Adoption Issues of Implementing Cloud Computing in Telemetry Equipment Manufacturing Industry

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Abstract: Cloud Computing has become more and more popular and it has been considered as one of the way to help the SMEs reduce costs and increase profits. However, several challenges that might affect the adoption rate. The main objective of this research paper is to discuss the adoption issues of implementing Cloud Computing in SMEs – manufacturing industry. This paper also discusses the success of Advanced Telemetry, a manufacturing industry, mainly manufacturing and marketing the flagship remote energy-monitoring software through the adoption of Cloud Computing. Rogers’ Diffusion of Innovation Theory has been used to explain the rate of adoption of Cloud Computing in the industry.

Keywords: Adoption, Cloud Computing, Diffusion of Innovation, Manufacturing Industry, Rate of Adoption, SMEs

1. Introduction

In today’s world, Cloud Computing is a very hot and highly discussed topic. [21] and [28] found that during the past 10 years, there is a huge paradigm shift in computer world that is the shift from traditional servers to the Cloud Computing to provide demand services. The main purpose of implementing cloud computing is to provide efficient and time distributed computing when needed [2]. [31] said it has becoming one of the most important technologies within these years. Cloud Computing has become more and more important especially to the business world. The adoption of Cloud Computing has become a major task for SMEs. According to [7] study, Cloud Computing has been ranked as top 10 most important technologies and it will bring with better prospect to the organizations. According to National Institute of Standards and Technology (NIST), they defined Cloud Computing as “a model that provides convenient and easy on demand network access to users through Internet to a set of cloud resources (e.g. networks, servers, applications and services) with minimal management efforts” [25]. [35] defined Cloud Computing as a large pool that stored a lot of resources that are easily usable and accessible. These resources are able to adjust to various load / scale. [15] said Cloud Computing is a model that does not require users to prepare any resources or tools such as hardware and software, the users can directly use the service over the Internet. User involvement in system maintenance and system / hardware upgrade is not needed and they are not their duties. [29] said the word ‘cloud’ was illustrated from Information Technology which means remote environments (Internet). It was portrayed as cloud images to conceal the complexity behind, it provides users a simple interface. The following figure (see figure 1) shows the four-layer architecture of Cloud Computing.

According to [1] and [11], they explain cloud architecture as follow: The bottom layer, Fabric, contains the raw hardware resources such as computing, storage and network. The unified resources usually contain the virtualized resources in order to show to end users as integrated resources. In platform layer, new resources are added on to the top of unified resources such as a collection of specialized tools, middleware and services.

Figure 1. Four-layer Cloud Architecture. [1]
2. Problem Statement

Although adopting Cloud Computing in SMEs will bring benefits, however, some of the SMEs especially manufacturing industry is still not adopting due to some issues. The major issues such as security and privacy are the reasons that the manufacturing industry still not adopting. They worried about the security of the data transmission. Some of them refused to adopt cloud computing due to they have sensitive data and they do not know where it stored. Most of their clients worried that they will lose control on their data that could be locked by the service providers. Although service providers have implemented and provided different protection, the clients are not giving confident to them and they are still suffering the lose control of their data. Some of manufacturing industries are not giving much confidence on cloud computing as once the system down, they may lose their business.

