
# Cloud Computing Approach for UTP Educational Hardware and Software Resource Sharing

# (Feasibility Study)

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A Dissertation submitted in partial fulfillment of the requirement for

Bachelor of Technology (HONS)

(Information and Communication Technology)

Universiti Teknologi Petronas

## CERTIFICATION DECLARATION

I hereby certify that this report and the project it describes is my original work and is not taken from the work of others save and to the extent that such work has been cited and acknowledged in the report.

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# ABSTRACT

**Background:** In the few years, the emergence of cloud computing has been receiving attention and a lot of higher education institution began to adopt cloud computing services for their educational system and reported that their performance increase. Therefore, it can be seen that cloud-based application is, generally, becoming a trend educational field.

**Aims:** In order to assess the feasibility of cloud computing approach for Universiti Teknologi PETRONAS (UTP), this study aims to investigate the thoughts of IT experts in UTP on adoption of cloud for resource sharing, as well as the factors that influence the acceptance of innovation in UTP.

**Methods:** This study adopted qualitative and quantitative research method. For qualitative method, snowball sampling approach is used to interview the participants and online survey is conducted for quantitative research methods.

**Results:** Based on the theory of diffusion of innovation, the results of data analysis suggest that most IT experts in UTP which consists of lecturers and IT staff do not have extensive understanding of cloud computing: and this has influenced the rate of adoption of innovation in UTP. In addition, it seems that although most of the lecturers, staff and students already have experience in using cloud service in everyday live, they are not aware of the different type of cloud services. From the result analysis, most of them are expecting the cloud adoption, but until a proper implementation plan is made, the adoption seem quite hard to be done.

**Conclusion:** Although there are several obstacles to cloud adoption, the adoption is expectable and achievable with enough expertise and proper planning. If the effort to learn about cloud computing is high, the adoption will be much easier.

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# CHAPTER 1
# INTRODUCTION

## 1.1 Project Background

Cloud computing is a network model used to distribute task and share resources over the internet, be it hardware wise or software wise. Cloud computing refers to both the software that delivered as a services over the network (usually, the internet itself) and the hardware and systems software in the data centers that provide those services (Armbrust et al., 2010). Cloud computing can be generalized as having 2 sections, the front end and the back end. The front end is the side of the client or computer users see. The back end is the "Cloud" itself. The front end includes the user's device and the application required to access the cloud computing system, usually a web browser. The device does not need to be computer; it can be any device that can access to internet such as tablet and smart phones. The operating system of the devices also does not need to be the same; they can be any operating system as long as the operating system support the application needed to access the cloud computing system. The back end of the system comprises of various computers, servers and data storage system that create the so called "Cloud". In other word, cloud is basically a collection of computers, servers and computer program that we can imagine (Jonathan, n.d.).By using cloud computing technology, the work of IT support in UTP can be lessen as they no longer need to maintain computers and software. They only need to use current computer and install basic drivers for the computer and basic application such as web browser to access to the cloud, without facing all the hassle upgrading the computers and server to a more powerful one in order to meet current need, and buying software or renewing license of existing software. They also have more control towards the software used is UTP as all the software can be accessed from the cloud, so it is easier for them to manage the resource because all the resources were gathered in one place, which is the cloud. While it is easier for IT Department and support to manage IT resources in UTP, the costing for IT resources has also decreases. This is because of UTP does need to constantly upgrade computer and server hardware, as well as buying new software. They only need to pay monthly fee or yearly fee, depending on what kind of package of cloud technology UTP will be using, and usually these fees are much lower than

the cost of maintaining hardware and software periodically. Thus, it would be cost-effective for UTP to invest in cloud computing rather than spending money on maintaining IT resources in UTP. But not all about cloud computing is good. There are also risk implementing cloud computing and UTP need to consider a few things to actually implement this system. Because of these factors, not all the IT resources should be migrated to cloud computing; some parts of the resources, be it hardware or software, are better off left alone on the premise because of many reasons such as data security concerns(Oxford Consulting, 2011). As such, it is crucial to conduct feasibility studies to find out whether is there any risk implementing cloud computing into UTP and identify major roadblocks that prevent the implementation of cloud computing into UTP, as well as to identify what part of the resources need to be ported to public cloud, what part need to be ported to private cloud, and what part should not be ported at all.

## 1.2 Problem Statement and Research Rationale

With the number of universities that adopt cloud technology for their educational system is increases, it has boost the performance of said universities and the competition between universities around the world become greater. As one of the renowned universities around the world, UTP need to stay competitive and maintain its reputation. Adoption of cloud will be of help to UTP in order to improve its resource sharing to facilitate students, lecturer and researchers in their studies and indirectly boost UTP's performance in order to stay competitive with other renowned universities.

However, to implement cloud computing technology in UTP, many things must be considered first, such as security risk, budget, which part of IT resources that suitable to be ported to cloud, staff willingness to accept new system, the capability of UTP's internet connection, and compatibility of UTP's current system architecture with the system requirement to migrate to cloud computing technology. Cloud adoption comes with its own benefits and drawbacks. Not every system or organization is suitable to use cloud technology, as such, this feasibility study is carried out to find out feasibility of cloud computing approach in UTP.

