Spring 2012

The Adaptation of Cloud Computing by the Hotel Industry

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by

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Bachelor of Arts - Psychology
University of Washington
2009

A professional paper submitted in partial fulfillment
of the requirements for the

Master of Science Hotel Administration
William F. Harrah College of Hotel Administration

Graduate College
University of Nevada, Las Vegas
May 2012
Chair: Dr. Robert Woods

PART ONE

Introduction

The concept of cloud computing has many benefits for the hotel industry. The migration to cloud computing is expected to have a major impact on the way that information and computer resources are handled by the hotel industry. Investment in technology must bring value to a business whether it's a large international hotel chain or a small, independent resort. Since business strategy will vary, a detailed study must be performed to identify the major issues that must be analyzed before migrating to the cloud.

The cloud is a highly adaptive IT infrastructure that can be shared by many different end users, each of whom might use it in very different ways. Computing resources can be dynamically and instantaneously distributed by the cloud provider as more users join the system (Mell & Grance, 2010). Cloud providers utilize a cloud infrastructure that is flexible, and which uses a highly efficient economy of scale approach in order to expand computer resources.

Cloud computing can dramatically lower the time and cost of entry to business for smaller firms trying to benefit from computer-intensive business applications that were originally available only to very large corporations. Cloud computing offers an adaptable and dynamic provisioning of computer resources (Bandyopadhyay, Ghalsasi, Li, Marston, & Zhang, 2011). This allows for a very pliable scale of computing power that can distribute large amounts of computing power for relatively short amounts of time, or small, consistent streams. It can provide an almost immediate access to hardware resources, with little to no upfront capital investment. Since less IT hardware is necessary, computer resources become a smaller, operational expense with cloud computing.

Purpose

The purpose of this paper is to examine the current benefits and barriers to implementing cloud computing in the hotel industry.

Statement of objective

The objective of this paper is to study and analyze the major issues that are most likely to have an impact on a hotel company's decision to decide to move to cloud computing. The intent of this paper is to help a hotel company to understand many of the major issues that must be examined and dealt with before a company can proceed with a major move to acquire cloud computing resources.

Justification

Studying the adaptation of cloud computing by the hotel industry is an important issue for hotel management to discern. By examining the positive and negative issues in adopting cloud computing, this study can help assess whether or not it is viable for hotel companies to make a move to cloud computing.

Constraints

This research paper is based upon an interpretation and application of academic journal literature. This study doesn't have access to the financial records of the individual IT departments for hotel companies. Therefore, this study will be unable to develop a financially-based-assessment of whether or not it is cost effective to implement cloud computing for a hotel company. The true "value" in a decision to make the move will in time need a more quantitative study of financial records.

Operational Definitions

The U.S. Commerce Department's National Institute of Standards and Technology [NIST] recently revised its definition of cloud computing in 2010. This definition of cloud computing and its components are the most often cited descriptions of cloud computing in research literature. Cloud computing is essentially a model for creating a convenient, ubiquitous, on-demand network, which is accessible to a shared pool of configurable computing resources and applications that can be swiftly provisioned and acted upon with a minimal amount of management effort or cloud provider interactions (Mell & Grance, 2010).

PART TWO

Introduction

Many of the desired benefits in technology spending focus on creating a system which presents a better overall value for a corporation. Major desired characteristics include creating a system that is more flexible, agile, creates a better and more efficient business process improvement, and which ultimately reduces the necessity of a large, physical, technological footprint. Businesses value technological ideals which promote improved technological skill sets from service providers, the ability to improve the speed of technological implementation, and the ability to reduce maintenance and operation fees. In regards to the hotel industry, these sought out improvements should inevitably help hotels to focus on being able to service their guests rather than having to divert their important business energies on maintaining on-premise hardware and software. As the following literature suggests, cloud computing ultimately helps to add value and promote these individual business ideals and strategies in certain situations.

Another important aspect of cloud computing is that it creates the ability for providers to allow for businesses to scale their services. Since cloud providers typically manage their systems through large-scale, sophisticated and dynamic software applications, these providers can deploy new software and other services almost immediately to their clients as clients' needs evolve. The speed and ease in which cloud computing services can be accessed and grown makes cloud computing very appealing to companies.

While cloud computing has strategic and operational advantages, cloud computing adoption rates aren't growing as fast as expected (Banerjee, 2009; Brandic, Broberg, Buyya Venugopa, & Yeo, 2009). Chen, Low, & Wu, (2011) surveyed IT firms in Taiwan to understand what factors discouraged cloud computing adoption in the high-tech industry. They identified

five factors that distinguished cloud adopters from non-adopters. These five drivers for cloud computing adoption that they found were: relative advantages, support by top management, size of firm, competitive pressures, and the trading partner power. If one looks at these five variables, he or she can see that a common theme relates them all. This theme ultimately deals with the costs and values involved in switching to a cloud computing environment.

Etro (2011) discussed many common issues, which he found are repetitively discussed throughout cloud computing literature. These are the major issues that are believed to slow down the adoption rates of cloud computing in companies. He described the major issues as: a lack or limited understanding of the cloud by firms, privacy, reliability, security, systemic risk, interoperability with other systems, jurisdictional complexity, governance of data, general status quo inertia, and losing control of data. Many of these issues are further explored in this paper.

The Range of Cloud Computing Resources

The cloud is basically a metaphor for the Internet. Cloud computing is a method of making computer services via the Internet accessible. A company can eliminate two major enduring problems in IT service provisioning by adopting cloud computing: the typically large upfront costs from acquiring computational assets and the typical time delay in building out and deploying computer software applications (Katzan, 2010). By eliminating upfront costs, precious capital can be saved for other important business decisions.

The current cloud model is composed of three service models, cloud infrastructure as a service (IaaS), cloud platform as a service (PaaS), and cloud software as a service (SaaS).

In IaaS, the consumer can deploy and operate arbitrary software, such as, operating systems and software applications. The consumer doesn't control the infrastructure. The

consumer has control over the operating systems, deployed applications, storage, and sometimes slight control of select networking modules (for example, host firewalls) (Mell & Grance, 2010).