3. Literature Review

Technology-Organization-Environment (TOE) framework, developed by Rocco Depietro, Edith Wiarda and Mitchell Fleischer has been used to describe the factors that influence the adoption of technology [19,33]. The factors can be from technological context, organizational context and environmental context. Before the adoption of Cloud Computing, SMEs need to be very clear about the advantages of using cloud and it is important that that using cloud service will satisfy their business operation needs. When SMEs choose the types of cloud services, it is important to choose the one that is compatible and easy to use. They said using cloud service for start-up companies will help to save capital expenditure. Adoption of cloud services will improve the efficiency and less location dependent. [10] have done a research on the adoption of Cloud Computing in SMEs. The theory that has been used to indicate the convenience of the use of Cloud Computing is Technology Acceptance Model (TAM). They have found that the factors that SMEs choose to adopt Cloud Computing is the ease of use. Another researcher, [24] and [32] also found that the factors that encourage SMEs to adopt Cloud Computing are the ease of use, usefulness, advanced technology, social influences etc. The finding has indicated that the usefulness and security are the elements that influence the adoption of SaaS. According to [9], they have used TOE framework and explore with twenty-four business organizations on the adoption of Cloud Computing. After analysis, the most important factors that encourage these organizations to adopt cloud services are technology and organizational. [18] also revealed that the main factors that affect the adoption of Cloud Computing in SMEs are technological factors, organizational factors (increased in traceability, improvement in collaboration) and environmental factors (security). [17] and [27] have identified the factors that affect the adoption of Cloud Computing in SMEs using Diffusion of Innovation (DOI), TOE and Agent Network Theory (ANT) theories. They have grouped the factors into five main groups: “technological factors”, “organizational factors”, “environmental factors”, “human” and “non-human”. The main two factors that affect the most are security and advantages. Since the services will be shared in multi-tenant environment, most SMEs will increase the security concerns. The advantage of cloud services will positively affect the rate of adoption in SMEs. They believe the cloud services will increase the profit. [14] have used TOE model to assess the rate of adoption of Cloud Computing in SMEs using three elements such as technology, organization and environment. Based on their research, the most blamable factors that affect the adoption is lack of privacy. Besides, the security issues and data protection also negatively affect the rate. SMEs worried that they do not know where the location their data stored is and how secure it is. [16] also stated that there are at least seven issues including service outage for adoption of cloud computing in the organizations. He has mentioned “cloud-provider outages”, that is the unavailability of cloud services. This outage can be temporary or permanent. Temporary outage is inevitable and unavailable for short period while permanent outage will be a longer period. The outage of service will negatively affect business operation. [22] agreed with Kim by saying that availability of cloud services in SMEs can be a challenge. Besides, Kim et al also discussed about the security. The data stored on the system is not 100% secured. This might attract the hackers even the staff may do some modifications on them. Based on the research done by [3], the biggest issue of the adoption of cloud computing among SMEs is inadequateness of awareness. Most people agreed that poor awareness is the major factor that prevent the adoption of cloud computing. Besides, inadequate of skills to operate the cloud applications is also a reason. There are lots of organizations/enterprises refused to send their employees for training because of the cost and they afraid the employees might leave the organizations after they are back from training. Even some of the small organizations/enterprises, they do not have enough money to invest on cloud computing and enough knowledge on using cloud services to do business. According to [34], the factors that affect the adoption of cloud computing in SMEs are security, inadequate knowledge, unstable Internet connection, inadequate confidence and loss of control. [26] also said lack of confidence of service provider is also a barrier for the adoption. Some
organizations/enterprises do not have confidence on cloud computing as once the system down, some of them may lose their business. Although cloud computing will bring lots of advantages to the SMEs, however there are still some issues and challenges exist. According to [23], since the cloud service involve third party to provide service, thus security is the highest concern issue, which is 66%. Cloud service provider has all information about where the data located and authority to control all organizations’ data but the organizations do not have, this creates the security and privacy concern. They will worry that their data will be stolen or hacked.

4. Methodology

The method that has been used is using secondary research methods. That is to collect the data and information from the published journals, articles, case study, conferences etc. The case study that I have chosen is “Advanced Telemetry Start-up Uses Cloud Computing to Change Business Model, Becomes Instantly Profitable” [20]. In this case study it describes how the industry applied and used the cloud computing in order to reduce the difficulties they have and increase the profit. Advanced Telemetry is a manufacturing industry mainly manufacturing and marketing the flagship remote energy-monitoring software. The industry offers portable field-tested and null peak systems, GPS receivers, systems, and transmitters. The industry has used EcoView Web, a web portal used to monitor and control the buildings. In the beginning the industry found that the web portal brings lots of benefits to them and their business grows steadily. After a year, its customer base has doubled. Now the industry faced problems. The database they currently used can only store up six months of data. They need to pay more for the rack space when there is an increase in customers. Some of their customers are unhappy about sharing their personal data in servers with others but the industry cannot afford to buy separate banks of servers. Besides, the cost for maintaining IT infrastructure will be very high.