## 1.3 Research Questions

This study is aimed to find out whether cloud computing is suitable to be implemented in UTP resources sharing system. Therefore, this study will survey the diffusion of cloud computing in UTP resource sharing system and discuss the relevant questions listed below:

- Does current UTP resource sharing system need improvement / innovation?
- What are the benefits of cloud computing to UTP and the obstacle to implement cloud computing in UTP?
- What are the factors that UTP management considers to accept the innovation?

## 1.4 Objectives

The objectives of this project are:

- To examine UTP current resource sharing system.
- To identify the benefits and drawbacks of cloud computing adoption in UTP.
- To identify obstacle and potential problems that might occur when implementing cloud computing into UTP resource sharing system.
- To investigate factors influencing the rate of innovation adoption in UTP.

## 1.5 Scope of Study

a) Theory and architecture of cloud computing.
b) UTP hardware and software resources system.
c) UTP management policy in accepting innovation / new system.
d) UTP residents' thought and opinion about the adoption of cloud computing.

## 1.6 Relevancy of project

Feasibility study on cloud computing approach for UTP educational hardware and software resource sharing will definitely be useful to UTP as UTP management would consider implement cloud computing in UTP network seeing it would profitable for them instead having huge cost upgrading existing hardware and software in order to cater students' needs parallel to current learning process. The

only problem is that whether it is makes sense or not to utilize cloud computing was still not decided. So this project will greatly help UTP management in making decision whether to implement cloud computing or not.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Cloud Computing Types and Models

Cloud computing is a technology where computer resources are being send over the internet as a service. Cloud computing technology comprises of 2 sections, which are the front-end and the back-end. The front-end is what the user or the client sees using their own device. One of the good thing about cloud computing is its accessibility where user can use any device or operating system to access the cloud as long as the device has internet connection and the operating system support the application used to access to the cloud, which usually is a web browser. The back-end is actually the cloud itself. The cloud is actually a collection of computer resources gathered and hosted around the world and connected to each other, forming a huge network that we call a cloud. The cloud contains practically any computer programs and hardware that you can imagine. Usually, each program or application will have its own dedicated server that is concealed from the users or client. All that users sees is a big cloud that may contains everything that he needs, without knowing what is inside the cloud.

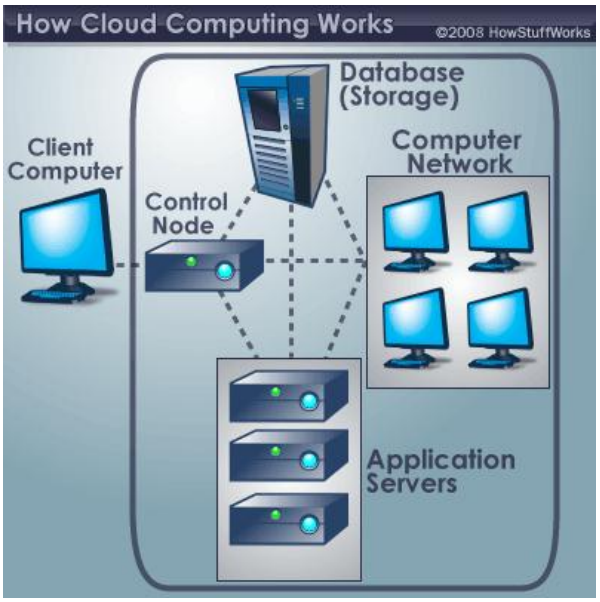



**Figure 2-1 – Cloud Computing Network (Taken from howstuffworks.com)**

There are many types of cloud computing or services model that available for user to choose which suits him the best. One of them is Infrastructure as a Service (IaaS). This type of cloud computing offers computer hardware as physical processing power or as virtual machine that user can use to process something that require powerful processing unit. Usually, there are additional resources offered in IaaS cloud such as images in a virtual machine image library, raw (block) and file-

based storage, firewalls, load balancers, IP addresses, virtual local area networks (VLANs), and software bundles (Amies et al., 2012). Another type of cloud computing is Platform as a Service (PaaS). In this cloud type, the cloud providers offers a computing platform that contains operating system, programming language execution environment, database and web server, basically everything that is needed for an application developer. Other type of cloud is Software as a Service. In this cloud type, the cloud providers offer application software in the cloud and user can access the software from the cloud clients. Users only need to install the cloud clients in their device and they can access wide range of application offered by the cloud providers. User benefits from the scalability of this cloud type as the task will clone to multiple virtual machine at run-time to meet the changing work demand (Hamdaqa et al., n.d.).