In PaaS, the consumer can deploy onto the infrastructure their consumer-created or applications created by using tools and programming languages supported by the cloud provider. The consumer doesn't have control over the cloud infrastructure, servers, storage, operating systems, or network, but the user has control over the applications and application-hosting environment configurations (Mell & Grance, 2010).

In SaaS, the consumer can use the cloud provider's applications running on the cloud infrastructure. These applications are available from various client sources or devices using a thin client interface. For example, a web browser or perhaps web-based email can be the thin client. The consumer doesn't control the cloud infrastructure, operating systems, storage servers, or network. The user may not have control over individual application capabilities, but may have access to limited specific application software configuration settings (Mell & Grance, 2010).

It's important to know the difference between the types of cloud infrastructures. A company could choose to adapt their potential move to just certain cloud services if they have already expended capital on certain IT hardware or software. Companies must weigh the potential benefits versus the risks in a cost analysis before deciding to implement cloud computing. A potential customer must carefully analyze every potential use for cloud computing. These uses must be examined from a wide range of perspectives, such as from a legal, regulatory, technological, and business strategy viewpoint to determine if cost savings justify making a full move to the cloud or if making a smaller move such as by using PaaS, SaaS, or IaaS service models make more sense. If the costs or risks are found to be too high, then

making partial moves to IaaS, SaaS, or PaaS might be much more efficient (Ryan & Loeffler, 2010). If a company determines that risks aren't too high, but that it isn't prepared for a complete move to the clouds, then a smaller or subtle move to the clouds might be more cost efficient.

In a private cloud, all the technology components, servers, and software are maintained by an individual organization. The solution or system setup might be managed by the user or even a third party host, but it's nevertheless provided for the benefit of solely one organization (Mell & Grance, 2010). The development of private clouds is becoming more popular within large corporations. In a private cloud, a user can use a pooled resource. For example, not every laptop needs to have a specific software program installed on it. The user may use a pooled software program from one server with other users connected to this private cloud. In the future, users may not even require the use of a hard drive in every single laptop. This could help corporations minimize hardware costs.

A public cloud is commercially made available to everyone or to larger industry groups. A public cloud is typically maintained by the provider of the specific service. Examples of a public cloud are salesforce.com, Amazon's EC2 cloud offering, and Google's Gmail. Large corporations are increasingly using this type of deployment for discrete services and are experimenting with various ways to use this model (Mell & Grance, 2010). This cloud deployment model offers great potential flexibility and savings because of the large economy of scale that is utilized. On the other hand, it grants the provider virtually exclusive control over all the technological capabilities, and typically makes the user totally dependent on their service.

Sultan (2009) categorizes three major service types which can be distributed by the cloud, infrastructure, software, and platform. Infrastructure services are services offered by a remote

delivery of a complete system of computer infrastructure. This infrastructure is composed of such things as storage devices, virtual computers, and servers. Software services are distributed through the Internet using smaller, sophisticated applications. This eliminates the necessity of having to maintain and install software on numerous laptops and desktops. Platform services are services such as operating systems, web servers, middleware, and data basing provided remotely by vendors.

In IaaS, a company outsources the required equipment used to fulfill IT operations, such as, servers, storage, networking components, and other hardware (Sultan, 2009). The IaaS provider owns the technology equipment and is responsible for operating and maintaining the equipment. Cloud clients may typically pay by a per-use basis. Some examples of IaaS type provider services are Amazon.com AWS, SUN network.com, Verizon CaaS, and IBM Blue Cloud.

In SaaS, various types of software applications are distributed by the Application Service Provider (ASP) as rentals through the Internet (Sultan, 2009). Some examples of SaaS providers are Google Apps, Oracle Siebel on Demand Microsoft BPOS, and Salesforce.com CRM.

In PaaS, clients access computer services, such as, data basing and storage within a virtualized delivery system through the Internet (Sultan, 2009). Some examples of PaaS providers are Google App Engine, Microsoft Azure, and Salesforce.com.

Open source software (OSS) is anticipated to become a key enabler of cloud computing. Cloud adoption should be enhanced by the growing ubiquity of this freely used, OSS for the cloud infrastructure (Dwivedi & Mustafee, 2010). There are major costs connected with cloud computing - storage and network bandwidth costs, costs for the application (SaaS), and CPU costs. The ability to modify source code makes OSS very attractive for companies. Proprietary

software applications usually don't allow, nor provide clients access to source code. OSS, conversely, allows users full access to the source code. This is valuable for companies, since this software can be manipulated to suit specific company requirements. Since there's a growing number of free OSS applications, promoting and allowing greater cloud access to OSS would reduce costs for SaaS. An example of one major OSS system is Google's Chromium Projects. The Google OSS project is developing an operating system that is cloud-based.

One of the most important enablers of cloud computing has been met by utilizing a commodity-driven purchase of computing resources using very large economies of scale in the construction and operation of extremely large computer data centers in low-cost locations. These locations with very large economies of scale have uncovered from factors of 5 to 7 in the decrease in hardware necessary, cost of electricity, software, operations, and network bandwidth (Armbrust, Fox, Griffith, Joseph, Katz, Konwinski, & Zaharia, 2010).

There are four aspects which will further bring tremendous cost savings with regard to the diminished need for computer hardware. The first aspect is the ability of cloud computing resources that are available on demand, which will be quick enough to support seemingly infinite data load surges, subsequently eliminating the necessity for cloud users from having to plan far ahead and to make provisions for computing bottlenecks. The second will be the eradication of up-front commitment costs for cloud users. This will allow companies to start small and allow for incremental increases in resources as their needs grow. The third will be the ability to pay on a short-term basis for computing resources as needed such as, purchasing processing power by hour or storage by day. The fourth will be the freedom to immediately terminate services when they aren't needed.

As corporate desktop computers age, the need and dependency on cloud infrastructure will grow. Currently, SaaS is the dominate form of cloud computing, but IaaS is expected to grow over the coming years. SaaS represented 70% of 2010 revenue, with IaaS accounting for the remaining 30%. By 2015, the split is expected to shift to 60% SaaS and 40% IaaS. Solution providers, resellers, and other agents will account for 39% of end-customer generated revenue by 2015 ("Top 10", 2010). SaaS is currently the most used form of cloud computing since corporations are still using desktop computers which are still in good working order, but SaaS will eventually even out with IaaS in demand as that computing hardware depreciates.