After that the industry has moved its IT infrastructure to Microsoft Windows Azure Cloud Service and Microsoft SQL Azure. Through this the industry has saved around 75% of total IT infrastructure expenses, 80% of marketing costs and new revenue from customization.

The theory that used to discuss this case study is Diffusion of Innovation theory, developed by Everett Mitchell Rogers in 1962. This theory has been recognized as most appropriate theory used to investigate technology adoption [13]. [8] said if the adopter is new, then the concept or technology or product can be called innovation. According to [6], he said this model is used to explain the process and reasons that affect the adoption of new innovation.

5. Discussion

This section explains how Rogers’ Diffusion of Innovation Theory can be linked with the case study. There are five attributes used to explain the rate of adoption in Advanced Telemetry.

The first attribute is Relative Advantage. Rogers explained this relative advantage as “degree to which innovation is perceived as providing more benefits than its predecessor” [6]. According to [12], they said innovation relative advantage is positively related to the adoption rate. When the people found a new technology has a higher relative advantage, they will tend to adopt it [5]. By using Windows Azure, it enables the industry to run all the necessary applications and programs in Windows-based platform on servers. The cloud computing services provides the functions that allow the industry to run their web presentation tier, remote monitoring and control middleware. Besides, they can also store their customers’ non-relational historical data. Windows Azure also provides them a computing environment which is similar to Microsoft Visual Studio 2008 Professional for their system developers to develop applications. Advanced Telemetry can use its relational database service to store their customers’ configurations and metadata in SQL Azure. The services such as Windows Azure Blob Storage and Windows Azure Table Storage which can store petabytes of data without implementing and managing the infrastructure themselves. When they started using cloud computing, it has successfully replaced the unprofitable business model. The new innovation acts as a powerful tool to attract new original equipment manufacturer licensees (OEM) to help them expanding into new vertical markets. This new OEM also helps the industry to generate new revenue from the extra customization work. Besides, the security-enhanced connectivity provided by Windows Azure also increases the respond speed to the customers’ needs. The industry is now able to use the OEM business model to expand their market. The new data storage paradigm that does not require any hardware costs also help them to save a lot of resources and budgets. Advanced Telemetry has successfully reduced around 25% of overhead expenses for their server support, hardware, and software and collocation fees. Since most of the functions are supported by the cloud computing, they require less IT staff to work directly with the Azure platform. Besides, they also saved around 80% of expenses in their business development and marketing.

The second attribute is Compatibility. [6] defined compatibility as “degree to which an innovation is perceived as consistent with the
existing values, past experiences, and needs of potential adopters”. [30] also stated that the compatibility will positively affect the adoption rate. The industry has successfully migrating their applications to the cloud. According to the founder of Advanced Telemetry, he said that the storage of Windows Azure is performing well and compact to their applications. The application is able to handle about 200,000 messages within one hour. In each message, it contains 10 individual point updates. Besides, the industry is able to obtain the data from a variety of sources to maintain a workable size for operational data. They also fully used the features such as table storage, BLOB storage, queues and worker roles.

The third attribute is Complexity. [4] and [6] explained complexity as the difficulty of understanding and using the new innovation. The initial design of cloud transaction is asynchronous. It increases the complexity for the industry to design the architecture such as Hybrid relational and NoSQL data storage or Event-driven design. These transactions are stored in Windows Azure Blob Storage and Windows Azure Queue. Thus it needs a lot of transactions based on the transaction change model for Windows Azure Queue. This increases the complexity that the industry needs to manage the transactions and significant costs.

