Moving to the Cloud

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ABSTRACT

The growth of cloud computing has been increasing fast since a few years ago, although it is still a small part of overall Information Technology (IT) spending of organizations. Both private and public sectors are embracing cloud computing as it offers an innovative computing model, simplifying IT resource management, offering cost savings and flexible scaling. The question is no longer whether to adopt cloud computing or not, but what should be adopted and how? The transaction cost economy theory offers a rationale for the adoption and the decision-making theory helps construct stages for the adoption and operate cloud computing to provide effective and optimal IT solutions for organizations. This paper offers decision makers to overview cloud computing, especially in utilizing values offered and selecting resources or operations that can be migrated to the cloud.

KEYWORDS
- Cloud Computing
- Decision Theory
- Outsourcing
- Pay-Per-Use
- Transaction Cost Economy

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1. Introduction

The root idea of cloud computing model can be traced back to the utility computing of McCarty (Garfinkel, 1999) in which a pull of computing resources can be utilized on demand, and the cost of utilization is calculated based on the amount of usage, a similar model to existing utilities like water, gas, electricity, and telephone. The idea can only be realized with the availability of high-speed global network connections that can link users with servers to execute tasks remotely and efficiently.

The recent advancement of the Internet with broadband networks, both with wire and wireless connection, is the main driver of the rise of the internet computing model called cloud computing. With this computing model, people or organizations do not need to own expensive computing resources as they can rent the resources needed to the cloud. Hence, significant cost savings can be anticipated, especially the investment cost and maintenance cost. As the maintenance cost normally contributes to the large portion of the total ownership cost of information technology (IT) resources, cloud computing offers very attractive computing models to users. For example, cloud computing providers offer payment similar to the utility providers. They normally charge using a renting model and/or pay-per-use model for their services. Many cloud computing providers offer free of charge for their basic services offered to individuals, such as Google, Amazon Web Services, and most Social Media vendors. As such, many users are familiar with cloud computing services.

Most current networked-based computer systems adopt the client-server architecture. A notable example that we use every day is email and the Web. Both email and the Web use the client-server architecture, where servers are normally powerful computers that store data and information and control information flow. While clients, which are normally less powerful and much cheaper computers (such as desktops, laptops, tablets, and smartphones), access information or any services provided the servers. In the conventional business model, servers and most client machines are normally owned by organizations. In the cloud computing business model, service providers own servers and offer various services that are to be made available to client machines via the Internet.

The adoption of cloud computing is growing both by individuals and organizations globally as they only need to prepare client machines, which can be desktops, laptops, tablets or smartphones to access various cloud computing services. Consequently, the number of cloud computing providers is growing and big players such as Google, Amazon, IBM, and Microsoft have jumped in to offer their cloud computing services. These companies and other cloud computing providers foresee lucrative markets for various cloud computing services as many companies have been outsourcing their computing systems to the cloud, taking advantage of numerous benefits offered by the cloud computing model.

Pew Internet reported that the future of cloud computing is promising (Anderson and Rainie, 2010). According to the report, the Internet will be the major medium for people accessing computing resources and sharing information as agreed by the majority of stakeholders and experts participated in a survey on the expected future of the Internet by 2020. Consequently, most people will adopt cloud computing, which is predicted to be a dominant computing model in the next decade. As cloud computing is relatively new, there are still many issues to settle to raise the adoption (Kim, Kim, Lee, & Lee, 2009).

What is cloud computing? There many definitions of cloud computing. According to Vaquero, Rodero-Merino, Caceres, and Lindner (2009), there are at least 20 definitions. Their study extracts the common ground – a pay-per-use method of payment, a large pool of computing resources accessible through a computer network, and dynamically and scalable resource allocations. The US National Institute of Standards and Technology (NIST) offers a short and good definition cloud computing: "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." (Mell and Grance, 2011).