The Growing Cost Benefits from the Cloud

The cost benefits of cloud computing are drawing a large amount of interest from companies. A survey which was taken in 2009 demonstrated that 75% of the companies that used computing resources, intended to begin allocating or increasing their budget in cloud technological development (Stinchcombe, 2009). The International Data Corporation (IDC) predicts that by 2013, worldwide cloud service revenue will reach $44.2 billion. Revenues from the European market will amount to €6 billion (euros) (Gorniak, 2009). This migration to cloud computing signifies a strategic motivation by these companies to create a competitive advantage. IDC (2009) describes that IDC's 2009 report focused on cloud-based application development and test services - customers leading requirements and provider preferences. This report was put together with input from 400 IT specialists and business executives from the U.S. and Europe. It concluded that large enterprises are moving to the cloud in pursuit of greater cost savings and creating quicker times to market for such things as software application development and for testing services.

There are many wide-ranging estimates about how much the potential cost savings could be by moving to the cloud. Some business literature proposes that by instituting a cloud-based system throughout a corporation, the magnitude of the cost savings in the Information and communications technology (ICT) spending can be large. ICT is synonymous with IT. IDC (2009) estimates total cost reductions of about 50% for the private sector, but more realistic estimates in more negative scenarios could drop to 20% cost reductions. Estimates for the public sector range from total cost reductions from 10% in pessimistic scenarios and 30% in optimistic ones. West (2010) estimates that a cost reduction from 25% to 50% is most likely. West cites a successful example about when The City of Los Angeles switched over to a Google Gmail-based cloud solution for e-mail service in 2009. Estimated cost reductions were around 25%, since nine jobs were eventually eliminated and nearly 100 servers were relocated to different uses. West cites that another similar switch was undertaken in Washington, DC with an estimated cost savings near 50%. West cites another example from Carlsbad, California, where a switch to a Microsoft-based cloud email service solution created cost savings of nearly 40% per year.

The ability of small and medium-sized companies (SMEs) to compete with larger companies, which can take advantage of their stronger negotiating power position and impose their way of doing business upon the SMEs presents a major barrier to ICT spending. Bajenaru (2010) suggests that since most large companies are already intense ICT users, a lag in ICT adoption could develop in SMEs. This lag may create a growing technological gap between SMEs and large companies and leave SMEs unable to compete against these larger companies.

On the other hand, Bajenaru (2010) suggests that because of the lowered cost of entry into ICT, since limited computer hardware is necessary and less capital costs are necessary, cloud computing makes logical sense for newer SMEs. Large corporations, On the other hand,

have significant organizational, operational and technical issues which must be addressed before clouds are implemented extensively at them. If a large company has developed a best-of-breed efficiency from their current computer operations, then it is very unlikely for that company to be able to make a quick switch to a cost-effective cloud solution. Tucker (2009) uncovered that 'typical' data centers of large corporations can currently be operated at significantly lower costs than the costs to outsource to a cloud provider, such as Amazon.com's EC2 system. Tucker adds that this data center price can be lowered significantly via pre-payment schemes, and by using OSS Linux systems. Tucker estimates though that the cloud service would only lower labor costs by a modest 10–15%.

Like most technological systems, cloud computing may inevitably become a commoditized service if the competition becomes fierce among the providers. Companies will be able to rent computing power, such as, hardware, software, and storage from service providers. These rented services could most likely be paid on demand, such as how electricity is paid for (Truong, 2010). This change to an on demand service could have a profound, positive effect on how company budgets are shaped, since upfront capital costs will ultimately be lessened since much of the upfront hardware and software costs will be appropriated to actual usage and not to providing many underutilized resources (hardware and software components) wastefully to every single user at a company. The potential cost savings and benefits from this change to an actual usage model could positively benefit business creation, job creation, and create other opportunities for spending. Cloud computing potentially allows new entrants to save money on the fixed costs attached with hardware and software adoption and with the general ICT investment. This adaptation changes capital expenditure into an operative expenditure, and it ultimately becomes a variable cost (Armbrust et al., 2010; Truong, 2010). This change creates

potential value and reduces entry costs and ideally promotes spending for business creation. The reduction of these fixed costs could vastly reduce the risk of failure or bankruptcy and promote business entry more, especially for newer companies.

As with any new technology, the total cost of 'ownership' for cloud computing resources is in limbo. Bajenaru (2010) contemplates that there are still unknowns regarding the total cost of ownership over longer periods of time, versus traditional cost models. Future expenditures regarding cloud computing are made fuzzy because of potential changes in the law and the potential for new hardware, and software requirements.

Cloud Provider Pricing

Providers could potentially move to many different potential pricing models or policies. Some of the major types of pricing could utilize a pay-per-usage fee, a flat fee, a pay-per-use fee, or perhaps some type of mixture of these fees. These fees should be analyzed with capacity investment decisions and quality of service guarantees in mind (Alford & Morton, 2009). It would ultimately be up to the individual companies to examine which potential pricing strategy and guarantees are best suited for their computing and IT needs. On the other hand, the providers need to be realistic about what pricing models will allow them to be profitable.

Li (2011) argues that complicated pricing mechanisms for cloud computing services could very well deter price sensitive customers from employing this new technology. He uses the simple flat rate pricing mechanism as an example that has proven to be successful in the experience of networking access services, such as ADSL, cable internet, or 3G in order to promote cloud adoption.

For most companies that use a lot of computing resources, certain times of the day require more bandwidth and more computing power. Consequently, the flat rate pricing scheme

exhibits many potential problems for providers with its practicality. The major issue under this pricing model has mainly to do with congestion, since most companies operate in between the daylight hours. To resolve the potential congestion issues and in order to keep cloud computing pricing fair and simple for the provider, Li recommends that providers utilize a flat rate pricing model with congestion control (FRPCC). Creating fairness and congestion controls are critical for the cloud computing provider in order to realistically distribute its services. Li suggests that future, inevitable congestion can be controlled and adjusted by the cloud, so that at times of major traffic congestion, large bandwidth data hogs, such as multimedia files, can be slowed or even dropped while active users using a fraction of the bandwidth resources and not using these large files, can operate normally. By dropping these large bandwidth hogs during congestion, pricing for cloud services can be simple and cheap. By keeping the provider pricing simple, the cloud computing model can potentially follow other successful technology industry models, such as with how internet service providers have priced their services.