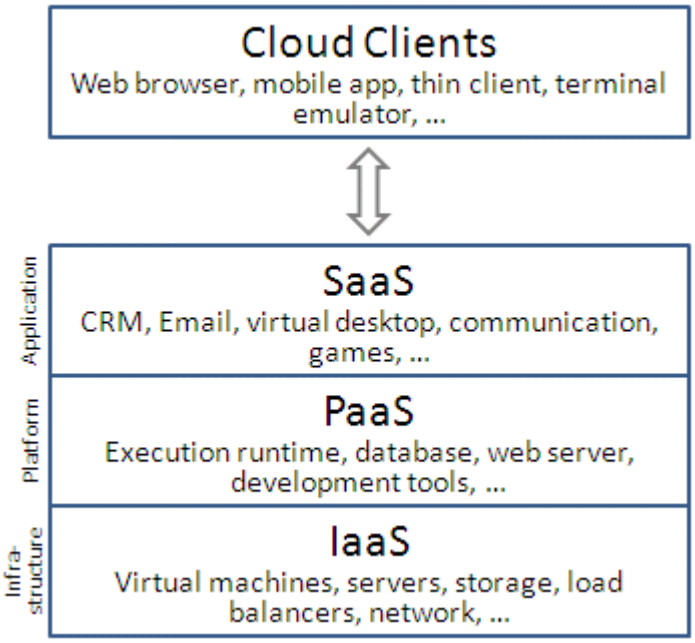



Figure 1-2

## 2.2 Cloud Computing Deployment Models for Educational Institution

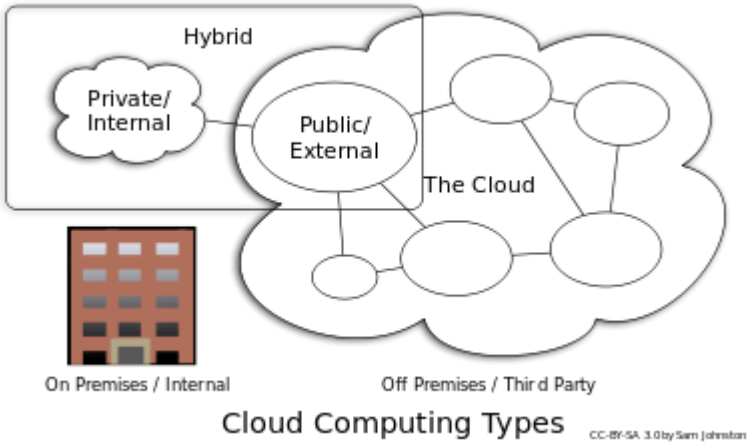



**Figure 2-2 - Cloud Computing Model (Taken from Wikipedia)**

There are 4 major deployment models that often used when implementing cloud computing technology, which are public cloud, community cloud, private cloud and hybrid cloud.

Public cloud is a cloud whose application, storage and other resources are made available for public use by a service provider. Some of these services and free to use or need to be paid every time we want to use it. Usually, public cloud can only be accessed via internet, no direct connection is offered (Gens, 2008).

Community cloud in the other hand, is a cloud model that shares infrastructure between several organization from the same industry, or community, usually possess similar concern or interest. This cloud can be managed either by internally or by third-party and hosted internally or externally. The costs are spread between the organizations that share that same community cloud (Mell & Grance, 2011).

Private cloud is a cloud operated solely for an organization. It could be managed internally or by a third-party and hosted internally or externally (Mell & Grance, 2011). Private cloud can have the cloud infrastructure altered according to the organization needs, but to implement private cloud requires significant level and degree of engagement to virtualize the organization environment, and the organization need to make important decision about existing resources.

Lastly, the hybrid cloud is a cloud structure comprises of two or more cloud models (private, community or public) that are bound together, offering the benefits of multiple deployment models (Mell & Grance, 2011). By using hybrid cloud, organization can gain higher degree of fault tolerance and the ability to immediately access into the cloud without requiring internet connection. But to implement it, hybrid requires both on-premises resources and remote server-based cloud. However, the in-house cloud, i.e. the private cloud lack the flexibility, security and certainty aspect because of limited application available in the private cloud compared to public cloud (Stevens, 2011).

The high availability, accessibility and efficiency aspect of cloud computing has made it very promising to universities as they begin to consider cloud computing approach for their educational resources (Nicholson, 2011). For university, public cloud may bring far more benefits as it has lowest cost of implementation compared to private and hybrid, but offer a lot more flexibility and accessibility compared to private cloud (CISCO system, n.d.). Hybrid cloud may be more perfect compared to public, but the additional installation and alteration of the cloud infrastructure cost more for a little more flexibility that is not significant to a university compared to a business organization.

## 2.3 Conducting Quantitative and Qualitative Research

Quantitative and Qualitative research method has been recognized as great methods to conduct research effectively. Both quantitative and qualitative has its own advantages and disadvantages and should be used accordingly to where it excels more compared to the other method.