Based on the structure of a computer system, various cloud computing services can be classified into three service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Depending on their needs, organizations can outsource their computing need through these three models. There are four deployment models: public cloud, private cloud, hybrid cloud, and community cloud. Shifting computing resources to the cloud, which resource to move and which service and deployment model to adopt need to be considered properly. This paper uses Transaction Cost Economy Theory (TCE) to help make a rational decision to outsource computing resources to the cloud. A decision-making theory is utilized to construct stages on how to adopt (outsource) and operate cloud computing.

This paper discusses the concepts and applications of cloud computing. Advantages and disadvantages of cloud computing, and some issues, including adoption issues, will be discussed. The next section discusses cloud computing architecture, service models and deployment models. Section 3 is the theoretical construct. Section 4 discusses outsourcing rationales using TCE and stages to outsource and operate cloud computing using decision theory. Section 5 discusses some benefits and issues of cloud computing, and Section 6 is the conclusion.

2. Cloud Computing Model

Cloud computing is basically remote access of computing resources through the Internet. This method of computing resource access is nothing new as it was practiced during the mainframe decades. Similarly, virtualization technology, a core concept in cloud computing, is part of the mainframe technology (Zhang, Cheng, and Boutaba, 2010). However, in a mainframe computing system, many users access the mainframe resources through terminals (monitors or screens) and all computing processes are conducted by the mainframe.

Computer networks were introduced in the 70s and the TCP/IP network (Internet) was introduced in 80s and subsequently adopted widely. At about the same time a new computing model that takes advantage of the Internet, client-server computing, was introduced. Client-server computing offers much cheaper computing system compared to the mainframe computing system as a server that can serve many client computers are normally much cheaper than a mainframe. In client-server computing, the server provides services to clients such as providing data or allocating resources needed by clients. Unlike a terminal in a mainframe computing system, a client machine has data processing capability such as a desktop or laptop computer. Many internet-based applications such as email and world-wide web (WWW or the Web) run based on the client-server computing system.

In term of technology, cloud computing utilized both mainframe and client-server computing technologies to provide various services to many clients. There are two closely related computing concepts developed, namely utility computing and grid computing. Utility computing is a computing system in which computing resources are rented to users through the pay-per-use method of payment. Grid computing is a computing system designed to solve computing intensive problems at low cost through an interconnected heterogeneous computer connected with a high-speed network. A grid computer is basically a low-cost virtual supercomputer that can perform like a high-cost supercomputer (Buyya and Venugopal, 2005; Anshari et al., 2015).

In essence, cloud computing is a large scale client-server computing supported by many servers to serve myriad of users scatter all over the world accessing the services using their heterogeneous client machines through the Internet. To create powerful processing capacity in providing services to a large number of users with acceptable response and speed, cloud computing employs grid computing concept in connecting myriad of servers using a high-speed computer network. However, the main purpose of grid computing is to share computing resources through a network of servers from many organizations. While a network of servers in cloud computing normally belongs to a firm (providers) located in data centers for a commercial purpose.

Although a number of servers in a cloud computing is normally many, to serve a large number of users with different needs exclusively, cloud computing uses virtualization technology to create many virtual servers on one machine. Each virtual server can serve a particular purpose. With virtualization, many virtual machines can be created and decimated on-demand on a single machine to create optimal flexibility (Buyya, Yeo, Venugopal, Broberg, and Brandic, 2009; Zhang, Cheng, and Boutaba, 2010)