Security

Along with the changing business model for the deployment of SaaS, security must also change with the adoption of cloud computing. The ownership of software shifts from the client to the provider, along with the responsibility of providing a secure environment.

Security is one of the most often-cited objections to embracing cloud computing for most individuals and corporations. Companies may only feel comfortable using some of the more common cloud services, such as email and payroll services, but have reservations in trusting newer services that so far remain unproven security-wise. There are regulations that must be met before a corporation can move data to the cloud. The Sarbanes-Oxley and Health and Human Services Health Insurance Portability and Accountability Act (HIPAA) establish legal

requirements for auditability and data confidentiality (Armbrust et al., 2010). These legal requirements necessitate that auditability and data confidentiality must be proven to be secure before a corporation can make the migration to the cloud.

Some key issues about cloud security deal with privacy, identity, and accountability for the information managed. One of the biggest issues about security deals with the matter of control of the cloud information (Katzan, 2010). The corporation must make sure that it solely controls the information that it distributes over the cloud.

If all of the corporation's business data is stored on a virtual server, the data will be more vulnerable to cyber-attacks and hacking (Truong, 2010). A problem that arises from hacking and cyber-attacks deals with the protection of intellectual property management. The cloud computing provider must ensure the privacy of their customer's data and that all data will be kept confidential. Cyber-attacks could also harm a provider's reliability. Truong suggests that overload capacity, delay, and breakdown of the cloud could result in the interruption of the customer's business and affect their business performance.

Cloud systems could actually provide better overall security benefits in terms of the benefits of scale and with standardizing interfaces (Cody, Rao, Sharman, & Upadhyaya, 2008). These benefits could provide better protection in terms of patch management, filtering, rapidity to the response to security attacks, and deployment of standard IS policy.

There are already many benefits in security from cloud services. Web browsers (all of the major web browsers now automatically update via cloud services) have built-in features, which check URL blacklists, in order to prevent viruses and malware from suspect or malicious websites from infecting a computer browser ("The brightening", 2009). Google provides a cloud security service for Yahoo searches, for example, sites which have failed a Google antivirus

check, receive a warning notice from the Yahoo search that the site may harm your computer. By using the benefits of scale, Google is able to provide and distribute an excellent and highly efficient form of cloud security. Google visits a huge number of sites regularly to index them for fast searches, and also analyzes the sites for known exploits and malware using a variety of antivirus software ("The brightening", 2009). Antivirus scanning can ultimately be an expensive, computing, resource operation. Antivirus scanners typically require a lot of CPU and memory allocation. Through Google's cloud antivirus scanning of sites, individual and corporate computers are spared from this repetitive activity, and computer resources are spared from this unnecessary burden.

Finding a trustworthy provider

Hotel IT decision makers must find knowledgeable and responsible cloud partners. While some of the big cloud providers can deliver quality and reliable services, the cheaper and smaller providers may inescapably deal with operating problems such as overload capacity, delay, breakdown (Truong, 2010). These disruptive issues could result in a severe interruption of a customer's business and affect financial performance. An example of a severe interruption occurred on the morning of April, 21 2010. Amazon's EC2 cloud-based data center in Virginia crashed, and ended up taking down several very popular websites and small businesses that depended on it (Chatterjee, 2011). Some of the largest of these sites that went down were Foursquare, Reddit, Quora, and Evite. This failure at Amazon's EC2 (Elastic Cloud Computing) center created the appearance that cloud computing was an unstable and unreliable option. The businesses harmed by the EC2 outage that day lost hours of ad revenues, potential business opportunities, and an immeasurable drop in the trust of loyal followers of these internet sites (Chatterjee, 2011). The monetary losses from this crash of the EC2 are hard to quantify. The

lesson learned from the cloud computing users was that they need to diversify their computing resources: perhaps to use their own servers for specific operations; to perhaps use multiple cloud system providers; to perhaps be able to seamlessly move between these providers with ease.

For a business, it makes logical sense to not wholly depend on an individual cloud provider or a single data center exclusively. Being dependent solely upon a single provider could be viewed as if putting all your eggs in a single basket. Utilizing redundancy in cloud computing is something that should definitely be deliberated - this involves spreading out servers in different locations or by using more than one cloud provider. Armbrust et al. (2010) suggest that the management of a cloud computing service by a single company is in fact a single point of failure. Even if the company has multiple data centers in different geographic regions using different network providers, it may have common software infrastructure and accounting systems, or a provider company could simply go out of business. Large customers will be reluctant to migrate to cloud computing without a business continuity strategy for such situations. Cloud services should be provided by different companies. Just as large Internet service providers use multiple network providers so that failure by a single company will not take them off the air, a sensible solution to create very high availability service is to use multiple cloud computing providers.

Cloud providers must offer better transparency and more consumer control of their data and processes in order to gain or regain consumers' trust (Khan & Malluhi, 2010). Because of the issues with control over business information, trusting cloud computing providers might be a more complex issue as compared with trusting other IT systems, but the overall objective to adapt a new technology is to improve business and remain competitive by exploiting the positive

benefits of the new technology. New technologies can gradually build trust over time for consumers by establishing good performance and security.

A way to overcome issues with trust and dependability from a provider is to establish a contract with them in order to maintain a certain degree of acceptable performance standards. The service level agreement (SLA) can contractually enforce minimal expectations and alleviate concerns about a lack of support or downtimes, by providing certain guarantees for the services (Stinchcombe, 2009). Cloud providers may sometimes readily create and provide their own SLA in order to boost their customers' trust. On the other hand, providing these SLAs may not be very helpful at all for a provider, since creating trust in cloud computing should be more geared to preventing a violation of trust, rather than guaranteeing compensation should a violation potentially occur. The loss of reputation of a cloud provider could ultimately mean certain death for that company (Khan & Malluhi, 2010). Instead of focusing on post-failure compensation, it would be wiser for the provider to underscore its energies towards preventing failures in service.

