgery), it could have detrimental effects on a patient's health [10].

Performance as a concern varies not only by sector, but also by country. For example, Carcary, Doherty, and Conway found that slow broadband speed was an obstacle to cloud adoption for Irish SMEs. The authors note that Ireland was slow to adopt broadband, and that speeds still lag behind other parts of Europe [1].

A major performance-related obstacle to cloud adoption for some organizations is Internet dependence. On the one hand, the Internet allows employees to access resources from multiple devices and locations. However, because cloud computing requires an Internet connection, some organizations are concerned about their ability to conduct business in the event of Internet outages. Indeed, some of the organizational leaders interviewed by Stieninger and Nedbal cited "missing redundancy of connections" as a concern [21].

Lack of Economic Gains

Cost savings are a factor in many organizations' adoption of cloud services [24]. Kuo, Kushniruk, and Borycki [16] argued that, because cloud computing is still a fairly new technology, there is little perceived evidence for its effectiveness in the health sector. Although their paper was specifically about the health care industry, the as-yet unproven nature of cloud computing could serve as an obstacle to adoption for organizations in other industries as well. This is especially true whenever organizations have already invested considerable resources in legacy systems, as Wu, Lan, and Lee [25] have argued. Iyer and colleagues note similar concerns, but suggest that, as existing infrastructures age, organizations may be more likely to move to cloud computing [10].

A survey of 3645 IT professionals [9] found that cost reductions realized by organizations that had adopted cloud solutions were not as great as some would have hoped. For example, 23% of US organizations saw no cost savings at all, while 35% realized savings less than $20,000. Nevertheless, 82 % of all organizations surveyed (from eight countries) saved some money. Furthermore, some savings may not materialize immediately. Savings from maintenance of legacy infrastructures, ongoing training, security audits, etc. may not show up during the first few years following a cloud migration.

REMEDIATING CONCERNS

The decision to implement any technology initiative ultimately rests with the adopting organization, and discussions of obstacles to the adoption of cloud solutions must consider the attitudes and perceptions of potential adopters. In the literature review, we discussed four types of obstacles that previous studies have identified: security, organizational resistance, performance, and lack of economic gains.

The obstacles identified can be grouped into two broad types: technological and perceptual. From a technological viewpoint, cloud providers can take concrete steps on their end to remediate potential flaws in security and inadequate performance. From a perceptual viewpoint, providers must communicate the advantages of cloud computing if they are to have a chance at improving perception of their products. We suggest the following best practices to remediate concerns about cloud computing.

Security

Cloud providers can overcome the security obstacle by employing security experts to identify existing and potential security flaws in their platforms, and by taking steps to remedy those flaws. Having done so, it will be critical to communicate what steps they have taken to organizations considering adoption. Münch, Doubrava, and Essoh recommend several measures to ensure security of private clouds, some of which are applicable to public cloud

providers as well. They include separation of users' data, secure configuration of components, separation of roles and responsibilities (with implementation of the principle of least privilege), training for administrators (to extend this suggestion to public clouds, users in the adopting organization should be trained in how to use the new technology on their end), and security of web interfaces [18]. As to the issue of data responsibility, providers will need to draw up clear and unambiguous guidelines, in consultation with both the adopting organization and their own legal teams (to ensure that guidelines meet all legal and regulatory requirements).

Organizational Resistance

Providers can partially overcome organizational resistance by taking two essential steps: First, encourage potential adopters to seek involvement from all stakeholders before implementing a cloud solution. This includes explaining the usefulness and ease of use of the new technology [7]. Furthermore, it is necessary to attempt to assuage the concerns of employees who may be anxious about losing their jobs following cloud implementation. It would be wise for management to point out that cloud implementation often leads to increased hiring [9].

The second step providers can take is to encourage potential adopters to consider their business needs. While it may be tempting to try to sell services to any potentially interested organization, an adopting organization is more likely to be satisfied if its existing business needs are met. Regardless of the degree of organizational resistance present before adoption of cloud services, careful planning is crucial. Carcary, Doherty, and Conway found that Irish SMEs that had planned ahead for cloud adoption experienced smoother transitions to the cloud [1]. Measures that some organizations took included instituting processes to determine which services were most suited to cloud migration (and equally important, which ones were not), establishing strategies to review the organizations' needs for cloud services, establishing a strategy to manage transition of services to the cloud, designing services for easy cloud transition in the future, developing a strategy to select a service provider, and encouraging involvement on the part of all stakeholders [1]. Cloud providers could play a role in helping organizations decide which business functions would be suitable for cloud migration, both by creating checklists for potential adopters to use, and by consulting with them on their business needs before adoption.

Performance

Providers can address the obstacle of perceived inadequate performance by identifying areas where performance needs to be improved, and then adopting appropriate measures. This might include installing additional servers to increase speed and improve performance. Some cloud providers have suggested working with several Internet providers, which could ensure fault tolerance for connectivity. If one provider should go down, another one could take over, providing uninterrupted Internet access [5].

Lack of Economic Gains

Providers can address the obstacle of perceived lack of economic gains by explaining the potential savings associated with cloud computing. This will include conducting follow-up surveys or interviews with organizations that have adopted their services, noting their cost savings, and communicating them in advertising copy. Crucially, providers must communicate the notion that, although savings may not be realized immediately, cloud integration is likely to be cost effective in the long run.

COMMUNICATION BEST PRACTICES

A review of the websites of the top 25 cloud providers for 2014 [22] revealed that most of them did not describe their practices for addressing concerns. Doing so could potentially improve customers' willingness to adopt cloud solutions. In addition to the recommendations listed in the previous section on remediating concerns, we suggest that cloud providers communicate their solutions on their websites. That kind of transparency could go a long way towards reassuring potential customers. We offer the following rubric as a starting place for companies interested in communicating their practices on their websites. We have written the rubric from the viewpoint of a potential cloud adopter, thus allowing providers to put themselves momentarily into the shoes of a customer for the purposes of evaluating their own communicative practices.

Security
- Does the provider have regular security audits? If so, who conducts them? What measures are in place to remediate potential flaws?
- Are guidelines for data responsibility listed online? If not, does the website detail measures for how guidelines are drawn up with adopting organizations?
- What other security measures does the website outline?

Organizational Resistance
- What measures does the provider take to encourage buy-in from all stakeholders?
- How does it analyze an organization's needs?
- What other measures to address organizational resistance does the website mention?

Performance
- What does the provider do to ensure connectivity? Does it work with multiple ISPs for fault tolerance, for example?
- What other performance-enhancing measures has the provider taken?

Economic Gains
- Does the provider outline potential cost savings in detail?
- Does it recount stories of other organizations' savings after cloud adoption?

CONCLUSIONS AND FURTHER RESEARCH

As several scholars [5, 17, 19] have noted, attitudes toward new technologies matter, and can even be predictive of intent to use the technology [23]. Still, perceptual data do not tell us the whole story. In order to test whether the implementation of some or all of the proposed practices actually results in increased adoption of cloud services, we would need longitudinal data. For this reason, it will be important to follow up with a survey of providers that implemented the proposed recommendations. Their data can be compared to a control group of cloud providers that did not do so. The study could examine the increase in new customers, as well as new revenue, during a given period of time (perhaps for one year following cloud adoption). Such a study remains an opportunity for future research.

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