Quantitative research generates data that can be expressed in number, meaning that researchers can apply statistical test in making statements about the data. Quantitative research can be used to quantify the problem and understand it form numerical point of view, by looking at projectable results to a larger population. Common data collection methods used in quantitative research includes surveys, audits, point of purchase and click-streams (Mora, 2010). Some of the uses of qualitative research are:

- Recommend a final course of action
- Find whether there is consensus on a particular issue
- Project results to a larger population
- Identify evidence regarding cause-and-effect relationships
- Describe characteristics of relevant groups of people
- Test specific hypotheses and examine specific relationship
- Identify and size market segments

Qualitative research on the other hand, generates data that describe the qualities or characteristics of something. It is a subjective opinion that cannot be reduced to numbers. Whereas, quantitative research refers to counts and measures of things, qualitative research refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things. Common data collection methods used in conducting qualitative research includes focus groups, triads, dyads, in-depth interview, uninterrupted observation, bulletin boards, and ethnographic participation or observation. Some of the uses of the qualitative research are:

- Develop an initial understanding of an issue or problem
- Look for a range of ideas and feelings about something
- Understand different perspective between groups and categories of people

- Uncover underlying motivations and factors that influence decision making and opinion
- Provide information needed to design a quantitative study
- Explains findings from a quantitative study

| Qualitative | Quantitative |
|---|---|
| "All research ultimately has a qualitative grounding" - Donald Campbell | "There's no such thing as qualitative data. Everything is either 1 or 0" - Fred Kerlinger |
| The aim is a complete, detailed description. | The aim is to classify features, count them, and construct statistical models in an attempt to explain what is observed. |
| Researcher may only know roughly in advance what he/she is looking for. | Researcher knows clearly in advance what he/she is looking for. |
| Recommended during earlier phases of research projects. | Recommended during latter phases of research projects. |
| The design emerges as the study unfolds. | All aspects of the study are carefully designed before data is collected. |
| Researcher is the data gathering instrument. | Researcher uses tools, such as questionnaires or equipment to collect numerical data. |
| Data is in the form of words, pictures or objects. | Data is in the form of numbers and statistics. |
| Subjective – individuals interpretation of events is important ,e.g., uses participant observation, in-depth interviews etc. | Objective seeks precise measurement & analysis of target concepts, e.g., uses surveys, questionnaires etc. |
| Qualitative data is more 'rich', time consuming, and less able to be generalized. | Quantitative data is more efficient, able to test hypotheses, but may miss contextual detail. |
| Researcher tends to become subjectively immersed in the subject matter. | Researcher tends to remain objectively separated from the subject matter. |

*Table 2-1 (the two quotes are from Miles & Huberman (1994, p. 40).*

# CHAPTER 3
# RESEARCH FRAMEWORK

This chapter builds the research framework for assessing the feasibility of cloud computing approach for UTP educational hardware and software resource sharing. Things that will be covered in this chapter include personal cognition, the variables determining the rate of the adoption and the strategy situation analysis. The first part of this chapter will discuss the variables that affect the feasibility of cloud computing with UTP resource sharing environment. The second part of this chapter will discuss about the elements of the strategy situation analysis. This research framework mainly refers to the diffusion of innovation theory. Figure 3-1 shows the conceptual structure of this framework and the way to assess the feasibility of cloud adoption. This framework will help investigate the factors influencing cloud adoption in organizations.

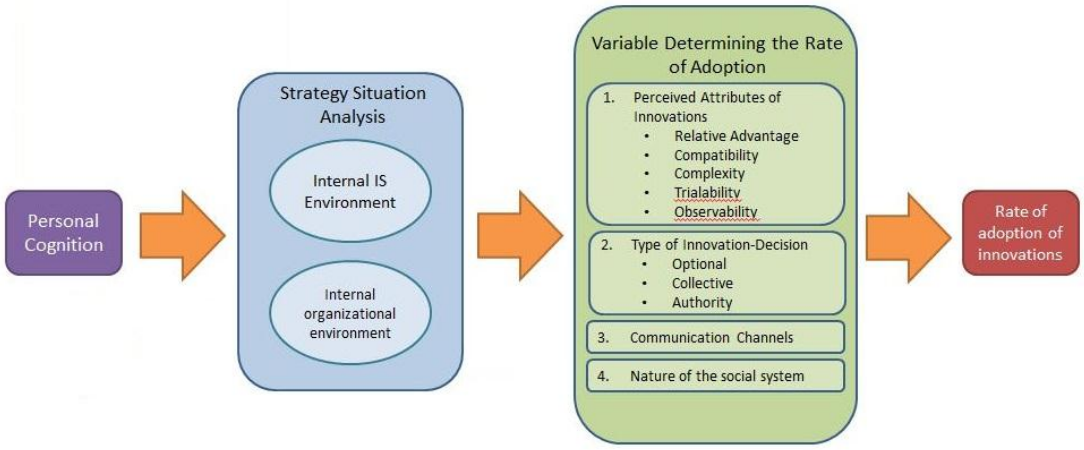



*Figure 3-1 Framework for assessing cloud adoption*

## 3.1 Variables Determining the Rate of Adoption

The implementation of cloud computing in UTP resource sharing environment can be regarded as an innovation because it offers a new way to handle the educational hardware and software resource sharing in UTP. According to Rogers (1995:216), there are many keys issues that are considered when it comes to accepting an innovation, such as the generation of the innovations, the formation of innovation-decision, attributes of innovations and rate of adoption, diffusion network, innovativeness and categories of adopter, innovations in organizations and the promotional efforts of change agents. Although all of these are important, this study only focuses on the rate of adoption of the innovation as this study aim to find out the feasibility of cloud computing approach in UTP's resource sharing environment.