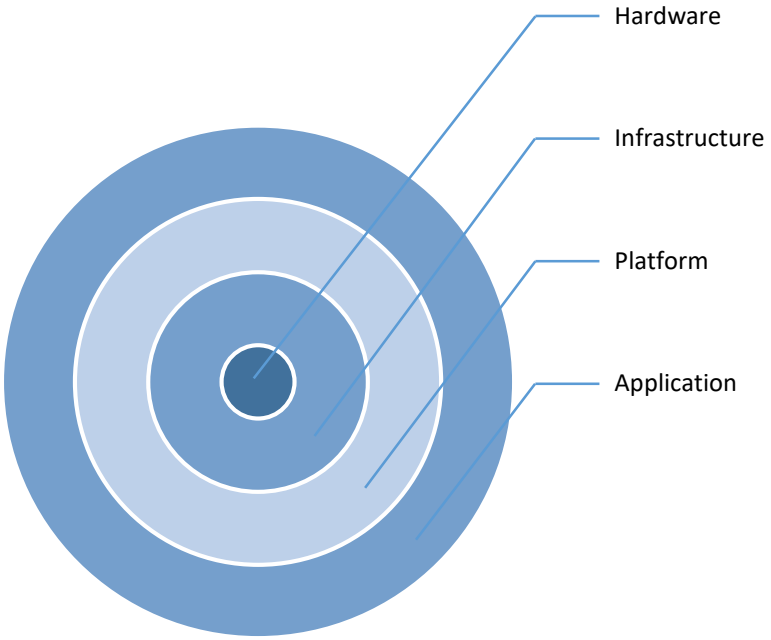
2.1. Architecture, Service and Deployment Models

Cloud computing architecture and service models are highly related as service models are built based on the architecture. The cloud computing architecture is an abstraction of cloud computing structure while service models are basically level of computing support that can be provided to users.

Architecture

In general, cloud computing can be divided into four layers, namely the physical layer or hardware layer, an infrastructure layer, the platform layer and application layer (Zhang et al., 2010). Figure 1 shows this layered architecture.

Figure 1. Layered Cloud Computing Architecture



The hardware layer includes processors, memories, mass storages, switches power, and others that provide computing resources for the cloud. The collection of hardware is normally organized in a data center. The infrastructure layer is the layer that provides virtual machines that created from the virtualization of machines in the hardware layers. Note that each virtual machine can be run independently and many virtual machines can be created from one real machine. The platform layer is constructed on top of the infrastructure layer. It comprises an operating system,

servers such as a web server, and application frameworks. The top layer is the application layer where many cloud applications reside in which up-scale and down-scale applications can be done automatically on-demand basis.

Service Models

Most cloud computing literature classifies services into three layers: Infrastructure as a Service (IaaS) offers the most basic service such virtual servers, Platform as a Service (PaaS) offers servers equips with operating systems and other platform systems such as web servers and database servers, and Software as a Service (SaaS) offers various applications needed by users (Badger, Grance, Patt-Corner, & Voas, 2012; Sultan, 2009; Zhang et al., 2010; Anshari et al., 2016). This in line with the architecture described above.

Service in the first layer is IaaS. IaaS providers offer virtual servers to their customers. IaaS providers, by using the virtualization technology, turn a computer into several virtual servers. Normally, IaaS providers have multiple data centers which possess a myriad of servers. For instance, the Amazon Elastic Computer Cloud (EC2) has 454,400 Linux servers (Liu, 2012) in its data centers. Through virtualization, millions of virtual servers can be created from EC2. One or more virtual servers can serve an organization. In addition to virtual servers, additional services such as network-accessible storage and network infrastructure components can be provided on-demand (Badger et al., 2012).

The next layer service is PaaS. Platform services are built on the existing infrastructure. Services may include operating systems, web servers and related development tools, database servers and application development tools (Badger et al., 2012; Zhang et al., 2010). For example, Sourceforge.net is a PaaS provider that serves application developers with a platform and various application development tools to help them develop applications, including mobile applications (Columbus, 2013a). Other PaaS well-known providers are Google through its Google App Engine (https://developers.google.com/appengine/) and Microsoft Corp through its Windows Azure (http://www.windowsazure.com/en-us/).

The most common cloud computing service is SaaS, the last layer of service. Service providers of SaaS offer their applications through the Internet. These services can be in term of web-based services, applications are accessible through the Web or various applications accessible through the Internet. Many SaaS providers offer their services on the Internet. Some examples are iCloud from Apple, Google Apps from Google, and Adobe Creative Cloud from Adobe.