Provider SLAs may sometimes be worded too strongly in their favor. Concern and confusion about the difficulty of extracting data from the cloud is dissuading some organizations from adopting cloud computing (Armbrust et al., 2010). A strongly worded provider SLA could cause cloud customers to be fearful of being locked into a contract which could make them vulnerable to reliability problems, the provider going out of business, and price increases.

Legal Issues that weigh on the Cloud

By using web applications based on a cloud, an individual or company can lose control of information. Subsequently, the pendulum of computing power appears to be pulling away from individual autonomy towards a higher degree of concentrated power in fewer hands (Miller &

Voas, 2010). Cloud computing can be seen as further increasing a centralized form of computing power and harnessing control of user data. If a company gives their data to a cloud provider, they are placing a great deal of trust upon that cloud.

Managing and protecting the security of data is of utmost importance. Concerns about liability must be hashed out before a company puts their information and data on a cloud. Many cloud providers currently limit or disclaim any liability for data that is stolen from their cloud (Dysart, 2011). It would be wise to create an indemnification provision for potential losses, should the provider be at fault for losing data.

Ensuring that your data remains in a usable form that can be controlled by in-house computers is also critical. Cloud providers many times reserve the right to alter any content or data that you put into the cloud (Dysart, 2011). Control of the data form is important, since the capability to modify content can paralyze the ability to extract data from a cloud or switch cloud provider.

Legal disclosure issues could eventually become a large problem. If a court issues a subpoena to obtain a company's data from a cloud, current law permits cloud providers to simply release it. A cloud provider can't be held liable for disclosing data pursuant to a legitimate legal order, and also, a civil suit can't be made against the government for disclosure violations (Dysart, 2011). A company's only recourse may be to create a provision in a SLA in order to receive prior notice before a release of information to the government or the courts.

Scalability

Cloud computing makes it easier for enterprises to scale their services. Since computing resources are managed through cloud software applications, they can be deployed virtually as fast as new requirements arise. Katzan (2009) suggests that the goal of cloud computing is to

scale resources up or down dynamically through software application programming interfaces (ways that software communicate to each other) depending on client load, with minimal service provider interaction or maintenance.

Scalability suggests that a utility has sufficient capacity to expand later and provides an economy of scale (Katzan, 2009). For cloud computing, data transfer bottlenecks are the major issues in scalability. As time goes on, software applications become more data-intensive and demand more bandwidth. In 2010, with costs of $100 to $150 per terabyte transferred, user costs could quickly build up, making data transfer expenditures a major issue (Armbrust et al., 2010). Scalability is an important issue to be concerned about since users and providers must think about the implications of the placement of traffic at every level of the system in order to make a cost-effective system.

When Green Means Money

Green computing encourages environmentally friendly computing and its major objective is to promote an efficient use of electricity. Cloud Computing provider infrastructures are typically constructed as very large data centers. By using innovative technology in these large data centers, a provider can generate enormous energy savings and reduce harmful carbon emissions. One example of a cutting-edge data center is the ones constructed by Google. These Google-built data centers use almost half the energy of typical data centers (Dwivedi & Mustafee, 2010). Growing concerns about the environment could possibly be a major factor for driving and inspiring the adoption of cloud computing.

Economically efficient and resourceful IT departments also fulfill the objectives behind green computing. For example, servers and data centers can be intentionally located in regions which have accessibility to cheaper electricity, such as near hydroelectric dams, while the

computing power can be dispersed and accessed from far-reaching distances through the Internet (Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011). Improved accounting of total resource consumption can also create efficient green benefits. Adapting a "utility computing" ideology can help IT departments focus attention on energy efficiency and the desire to acquire resources only when absolutely necessary. Using more stringent utility computing accounting methods should allow for better measurements of operational inefficiencies.

According to Amazon.com's estimations, expenses related to the operation and cost of the servers at its data centers accounted for 53% of their total budget (based upon a 3-year amortization schedule), while energy-related costs amounted to 42% of the total costs (which includes both direct power consumption (19%) and the cooling infrastructure (23%) (amortized over a 15-year period), (Hamilton, 2009). Hamilton discusses that almost 60% of the power that is utilized at these intensively employed data centers is used by the computer servers. Hamilton argues that server energy efficiency is paramount for conserving energy resources. With cloud computing's economy of scale, server use is maximized, since time purchased on the cloud server is leased out typically in advance. The typical, wasted hours of non-desktop usage at company offices, for example, from 5pm to 8am - is no longer wasted resources when using a cloud provider. Typical company standard policies require that most computer users leave their computers on 24hours a day – in order to preserve and extend the life of the sensitive desktop computer hardware from extremes in heat changes – the computer being on, and extremes in coldness, which as hardware technicians suggest will prevent the wires and components from cracking from the temperature changes (Hamilton, 2009). These policies waste a lot of energy and imply that networked desktop computer systems are highly inefficient and wasteful.

A benefit from scaling computer resources at data centers and by creating an economy of scale for computing resources is that it can conserve resources as well as money. It is estimated that an idle server uses two/thirds the power of what a "busy" server uses (Armbrust et al., 2010). A company's networked desktop computers and servers can be very wasteful. By emphasizing an extremely efficient use of computer resources, such as with the way cloud data centers are utilized, this efficiency could reduce the impact of computing on the environment.

The amount of money saved in energy costs by using data centers, rather than a company running its own servers to perform computing tasks has been found to be very significant. A savings of 20% can be realized in network and server energy consumption with respect to current levels, and these savings may also induce an additional 30% saving in server cooling cost needs (Berl, Dang, Gelenbe, Girolamo, Giuliani, Meer, & Pentikousis, 2010). There are significant economic and environmental gains that can be obtained from advances in energy efficiency in IT and computing. For example, by using virtualization techniques, peak-time loads can be allocated to other parts of the cloud; the aggregation of the data and the cloud's resources can employ higher hardware utilization (Berl et al., 2010).