### *3.1.1 Perceived attributes of innovations*

Cloud computing is known to be an innovation of technology that has been gradually adopted in IT industry and also among educational institution. Rogers (1995: 207) indicates that there are five attributes that affect the rate adoption of the innovation. These attributes of innovations are as follows:

| Attributes | definitions |
|---|---|
| Relative Advantage | The degree to which an innovation is perceived as being better than the idea it supersedes |
| Compatibility | The degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters |
| Complexity | The degree to which an innovation is perceived as relatively difficult to understand and use |
| Trialability | The degree to which an innovation may be experimented with on a limited basis |
| Observability | The degree to which the results of an innovation are visible to others |

Based on Rogers' 5 attributes of innovation, we can say that we can use these to evaluate the rate of adoption of the innovation, which if we relate to this study, the rate of adoption of cloud computing in UTP resource sharing environment.

### *3.1.2 Type of Innovation-decision*

According to Rogers (1995:206), the type of innovation-decision will also affect the rate of adoption. In this context, whether the decision is made by individuals or an organizational decision-making unit. However, among the types of innovation decision, decision made by individuals are proven to be more effecting the rate of adoption because the number of individuals involve in the formulation to find the rate of adoption will affect directly the rate of adoption. According to Rogers (1995: 372), three types of innovation-decisions that will be used to evaluate the rate of cloud computing adoption are as follow:

1. **Optional** – An individual decides to adopt or reject an innovation.
2. **Collective** – Most members of an organization decide to adopt or reject an innovation.
3. **Authority** – A relevant individual who owns power, status or technical expertise in an organization decides to adopt or reject an innovation.

### *3.1.3 Communication channels*

There are several stages in innovation-decision process, which are:

1. The acquisition of knowledge
2. Persuasion
3. Decision Making
4. Implementation
5. Confirmation

According to Rogers (1995: 162), the five stages above helps to identify the roles of different communication channels, whether it is interpersonal or massive media, or, local or global sources. At every stage, only some of the communication channels are important. For example, at acquisition of knowledge stage, massive media is more important than interpersonal because massive media enables large number of people to acquire that knowledge and more rapidly. However in persuasion stage, interpersonal is more important compared to massive media as people will listen to another people's opinion and they can trade information between them and finally

persuade people. In the other hand, local or global resource will also affect the rate of adoption. The simple example of this would be the language of the communication. As we know, English is a language that is used globally, so English resources or materials are more plentiful compared to the other language.

### *3.1.4 Nature of the social system*

Rogers (1995: 23) stated that a social system is a system of a set of interrelated unit concentrate on addressing problems so that they achieve a common goal. Social system consists of individuals or organization, and it depends on the number of units in that system. So, when there are more units in that system, the rate of adoption will be faster. The degree of interconnection between the units also affects the rate of adoption. Based on this theory, this study will discuss on how the social system in UTP will affect the rate of cloud computing adoption in UTP's resource sharing environment. For example, how does UTP management accept the new innovation or how do UTP staffs and students accept cloud computing.

## 3.2 Strategy Situation Analysis

Before implementing cloud computing into UTP resource sharing, it would be wise to come up with an information strategy and plan to help UTP management adapt to the innovation. In order to gain strategic benefits, Daft (1998: 289) states that management can focus on technology, product and service changes, strategy and structure changes, and people and culture changes as well. The management should assess current status of their organization to accepting new changes to help them plan a suitable strategy accordingly. As such, this study focuses evaluating several dimensions of situation analysis with respect to the adoption of cloud computing. The dimensions are listed and explained as below:

### *3.2.1 Internal organization environment*

According to Rogers (1995: 133), the innovation-development process starts with needs or problems, which may be seen that the very first step of situation analysis is to identify the organizational needs. Goffin and Mitchell

(2005: 3) state that usually the needs for innovation and market change are usually caused by technological advances. Changing customers and needs, intensified competition and changing business environment. The value chain model is a common analytical technique at the business level and it enables organizations to understand individual value chains (Laudon and Laudon, 2006: 92). This methodology main objective is to analyze a variety of primary activities and support activities of the organization, which includes business process and structures in an organization. After identifying needs, the next step is to identify the different characteristics of the internal organizational environment which can affect the strategy of cloud adoption, such as organizational strategy, structure, system, style, staff skills and superordinate goals (Chaffey and Woods, 2005:294).