Deployment Models

Nowadays, most of the time people interact with various cloud applications, for examples search engines, emails, wikis, social media (such as Facebook, Twitter, and

Instagram). Many people now use cloud storages such Dropbox, Google Drive, and Microsoft OneDrive to store their files or documents. These applications and storages are deployed for the public, hence accessible by the public through the Internet or public cloud.

In general, there are four deployment models, namely public cloud, private cloud, community cloud, and hybrid cloud (Mell and Grance, 2011; Subashini and Kavitha, 2011). The most common deployment model is public cloud. However, other deployment models are available if the public deployment model is not suitable because of a circumstance such as security.

A public cloud normally provides cloud computing services that can be accessed through a public network such as the Internet, everyone, as long as he/she is connected to the Internet can subscribe to access the services offered. Many public cloud services, especially basic services are available for free. However, for additional or premium services, users need to pay using the utility payment model. Normally, a contract is not needed for the public to use the services Public cloud providers provide facilities (infrastructure, platform or applications) depending on the service model offered and the public has no control on this facilities.

As public cloud providers implement a multi-tenant environment for their services, where many users share the same computing resources, the most profound benefit of the public cloud is cost saving as user save not only operational cost but more importantly they save investment and maintenance cost. However, there are also some problems that can be faced by users of a public cloud such as reliability and security. Although cloud providers will try their best to reduce these problems, with the multi-tenancy environment and public access these problems cannot be totally removed.

A public cloud implies of sharing of services by many people (public), and the people have no control of the cloud. For some reasons, users such as private or public organizations want to own and have exclusive control in serving their intended users (such as workers or customers). This cloud is called a private cloud, a single tenant environment where computing resources are dedicated to a single entity (either a private or public organization).

Private clouds overcome some of the public clouds problems. For example, security, privacy and reliability issues are isolated and controlled as computing resources are not shared. A private cloud can be implemented both in-house and off-house. An in-house private cloud is much more expensive than an off-house one as it incurs both investment and maintenance cost. An off-house private cloud is a private cloud offered by a cloud computing provider with a single tenant environment. Private clouds, especially in-house private clouds are less flexible than public cloud, as

computing resource cannot be scaled up and down flexibly, so the potential of underuse of computing resource is high.

Hybrid clouds and the combination of public and private clouds where both clouds run independently but linked, provide the best trade-off advantages and disadvantages of public and private clouds. For example, for both private and public organizations considered data is highly valuable and need to be protected properly. These organizations can use hybrid cloud, storing data in the private clouds form maximum security and use public clouds to run applications that utilize the data through encryption channels (Sanders, 2014).

Community clouds are multi-tenancy environments where several organizations share computing resources. The resources can only be used by a limited number or organizations that agree to utilize the common resources and normally provide common facilities and applications which serve concerns of these organizations.

3. The Theoretical Construct

The cloud computing utilization by organizations is basically outsourcing computing resource to the cloud. Outsourcing is a management term to describe a mechanism in which a company utilizes services offered by another company, normally through a contract, to fulfill some of its required business resources or functions (Almunawar & Almunawar, 2018). Through outsourcing organizations are expected to streamline management and possibly cut cost.

IS outsourcing has been practiced since few decades ago. For example, Eastman Kodak outsourced the whole of its IS functions to IBM, DEC and Businessland in 1989 (Gupta & Gupta, 1992). Nowadays, with the advancement of the Internet, we witness that IS outsourcing has shifted to cloud computing where many organizations are moving parts or whole of their computing resources to cloud computing with the same expectation, simplifying management of IS resources and cut cost.