The fourth attribute is Observability. [6] stated observability as “degree which the results of an innovation are visible to others”. Since Advanced Telemetry has used a new computing paradigm, it has successfully attracted new OEM licensees. Through this, the industry can use a security-enhanced connectivity provided by Windows Azure. This has increased the respond speed to customers’ enquiry. Windows Azure allows the industry to migrate approximately hundred gigabytes of data. This enables the people to have a better and easier connectivity and access to massive amounts of data. Customer services of Advanced Telemetry also improved. More responsive service can be provided to their customers such as they are able to offer more features without modifying their core telemetry software. For example, whenever a new data is posted on the service bus, they need to make sure every subscriber receive it at the same time without affecting pre-existing services. Advanced Telemetry finished their migration of applications and data to cloud in April 2010.

Advanced Telemetry had successfully changed a new way of doing business after the adoption of Cloud Computing. The industry has expanded their markets with OEM business model. Through this they have attracted new potential OEM customers. Now they can offer their customers a data storage paradigm and agile computing without any hardware and software support costs. They also signed around hundreds of OEM licensees. Cloud Computing also helps Advanced Telemetry saved operational costs. Since they do not need to pay for infrastructure costs, they have saved around 75% of total expenses. Besides, the customer services of Advanced Telemetry also enhanced. New features can be added without affecting the existing functionalities.

The fifth attribute is Trialability. [6] defined trialability as “degree to which an innovation may be experimented with on a limited basis”. It also means to test the new technology before adoption. Before the industry begins to migrate to the cloud, they have tried and used Windows Azure platform to ensure that it is able to manage and support the collocated servers and the platform should be able to function 24/7. The industry migrates its applications to the cloud computing part-by-part. In August 2009, they migrated their web-based presentation layer to cloud computing. Presentation layer basically contains user interface components. Besides, the industry also subscribed and used Microsoft Silverlight 2.0 for its web management portal. During this time, the industry will test the stability of this new portal by using Microsoft .NET framework to implement a rich, user friendly and interactive web applications. After that, Advanced Telemetry has decided to add in more complicated middleware. More virtual machines (VM) has been created in Windows Azure in order to run all applications’ codes. The application developers test the functions by dividing the applications’ codes into web roles (using IIS) and worker roles (not using IIS). The developers can manage how many virtual machines need to be created. Besides, the developers also test how well the cloud computing is to balance and equalize the requests from outside into applications’ web roles. After that, the industry has moved their relational data which contains customers’ information to SQL Azure database. The developers test its robustness by creating SQL scripts using SQL Server Management Studio. Advanced Telemetry is then extending the middleware by using Windows Azure Service Bus to create a greater flexibility in order to handle more subscribers. Thus, they use Subscribe configuration in it. Whenever a new data is posted on the service bus, they need to make sure every subscriber receive it at the same time without affecting pre-existing services. Advanced Telemetry finished their migration of applications and data to cloud in April 2010.

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6. Recommendation

Some SMEs are worried about the security such as their loss of data. In order to prevent this occurs, a proper authentication and authorization should be applied in the services. This is to ensure that only authorized users have the access to information. It is important to implement a proper authentication and authorization that goes through multiple levels to check the validity of the tenants. Using encryption to
protect and secure data and information is also a way. Encryption is a way to prevent other people to access data and it can make the file unusable. Data and information should be encrypted whenever they are stored. The permission can be given to certain groups of people in SMEs to reduce the time to access. Hash code or function can be used for data integrity. Data confidentiality is increased as hash code will be attached whenever the data or information is communicated between SMEs and cloud computing. Only the receiver with proper decryption key is able to access the data.

7. Conclusion

This research paper has discussed on how SMEs choose and migrate to Cloud Computing. Cloud Computing has slowly brought the effect and sneaking into business strategies in SMEs. It has successfully satisfied the needs and demanded services from SMEs. The SMEs do not need to worry about the configuration and resources needed since these will be done by cloud. This is true as some SMEs have limited IT infrastructure. Cloud Computing has helped SMEs to save costs and increased profitability. Although Cloud Computing brings a lot of conveniences to the SMEs, however the adoption issues will never be avoided. The major factor that affect the adoption of Cloud Computing is security. What they are worried about is the security of sensitive data to security risks such as privacy and the loss of data. The rate of adoption will increase if the provider can ensure SMEs that their data is highly secure and safe.

8. References