### *3.2.2 Internal information system environment.*

This type of dimension involves reviewing the current information system usage within company (Chaffey and Woods, 2005: 296), which in regards of this study, the usage of resource sharing in UTP. According to Reese (2009: 11), there are two approaches to reform the existing system or build a new system, which are (1) Internal IT infrastructure and support, and (2) Outsourcing to managed services. Before adopting cloud computing, the organization must first evaluate the spending and effort required. To do that, this study use the feature-oriented reuse method (FORM) which is based on the feature-oriented domain analysis (FODA) feasibility study, to evaluate the transition from old system to new system.

According to Kang (1990: 21), the method of FODA emphasizes the feature model which relates the results of domain analysis to requirement analysis. First, the feature model is used to find out the capabilities of application with users or to evaluate the possibility of reusing software products. Then the feature model is used to develop reusable domain artifacts to that it can be integrated with the method of FORM (Kang et al, 1998: 145). There are four factors that enable IT experts to easily develop reusable components for many applications (Kang et al, 1990: 23). The four factors are as follow:

1. Capabilities – the capabilities of application satisfy the end-user's requirements.
2. Operating environment – The operating environment means the software or hardware environment in which application are used and operated.
3. Domain technology – The application domain technology means the specific knowledge which is the basis for developing applications.
4. Implementation techniques – Implementation techniques mean technical skills, development tools and algorithm which are used in the design.

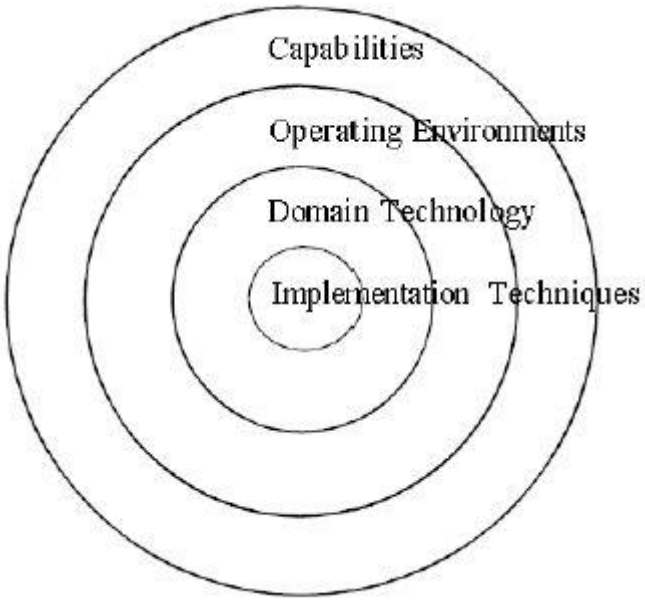



*Figure 3-2 Types of development decisions (Source: Kang et al., 1990: 24)*

Figures 3-2 shows that in general, the outer factors (the earlier development decisions) affect the inner range of decisions (Kang et al., 1990: 24). Similarly, FORM includes the four perspectives as well.

# CHAPTER 4

# STUDY METHODOLOGY

To complete this project, the study needs to be divided into 2 phases which are research and extensive literature review, and data collection and analysis. The reason why the studies is divided into 2 phases is because before conducting the feasibility study, one must have the sufficient knowledge regarding the matter which in this case, about cloud computing. After gaining enough information and knowledge then the feasibility study can be conducted smoothly and no time will be waste on things and are uncertain because of lack of knowledge. Table 4-1 shows the Gantt Chart for this project.

| Milestones | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | FYP2 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prelim Research | X | X | | | | | | | | | | | | | | | | | | | | | | | |
| Propose Title | | | X | | | | | | | | | | | | | | | | | | | | | | |
| Project Analysis | | | | X | X | X | | | | | | | | | | | | | | | | | | | |
| Project Planning | | | | | | | X | X | X | X | | | | | | | | | | | | | | | |
| Report | | | | | | | X | X | X | X | X | X | X | | | | | | | | | | | | |
| Prelim Studies | | | | | | | | | | | | | | | | X | X | | | | | | | | |
| Technical Res. | | | | | | | | | | | | | | | | | | X | X | X | X | X | | | |
| Organizational Res | | | | | | | | | | | | | | | | | | X | X | X | X | X | | | |
| Financial Res. | | | | | | | | | | | | | | | | | | X | X | X | X | X | | | |
| Analyze Data | | | | | | | | | | | | | | | | | | | | | | | X | X | |
| Procurement | | | | | | | | | | | | | | | | | | | | | | | | | X |

*Table 4-1 Gantt Chart of the Project*

### 4.1 Extensive Literature Review and Research

During phase 1 of this study, extensive reading, knowledge gathering and research will be done. The research and reading will be about the theory of cloud computing, the architecture and ideas behind those architecture, what cloud computing is capable of and what are the disadvantages if there is any or primary concern when it comes to implementing cloud computing. There will be also research about how cloud computing is implemented, and what are the things that needs to be considered before implementing cloud computing.