Outsourcing IS resources to cloud computing providers can be seen as a logical flow in decision making. According to Simon (1960) decision making process has four stages, *intelligence, design, choice* and *implementation*. Intelligence is basically the problem identification process where a problem(s) is clearly identified and specified. Alternative solutions are developed in the design stage. The choice stage is finding the best alternative solution to tackle the problem. The chosen solution is applied in the implementation stage.

Using Simon's decision model, Dibbern, Goles, Hirschheim, and Jayatilaka (2004) develop a model for assessing IS outsourcing called Stage Model of IS Outsourcing. Figure 2 shows the model. We use this model as a framework to guide organizations adopt or move to cloud computing. Stage Model of IS outsourcing has two phases, decision process phase and implementation phase. This paper focusses on the decision

process phase, especially to answer the why question. To do this we employ transaction cost economy (TCE) as a theoretical lens to provide good reasons for organizations in moving their computing resource to the cloud.

Figure 2. Stage Model of IS Outsourcing (Source: Dibbern et al. (2004))

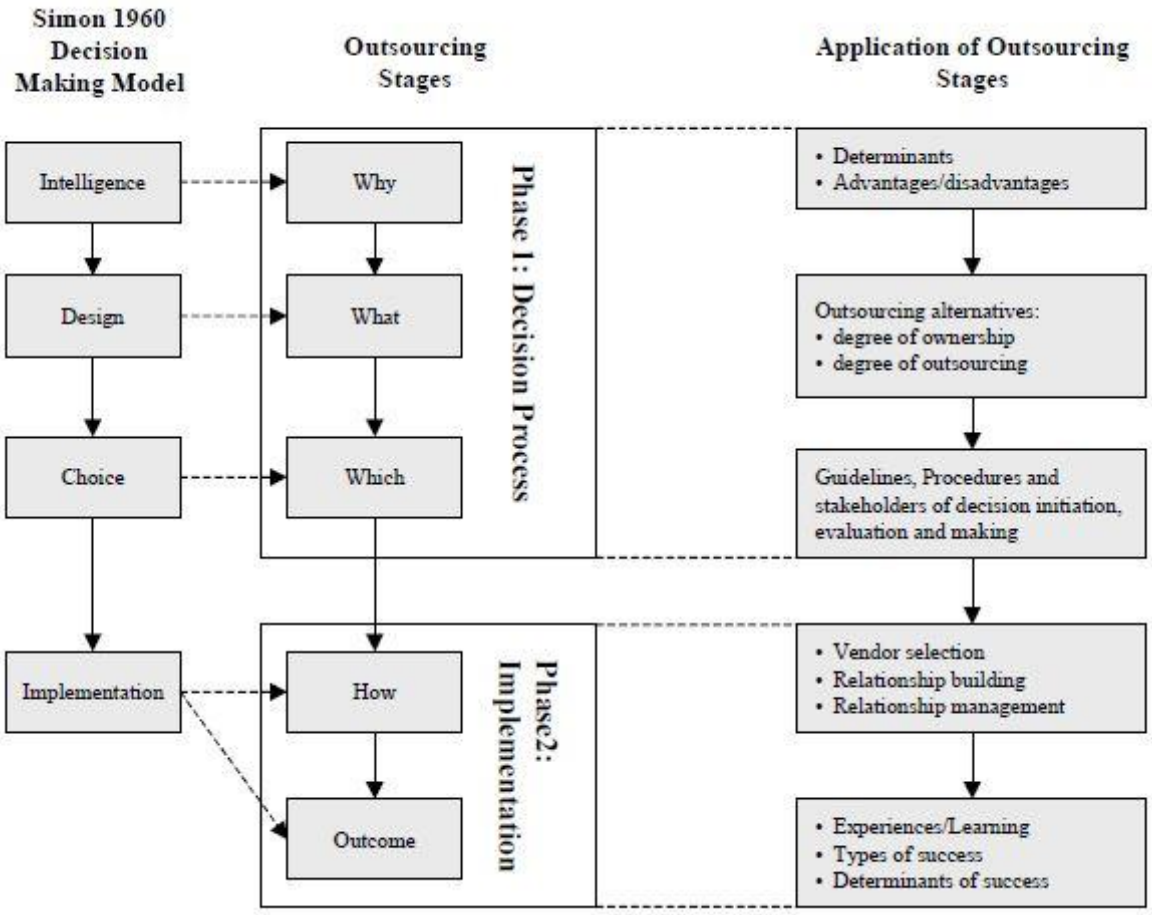


Figure 2 shows how Stage Model of IS outsourcing is derived from Simon's decision-making model. Phase 1 consists of 3 stages, *why, what* and *which*. In the outsourcing in the cloud, the *why* stage is corresponding to the intelligence stage. At this stage, organizations find the reason(s) for outsourcing such as key factors to consider (determinants) and advantages/disadvantages of outsourcing in the cloud. The *what* stage is about finding alternative outsourcing solutions to the cloud. The alternative may include considering both service and deployment models. The *which* stage is to come up with the best-fit cloud computing solution. The outcome of the first phase is the chosen solution to be implemented in the second phase.

The second phase is the implementation of cloud computing solution. The *how* stage is basically the detail on how to implement the solution such as finding and select the provider, setting service level agreement (SLA) and managing relationship with the provider. The last phase is the *outcome* phase which is the result of outsourcing in the cloud, success, failure, and lesson learned.

The most important step is the first step that provides a reason to outsource to the cloud. As mentioned above, we use TCE to provide a theoretical lens for this purpose. Coase (1937) introduces Transaction Cost theory that considers a firm as a governance structure instead of a production function. A transaction is basically an exchange of goods or services from one entity such a business organization to another one. Transaction cost is the cost of exchange