Improvements in energy efficient computing may aid in the reduction of total carbon emissions in a very substantial way (Armbrust et al., 2010). Through reducing software and hardware related energy costs through the use of highly efficient data centers that execute cloud computing applications, there can be substantial positive monetary benefits from the energy savings.

What Hotel Companies want from the Cloud

Gruber (2011) suggested that the ideal suite of cloud-based services for most hotels would have the following software applications bundled and distributed together – central

reservation system (CRS), property management systems (PMS), and revenue management systems (RMS) distributed via a SaaS model. Gruber argued that this software delivered over SaaS becomes an operational expenditure and not a capital one, software updates are no longer a delayed hassle, removes the burden of infrastructure and application management, and security can potentially be improved and increased over time. If these systems can be delivered reliably and affordably, then a SaaS model can bring many advantages over on-premise solutions for hoteliers.

PMS software has drawn keen interest from IT executives in the hotel industry over the past few decades. Software updates from these vendors were looked upon with great anticipation. Some of the largest PMS vendors for the hotel industry are Micros, Agylisis, RMS, CMS, Innquest, Softbrands, and Maxial. In a very crowded PMS landscape, these vendors must adapt quickly to their clients' software application needs. By using a cloud provider, updates could be instantaneous and applied broadly to cloud customers.

Horner (2010) believes that PMS has become commoditized. PMS investments can't and won't bring as strong of a competitive advantage as they once did. Subsequently, since this technology has become ubiquitous, it is worth less as an investment in IT, and costs for PMS should inevitably decline. Horner suggests that the major current trend from vendors in updating PMS software development lies with integration. Vendors are trying to integrate their PMS better with the hotel websites. Vendors are also trying to integrate other software systems better with their PMS, such as with customer relationship management, GDS systems, yield management, catering, and sales. Horner believes that the total upfront costs for PMS are too expensive and that these vendors need to move to a fee-based system for software usage. He

believes that hotels should create better SLA contracts with the vendors and more effective ways to terminate these contracts if the service is poor.

In the last few years, running virtualization software has reduced hardware costs for hotels ("Forecast", 2010). Virtualization software allows for one server to run multiple software programs, thus making one server do the actions which would normally require multiple servers (Mell & Grance, 2010). Virtualization uses specialized software, which divides the original server into expanded virtual environments, named private or virtual servers. Using virtualized servers provides many benefits, for example, it allows each virtual server to operate its own operating system, each virtual server section can also be separately rebooted of one another, and it can run multiple software programs (Mell & Grance, 2010). Since virtualization lessens the number of servers that are required, server virtualization cuts costs since less hardware is necessary. Before virtualization software came along, each major software program typically required its own server. So if a hotel had four major software programs, the hotel most likely required four separate servers. Commercial servers can typically cost $5000/server ("Forecast", 2010). By using virtualization software, a hotel can potentially put all of their software systems on one server now and avoid having to purchase costly, additional servers that each require maintenance.

Squires (2010) described the sentiments from hotel chain IT executives at the 2010 Hotel Technology Next Generation conference. Many IT executives wanted many of the same things from software vendors - that the vendors needed to provide virtual applications through SaaS, IP-converged network solutions and mobile-ready applications. Squires mentions that Nick Price, the CIO/CTO of Mandarin Oriental stated at the conference, "Virtual applications and cloud computing are the only way Mandarin Oriental will deploy systems beginning in 2011. Provide

them if you want to do business with us" (p.50). The high cost effectiveness of cloud computing is inspiring hotel executives to demand this technology from software vendors. Software vendors have a lot of work ahead of them to please these new sentiments.

PART THREE

Introduction

Cloud computing is an evolving technology that is increasingly drawing a great deal of attention. It has the potential be very beneficial for businesses, yet at the same time it presents some major challenges. Some companies may see instant success from using cloud resources, but others may rightfully want to postpone their decision whether or not to adapt to it. This research focuses on the major issues that weigh upon a hotel company's decision to implement cloud computing.

This research discusses how cloud computing can potentially benefit and enhance competitive advantage, and also how it may possibly harm a company. Some of the major issues that are examined are cost-effectiveness, efficiency, security, legal responsibility, reliability, trustworthiness, scalability, and environmental benefits. This research study should improve researchers' understanding of how cloud computing adds or diminishes value as a computational resource for a hotel company. This research also has practical implications. It helps practitioners, especially hotel owners, understand how implementing cloud computing wisely can simplify IT operations and requirements. While many companies may have a similar accessibility to cloud computing resources, it is important to understand how to exploit these advantages distinctively in order to create and sustain a competitive advantage.

Methodology

This research paper, will use and adapt the results of cloud computing research studies through a comparison of existing literature in various industries to develop a conceptual research model for cloud computing adoption, in order to understand how hotel companies are likely to progress into cloud computing. The intent of this method is to explain how this prior research

can shed new light on the major issues, which can determine whether or not a hotel will want to migrate to the cloud.

Results

A company can eliminate two major enduring problems in IT service provisioning by adopting cloud computing – the typical large upfront costs and time delays in building out and deploying hardware and software applications (Katzan, 2010). Purchasing on-demand services from a cloud provider allows for immediate growth without having to deal with IT growing pains. By eliminating upfront costs, precious time and capital can be saved for other important business decisions.

Hotel companies don't need to make a complete move to a cloud provider, they can adapt partially or slowly over time by using one of the three service models, IaaS, PaaS, and SaaS. Through adapting partially or slowly over time with one of these service models, a company can minimize the shock of adapting to cloud technology and limit upfront hardware costs (Mell & Grance, 2010).

Adapting OSS applications will save companies a lot of potential money, since this software is free and the source code can be manipulated by the company's software developers to suit individual company needs. OSS is anticipated to become a key promoter of cloud computing. Cloud adoption should benefit from the growing ubiquity of this freely used OSS operating in the cloud infrastructure (Dwivedi & Mustafee, 2010). Expensive proprietary software applications that aren't cloud friendly could lose their value against cloud-based OSS applications.

Cost savings for a hotel by moving to cloud computing can potentially be very high. West (2010) has estimated that a range between 25% to 50% cost savings is realistic. Tucker (2009) estimates that using the cloud service would potentially lower IT labor costs by 10–15%.