### 4.2 Data collection, data analysis

When all the required information and knowledge is gathered, phase 2 of this study will be carried out, which is the data collection and data analysis part. For the purpose of the study, qualitative research method which is often to as an inductive approach was employed to conduct the research. Neuman (2006: 157), states "*Qualitative researchers use a language of cases and contexts, employ bricolage, examine social processes and cases in their social context, and look at interpretations or the creation of meaning in specific settings. They look at social life from multiple points of view and explain how people construct identities*". Through the interviews, this study will be able to understand the thoughts and opinion of the interviewees regarding cloud computing approach for UTP resource sharing environment, the factors that affect the rate of the adoption as well as the pros and cons adopting cloud technology for UTP resource sharing system. The researchers will also understand the barriers to adoption of cloud computing.

In addition to qualitative research method, quantitative research method is also used in the form of online surveys. Quantitative research method offers numerical point of view to this study, allowing researchers to apply statistical test in making statements about the data, which help giving a clearer view of the result as it is easier to understand a result if it showed in numerical and statistical form.

Both qualitative and quantitative research methods complement each other, as each of them has its own strengths and weaknesses which both excel in different approach. Using both in conjunction to each other will help strengthen the result analysis as people can view the result from numerical perspective and subjective

perspective as well, giving people wider range of information and help them to understand better.

## 4.3 Participants

This section explains the method used in the study and the criteria for selecting subjects.

### *4.3.1 Snowball sampling*

For interview activity conducted for this study, snowball sampling method is used. Based on the statement of Neuman (2006: 223), "*it is based on an analogy to snowball, which begins small but becomes larger as it is rolled on wet snow and picks up additional snow*", it can be understood that snowball sampling enables the researcher to get a representative sample through an interconnected network of people or organizations (Bryman, 2004: 100), which in regards to this study, residents of UTP. Because of the cloud computing will have great impact on the resource sharing in UTP, snowball sampling is mainly used to investigate lecturers and staffs that has technical knowledge of cloud computing and resource sharing in UTP. First, the researcher identifies several lecturers from IS department that have networking and internet background and area of expertise to ensure that they have the knowledge about cloud computing and resource sharing in UTP. After interviewing the said lecturers, the researcher will ask them to refer him to another lecturer or staff that to their knowledge, also possess the knowledge or expertise in cloud computing and resource sharing in UTP. The participants do not have to be an expert in cloud computing field, it is enough that they have basic information and understanding about the cloud computing. Minimum knowledge in cloud computing is a must to ensure that they know what they are talking about and make their opinion and thoughts valuable and viable to be collected as result of the study.

#### *4.3.1.1 Sampling composition*

All participants for interview were selected from the population of information system lecturer and IT department staff. 7 interviewees were

successfully interviewed which consist of mixture of lecturers and IT staff. Five were male and two were female. 6 lecturers that were interviewed are from IS department of UTP and 1 IT staff is from UTP IT Management (ITMS).

| Code | Job Title | IT Area of Expertise |
|---|---|---|
| L1 | Associate Professor | Artificial Intelligence |
| L2 | Associate Professor | Virtual Reality |
| L3 | Associate Professor | Human Computer Interaction |
| L4 | Senior Lecturer | Wireless Technology |
| L5 | Senior Lecturer | Communication System |
| L6 | Lecturer | Computer Networking |
| S1 | Executive | IT Application Development & Support |

*Table 4-1 Details of the interviewees*

### *4.3.2 Online Survey*

An online survey regarding adoption of cloud computing was conducted among IT students. The survey form was made using Google's survey form and was spread through chain emails and through Google group. The reason the survey was spread using those two channels is to ensure that the survey participants are IT students. By spreading through emails and Google groups, target participant can be easily controlled and filtered. The researcher is an IT student, so the surveys start by spreading the online form among the researcher's classmates and course mates. There are 100 respondents that have successfully answered the survey questions.

# CHAPTER 5

# RESULT ANALYSIS

The chapter analyses the interview data in relation to the evaluation of the adoption of cloud computing in the development of information systems, and covers the following debates based on the evaluation framework of cloud adoption.

1. Perceived attributes of innovations
    - Relative advantages
    - Compatibility
    - Complexity
    - Trialability
    - Observability
2. Type of innovation-decision
3. Communication channels
4. Nature of the social system

## 5.1 Perceived Attributes of Cloud Computing

Rogers (1995: 206) states that the five perceived attributes are considered as independent variables and used to explain the rate of an innovation. Therefore, in order to evaluate the rate of cloud adoption in UTP, this section will use the perceived attributes to analyze the interview data.

### *5.1.1 Relative advantage*

Relative advantage is taken as a sign whether the adoption of the innovation will bring benefit greater than previous system or idea. Generally speaking, before potential adopters decide to adopt an innovation, they will analyze what specific type of the relative advantages is important to them (Rogers, 1995: 216). So, it is important for UTP to seek information about the relative advantages of the adoption of cloud computing in its resource sharing environment. Based on the interview data, analysis of the following perceived benefits and drawbacks are as follow:

- **The advantages:**

  According to results of the interviews, there are some benefits. First of all, interviewees felt that cloud-based applications enable them to easily access data anywhere via desktop computers, mobile devices. The second advantage is ease of use. In addition to friendly interfaces, the interviewees can easily utilize browser web applications without the installation of software. Moreover, they can collaborate and share data with others through the usage of Google Docs.