of goods or services. This cost may include communication cost, searching cost, commission fees, legal fees, and cost of delivery. A firm needs services or products to function. Those services and products can be bought from the market through market governance structure/price mechanism. However, if the cost for buying through the market is too high or too much uncertainty, arranging to get those products or services within the firm or in a more controlled governance structure (hierarchy) is preferred. The question is what variables that make a firm relies on products or services that it needs on the market or manages to integrate functions that can produce the products or services within the firm?

There are three important variables governing the commercial transactions (Williamson, 1981, 1989); asset specificity, uncertainty or disturbance of transactions, and frequency of the transactions. These three variables or dimensions determine how a firm performs routine activities to produce values: relies on the market, short-term or long-term contracts with other firms or in-house integration.

Asset specificity is the degree uniqueness of an item. Common or standardized items such as computers are not specific or have low asset specificity as they can be obtained from many suppliers and a supplier of the items can sell them to any buyer. Hence, there is no dependency between the two transacted parties. Highly specific items or items that have high asset specificity such as highly customized software create a dependency between the two transacted parties. For example, a supplier who cannot deliver a high asset specificity item requested by a buyer will create a serious problem for the buyer, as it cannot find the items easily from other suppliers. Similarly, if a buyer canceled buying a high asset specificity item from a supplier, the supplier cannot find a new buyer easily.

There is no perfect certainty any transaction as many kinds of events that can create uncertainty that can cause disturbances and in some cases may lead to cancellation of transactions. Uncertainty can be caused either by buyers (users in the cloud computing), suppliers (providers) or both. This may cover uncertainty in delivery, performance, and measurements in contracts. If the uncertainty of a transaction is too high, the transaction cost will be high, which may hinder the transaction, and the parties secure themselves by integration or internalization of the process to produce goods or services that needed.

The frequency of transactions of goods or services needed will influence the way for a firm to get the goods or services. In general, for low transaction frequency is it more

efficient for a firm to buy the goods or services needed to the market and for very high-frequency transaction, integration or internalization could be the best choice for a firm.