SMEs can typically achieve faster economic benefits from cloud computing. Bajenaru (2010) suggests that because of the lowered cost of entry for IT spending, since a limited amount of computer hardware is needed and less capital is necessary, cloud computing makes an efficient and logical sense for newer SMEs. Cloud computing doesn't make as much sense for older and larger companies that have already built out an expensive IT infrastructure.

Shifting to cloud-based computing systems changes fixed costs to variable costs. Instead of purchasing hardware and software outright, companies rent computing power. These rented services are paid on demand, such as how electricity is paid for (Truong, 2010). Costs will ultimately be lessened since costs are appropriated to actual usage and not potentially wasted by giving unused and unnecessary computing resources to every single user at a company. This change to an actual usage model could positively benefit companies spending budgets.

Cloud provider pricing must be fair and simple for consumers to understand in order for cloud services to become widely embraced. Li (2011) endorses that providers use a flat rate pricing model with congestion control (FRPCC). Creating fairness and congestion controls are necessary for the provider to realistically distribute its services economically. If the provider pricing is simple, the cloud computing model might follow other successful technology service models, such as with internet service providers.

There are legal requirements about auditability, accountability, and data confidentiality that must be met before legally moving to a cloud. The Sarbanes-Oxley and Health and Human Services Health Insurance Portability and Accountability Act enforce legal requirements for

auditability and data protection (Armbrust et al., 2010). It would be unwise for a hotel company to make the migration to the cloud until these legal obligations are met.

A hotel company must make it very clear who ones the data uploaded to the cloud. A major security issue deals with the matter of who controls the cloud information (Katzan, 2010). The corporation must make sure that it solely has legal control upon the information that it distributes over the cloud in order to protect its valuable proprietary information and consumer information.

Cloud systems could ultimately provide some better overall security benefits because of the benefits from an economy of scale and with standardizing interfaces (Cody et al., 2008). This could provide better filtering, patch management, rapidity to the response to security attacks, and promote better standard deployment of IS policy.

For a business, it makes logical sense to not wholly depend on an individual cloud provider or a single data center exclusively. Armbrust et al. (2010) suggest utilizing redundancy in cloud computing is something that should definitely be considered - this entails spreading out servers in various regions and using more than one cloud provider. Reliability and trust are some of the biggest factors for a company not wanting to move to a cloud provider. By using multiple systems from different regions, there should be better computing stability.

To overcome issues with trust and dependability from a provider, a company should create a binding contract with them in order to uphold a certain degree of acceptable performance standards. The service level agreement (SLA) can contractually enforce minimal expectations of service by providing binding guarantees (Stinchcombe, 2009). Strong SLAs can help promote trust that a provider will assume more legal and financial responsibilities, and make cloud customers more faithful in their services.

Concerns about liability must be hashed out before a company puts their information and data on a cloud. Liability for the continuity and integrity of the data must be ensured. Many cloud providers currently limit or disclaim any liability for data that is stolen from their cloud (Dysart, 2011). Dysart also argues that cloud providers many times reserve the right to alter any content or data that you put into the cloud. A company's only recourse may be to create capable provisions in a SLA. If the provider doesn't provide insurance that they will be liable for their potential service problems, or that they will not provide adequate support for their management of data, then the provider could dramatically increase legal and switching costs to a new provider.

Choosing a provider that allows a great deal of scalability will permit easier IT growth in the future. Cloud computing makes it easier for enterprises to scale their services, since computing resources are managed through cloud software applications, they can be deployed virtually as fast as new requirements arise through software application programming interfaces (Katzan, 2009). Without scalability, a company may be limited in its future size, and growth could be dramatically slowed from various service bottlenecks. With the large scale scalability that clouds typically provide, companies can potentially grow their IT services overnight with a simple service increase from their provider. The scalability of service should be much faster to grow than they could by developing their own systems, since cloud provider systems typically utilize an economy of scale.

Using a cloud provider can help the environment. Cloud providers are extremely efficient in their server computing usage (their server use is maximized) because they have been efficiently designed and built according to an economy of scale, thus, their servers use less energy (Hamilton, 2009). Hamilton explains that almost 60% of the power that is utilized at data

centers is used by the computer servers. On the other hand, corporate server computing environments typically aren't designed as efficiently as a cloud provider infrastructure. Since cloud computing providers use less energy, they can be seen as providing more efficient and greener computing. This benefits the environment, since less carbon emissions will potentially be released from their energy creation sources.

Using a cloud provider means that energy costs should go down as well. A benefit from scaling computer resources at data centers and by creating an economy of scale for computing resources is that it can fully utilize all the servers. It is estimated that an idle server uses two/thirds the power of what a "busy" server uses (Armbrust et al., 2010). A company's networked computing system can be very wasteful. A savings of 20% can be realized in network and server energy consumption with respect to current levels, and these savings may also induce an additional 30% saving in server cooling cost needs (Berl et al., 2010). Without the wasted server energy costs, companies should save money on energy costs.

Server virtualization may be another option or temporary upgrade instead of moving directly or fully to a cloud provider. Many small hotels may not need a large IT department or a large number of IT hardware, and may only need to operate a small handful of software applications. Virtualization software applications radically increase the efficiency of one server and allow one server to potentially serve the function of many different servers. Using virtualization software allows a company to cut IT hardware costs.

Gruber (2011) suggested that PMS, CRS, and RMS systems are the most likely used systems that hotels would benefit the most from in using cloud resources through a SaaS service model. If bundled together, these three systems should dramatically simplify IT management at

hotel properties. These systems must adapt and evolve and prove to be reliable and secure systems that are affordable to become ubiquitously deployed by hotels.

Conclusion

The purpose for implementing any new technology at a hotel should be to increase profits or to streamline operations. Cloud computing has the potential to offer hotels increasingly simplified IT and IS departments. Using a cloud-based system can also save money over the long term. Cloud computing presents many benefits over in-house based server systems, in terms of cost-effectiveness, efficiency, scalability, and environmental benefits. On the other hand, cloud computing presents some potentially troubling issues regarding security, legal responsibility, reliability, and trustworthiness. A hotel must make an informed and very careful decision to see if the benefits outweigh the problems before deciding to switch to a cloud-based system.