4. Reasons to Utilize Cloud Computing

This section will establish reasons for moving to the cloud by applying TCE and benefits offered by cloud computing. As cloud computing offers computing resources, we limit our discussion to reasons and benefits for outsourcing hardware and software to the cloud, which will be discussed in the next Section.

Unlike the traditional IS outsourcing business model, the cloud computing business model provides maximum flexibility in utilizing cloud computing resources, both in term of using the resources (expanding and shrinking of resource utilization can be done anytime, automatically) and in term of length or frequency of using the resource. Although cloud computing providers will try to secure long-term contracts with users, however, theoretically a very short-term contract, say a few days, is supported. Hence, although there are many similarities between IS outsourcing and cloud computing, there are some differences such as flexibility, services and payment model that make TCE views of cloud computing will be a bit different from TCE view of IS outsourcing.

Applying TCE as a framework for analyzing IS outsourcing decision and behavior was conducted by Aubert, Rivard, and Patry (1996, 2004). The three TCE variables or dimensions discussed earlier are applied. How these variables influence the decision to use cloud computing needs to be studied. However, a brief analysis of how users (firms) see cloud computing from TCE lens will help to lay a foundation for the study.

Asset specificity will influence the deployment model to be adopted. In general, firms will find low asset specificity items in the market. Standard computing services both in term of hardware and software have low asset specificity. Hence firms are expected to use public cloud to find services that match their requirements. For high specificity items, firms try to secure the items in-house or to have a long-term contract with a trusted supplier/provider. In the case of cloud computing, high specificity computing services can be provided through private cloud, or traditional IS outsourcing.

Every transaction is accompanied by a level of uncertainty. A firm will avoid high uncertainty transactions. Hence it has a high tendency to integrate the transactions in-house. Cloud computing services certainty is determined to service reliability, security level and network bandwidth for service delivery. As long as a firm can tolerate security level and the network bandwidth of service delivery and trust the cloud computing provider can provide reliable services, it may consider using the service offered by the provider.

Regarding frequency of transactions, cloud computing, with the pay-per-use model, cloud computing provides high flexibility for a firm to use cloud computing services either for the occasional or low frequency of transactions or high frequency of transactions.

Based on the simple analysis above, cloud computing is a viable solution for a firm to consider. To complete the next section we will provide some benefits and issues of cloud computing for firms to reason about cloud computing solution for some of their computing problems.

5. Some Benefits and Issues of Cloud Computing

5.1. Benefits

There are many benefits of cloud computing discussed in the literature. Here are six important ones.

Simplicity and flexibility. One of the most attractive features of cloud computing is simplicity and flexibility. To use cloud computing services users need only to provide affordable client machines and get connected to a chosen cloud provider through the Internet. No software licenses needed, hence users are free from costly license fee and the hassle of maintenance. Users can choose type and level of service offered by the provider automatically. Computing model offers users great flexibility as they can scale-up and scale-down services on demand quickly. In addition, cloud computing providers normally regularly upgrade their systems to provide better services. As such, users will benefit from the ever up-to-date technology, both software, and hardware.

Reliability and availability. Although services from the cloud are accessed remotely, as long as the Internet connection is good (note that the bandwidth is getting better) cloud computing services are generally reliable and available 24 hours and 7 days a week. Each cloud provider uses many servers at different sites so that failure in one site can be substituted by another site in real-time. Cloud providers implement redundancy to increase availability and reliability. As the traditional computing systems rely on one or a few servers, if problems happen in these servers services will be interrupted. Even upgrading a server may interrupt services. In the traditional computing environment, it is common practice that users receive messages from their system administrators because of service interruption for a few hours due to maintenance. Unlike the traditional computing system, in cloud computing systems, maintenance or server upgrades will not affect services as they are addressed by other servers seamlessly.

Service interruptions rarely happen in the cloud computing environment. A cloud computing service provider will definitely ensure high availability and reliability of its services as this is the root of its credibility.

Cost reduction. Cost of running computing resources (hardware and software) is dominated by investment such as buying hardware and licensing software and maintenance cost such as upgrading hardware and software. Cost reduction on IS spending is highly expected as investment and maintenance cost is replaced by operational cost through a pay-per-use method for using computing resource in the cloud.

Organizational Agility. It is important for a firm to adapt quickly and to take advantage of the ever-changing business environment. It is important to rapidly and effectively respond to customers' preferences to achieve a strategic adaptation (adapting to trends and issues) for a medium term and long term shaping. In cloud computing, a request of computing resources can be fulfilled in a very short time, and services can be deployed quickly. In addition, scale-up can be done immediately, if needed. This makes cloud computing support organizational agility. In addition, all services can be accessed any time anywhere using various client devices.

Scalable infrastructure. Scale-down and up as highlight previously can be done immediately. Cloud computing system is designed to accommodate new hardware and new nodes flexibly with limited modifications so that both horizontal and vertical expansions can be done seamlessly. As a result, the scale of the service can be expanded and shrunk as requested. Consequently, users can start with small and relatively inexpensive services and then expand the services as needed later.

Seamless upgrading and migration to new technology. It is well understood that the advancement of IT is very fast and it is relatively difficult to keep pace with the fast advancement of IT. In the traditional computing environment, a firm needs to keep upgrading their computer systems regularly and to keep them up to date, which is costly not only in term investment but also migration to the new system is also costly, including interruption of services. In a cloud computing system, upgrading technology or even migration to new technology is done seamlessly. Hence, the interruption of services is not necessary. In addition, cloud computing providers normally keep their systems up-to-date, and a system update has no impact on running services.

5.2. Issue and Challenges

Although cloud computing has many benefits, however, it also has some issues and challenges, such as issues on security, transparency, and trust. Here are some important issues with possible solutions.

Trust. Since cloud computing means remote access to computing resources owned providers, the first and obvious issue is users have lost control of their data. Trusting cloud providers is the key for users to adopt cloud computing service. For example, cloud providers need to convince their users that data or information stored in the cloud are safe and protected. As the trust problem has no easy solution, a third party

that can guarantee information privacy and security may be needed. Everett (2009) discusses the issue of trust in cloud computing. One possible solution to establish trust between a provider and users is an assurance by an independent party through certification or accreditation (such as ISO 27001 or SAS 70).

Security and privacy. Probably security is the hottest issue of cloud computing, and this issue is tightly related with trust. This issue exists in conventional computing. However, in cloud computing, users and their data are geographically separated, and data are accessed through the Internet. This highly affects the users' confidence in the cloud (Armbrust et al., 2010; Zhu, 2010) as the Internet is a public network. Security threats present in servers within the cloud, the client machines, and the network. In addition, each service model has its security issues. Subashini and Kavitha (2011) classify security issues on cloud computing into four categories: application security, data storage security, data transmission security, security related to third-party resources, and. A survey on cloud computing security issues can be found in (Subashini and Kavitha, 2011) and further discussion on security issues of cloud computing is available in (Jansen & Grance, 2011; Roberts and Al-Hamdani, 2011).

Performance. Although cloud computing providers utilize powerful computers to serve their customers, sharing of a computing resource in the cloud and the network speed and the distance between client machines and servers in the cloud highly affect the performance of computation. Also, the possibility of data transfer bottlenecks may happen in the increase of intensity of data processing and transfer and increase in a number of users accessing the data. This may complicate the performance and costs as data transfer consumes the communication bandwidth (Armbrust et al., 2010; Kim et al., 2009).

6. Conclusion

Cloud computing a viable solution of computing resource needed by organizations. Start-up companies will definitely get benefits from cloud computing services as they can avoid costly investment and maintenance of computing resources. Also, they can start with small and cheap services and then expand as needed. Existing companies will probably start considering moving some of their computing resources to the cloud. As such, they need to reason about the moving and select which function need to be moved and which one need to keep in-house.

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