Recommendations for future research

There hasn't been much research done on cloud computing and how it specifically relates to the hotel industry, more research is needed to see how many hotels currently use cloud computing resources and how many plan to switch in the coming years. There are many grey legal areas regarding the privacy and ownership of personal data in the cloud. The public policy movement on cloud security will continue to evolve and should become an important issue to research further.

References

Alford, T. Morton, G. (2009). The Economics of cloud computing. McLean, Virginia: Booz Allen Hamilton. 1-10.

Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R., Konwinski, A., & Zaharia, M. (2010). A view of cloud computing. *Communications of the ACM*, 53(4), 50-58.

Bajenaru, A. (2010). Software-as-A-service and cloud computing, a solution for small and medium-sized companies. *Bulletin of the Transilvania University of Brasov.Economic Sciences. 3*(20652194), 173-184.

Bandyopadhyay, S., Ghalsasi, A., Li, Z., Marston, S., & Zhang, J. (2011). Cloud computing — The business perspective. *Decision Support Systems, 51*(1), 176-189.

Banerjee, P. (2009). An intelligent IT infrastructure for the future, *Proceedings of 15th International Symposium on High-Performance Computer Architecture*, CA.

Berl, A., Dang, M. Q., Gelenbe, E., di Girolamo, M., Giuliani, G., de Meer, H., & Pentikousis, K. (2010). Energy-efficient cloud computing. *The Computer Journal, 53*(7), 1045.

Brandic, I., Broberg, J., Buyya, R., Venugopa, S., & Yeo, C.S. (2009), Cloud computing and emerging It platforms: vision, hype, and reality for delivering computing as the 5th utility, *Future Generation Computer Systems*, 25(6), 599-616.

Chatterjee, R. (2011, Apr 25). Amazon's trouble raises cloud computing doubts. *The Economic Times.* Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.proquest.com/docview/863092922?accountid=3611

Chen, Y., Low, C., Wu, M. (2011). Understanding the determinants of cloud computing adoption, *Industrial Management & Data Systems*, 111(7), 1006-1023.

Cody, E., Rao, R.H., Sharman, R., Upadhyaya, S. (2008). Security in grid computing: a review and synthesis. *Decision Support Systems*, 44 (4), 749–764.

Dwivedi, Y.K., Mustafee, N. (2010). It's unwritten in the Cloud: the technology enablers for realising the promise of Cloud Computing, Journal of Enterprise Information Management, 23(6), 673 - 679

Dysart, J. (2011). The trouble with terabytes. *ABA Journal, 97*(4), 33-37,62.

Etro, F. (2011). The economics of cloud computing. *IUP Journal of Managerial Economics, 9*(2), 7-22.

Forecast: Virtually cloudy with 90% chance of saving hotels money. (2010). *Hotel Business*, 19(6), 56.

Gorniak, S. (2009). *Cloud Computing European Network and Information Security Agency (ENISA)*. Retrieved from http://www.enisa.europa.eu/act/res/technologies/tech/dnssec/dnssec

Gruber, G. (2011). *Six questions hoteliers should ask providers of cloud-based systems.* Retrieved from http://www.tnooz.com/2011/06/21/news/six- questions-hoteliers-should-ask-providers-of-cloud-based-systems/

Hamilton, J. (2009) Cooperative expendable micro-slice servers (CEMS): Low cost, low power servers for internet-scale services. *Proc. 4th Biennial Conf. Innovative Data Systems Research* (*CIDR*), Asilomar, CA, USA, January.

Horner, T. (2010). Property management systems: Where to now?. *Hotel & Accommodation Management*, 14(2), 56.

IDC International Data Corporation (2009). *Aid to Recovery*. Retrieved from http://www.google.com/url?sa=t&rct=j&q=idc%20%20(2009)%2C%20aid%20to%20recovery&source=web&cd=2&sqi=2&ved=0CGIQFjAB&url=http%3A%2F%2Fdownload.microsoft.com%2Fdownload%2F4%2F1%2FA%2F41ACE8D7-8712-474A-9E45-2FEAFC7CEBCB%2F2009_OCT_Global_White_Paper_IDC_Study.pdf&ei=lj2rT4XVKKeqiAKe64jtDA&usg=AFQjCNHb-IGhyt88EzP2kHgbeMuoYWcUlQ&cad=rja

Katzan, H. (2010). On an ontological view of cloud computing. *Journal of Service Science*, 3(1), 1-6

Khan, K. M., & Malluhi, Q. (2010). Establishing trust in cloud computing. *IT Professional Magazine, 12*(5), 20-27.

Li, C. (2011). Cloud computing system management under flat rate pricing. *Journal of Network and Systems Management, 19*(3), 305-318.

Miller, K. W., & Voas, J. (2010). Ethics and the cloud. *IT Professional Magazine, 12*(5), 4-5.

Mell, P., & Grance, T. (2010). The NIST Definition of Cloud Computing. *Communications of the ACM*, 53(6), 50.

Ryan, W. M., & Loeffler, C. M. (2010). Insights into cloud computing. *Intellectual Property & Technology Law Journal, 22*(11), 22-28.

Stinchcombe, N. (2009). Cloud Computing in the Spotlight, *Infosecurity.com*. Retrieved from http://www.infosecuritymagazine.com/view/4755/cloud-computingin-the-spotlight/

Sultan, N. (2009). Cloud computing for education: A new dawn. International Journal of Information Management, in press.

Squires, M. (2010). Hotel tech executives want cloud solutions. *Lodging Hospitality*, 66(5), 50.

The brightening future of cloud security. (2009). *Network Security,* (10), 7-10.

Top 10 cloud stories of 2010. (2010). *Informationweek.* Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.proquest.com/docview/820953454?accountid=3611

Truong, D. (2010). How cloud computing enhances competitive advantages: A research model for small businesses. *The Business Review, Cambridge*, *15*(1), 59-65.

Tucker, L. (2009). *Introduction to cloud computing for Startups and Developers*. San Francisco, CA: Sun Microsystems, Inc.

West, D. (2010). *Saving Money Through Cloud Computing*. Retrieved from http://www.brookings.edu/papers/2010/0407_cloud_computing_west.aspx