  > *"The advantage of cloud-based applications is convenience. You do not need to install software on your own computer and you do not need to update applications installed in your computer. Take Google mail as an example, you can save your email online and then you can access the information anywhere via the Internet using any device. So it is quite convenient."* (L2)

  > *"You can access Gmail service anywhere as long as you have the internet. This enables the mobile device users to check their mails anywhere and its performance is satisfactory. Moreover, the application interface of Yahoo mail is easy to use and quite friendly because its design is the same as Outlook, in particular Windows users find it easier to adapt to the use of cloud applications."* (L4)

- **The disadvantages:**

  On the contrary, there are also some significant drawbacks of cloud computing. The first one is related to bandwidth. Obviously, if everyone using cloud service, the internet connection speed will be much slower as everyone is accessing the internet. Secondly, security is also a very important issue for the adoption of cloud computing. Thirdly, the performance and functionalities of cloud applications are limited compared to on-premises software (e.g. Microsoft Office)..

  > *"The main disadvantage of cloud computing is it will make UTP's internet connection become very slow because a lot of people is using the internet."* (L4)

*"Of course performance and functionalities of on-premises are faster and more complete than off-premises applications. But, as for Google docs, its support to the advanced functionalities may have some problems. Also, not all computer users can be always online. If UTP's internet connection is off, more than half of the computer capabilities were unavailable, making it hard to be always productive"* (S1)

*"As for security, it depends on the type of users. For most users, they may worry about the privacy of personal information. For me, as an IT professional, I believe that the security problems related to technology can be solved. However, I think that people should pay attention to reliable service compliance, rather than technology."* (L6)

### *5.1.2 Compatibility*

Compatibility refers to the consistency between the previous idea and the perceived innovation. When an innovation is more compatible with the existing values, past experiences and needs of potential adopters, the uncertainty will decrease. Also, the rate of adoption will increase (Rogers, 1995: 224). Through the interviews, the degree of consistency is discussed in two different aspects:

- **Internal IS environment:**

  The internal IS environment relates to reviewing the current sophistication of IS usage within an organization. In order to evaluate the feasibility of cloud adoption, this study focuses on the following two points. First of all, through the interviews, it seems that the definitions of cloud computing that the various interviewees gave are quite different.

  *"Cloud computing is that the remote servers provide computing power and practical services. Further service providers may charge users."* (L5)

  *"In short, all capacities on a computer will shift to the cloud and end-users will access cloud services via the Internet. Further, they can enjoy the resources of computing power and storage."* (S1)

*"As far as I know, cloud computing is to interconnect many computers via networks, in order to achieve high-performance computing power like a supercomputer."* (L3)

*"Cloud computing is like a regular service located somewhere and users can access its resources of computing power through the Internet."* (L5)

Secondly, based on the experiences of the interviewees, this research focuses on the prediction of the efforts to change existing systems to cloud-based systems. According to FODA method (Kang et al., 1990: 24), there are four factors in relation to the possibility of reusing software products: capabilities, operating environments, domain technology and implementation techniques. During the interview, the interviewees were questioned about potential efforts involved to change current resource sharing system to cloud computing. From an overall perspective, data analysis shows that the adoption of cloud computing will have a great impact on the resource sharing usage in UTP. The interviewees think that well designed implementation plan can ease the adoption and maintenance of cloud service.

*"If we decided to adopt cloud computing, our existing financial systems would have to be reformed substantially. This is because the existing financial software was based on an older infrastructure and it cannot integrate into the cloud-based infrastructure."* (L6)

*"I think that the effect of cloud computing on coding is more serious than others. When techniques are changed, you need to provide some sort of guidance in order the staff can adapt to it easily. If not, it will take time for the staff and user in UTP to adapt"* (S1)

- **Internal organizational environment:**

Internal organizational environment mainly focuses on organizational level assessment (Chaffey and Wood, 2005: 294). From the results of the interviews, it could be seen that cloud computing has received attention from organizations: in particular educational institution that are interested in cloud

computing. In the meantime, it also reveals significant problems associated with practical implementation of innovative business models.

> *"As for the current cloud services, I am more familiar with SaaS. I have some idea for implementing SaaS in UTP, but I have not found an appropriate practical opportunity for the implementation of cloud computing."* (L3)

> *"In our university, most of us is working under Petronas, so we have already used Petronas E-mail service to manage mail.That is also an example of cloud service that already adopted here."* (L5)

On the other hand, the interviewees think to that staff expertise, reliability of service providers and costs are potential factors which will influence the possibility of implementing cloud computing.

> *"If we adopted cloud services, service providers would have to offer stable and reliable services and avoid any disasters. Moreover, the management of IS systems is also important. To compare with our current systems: these can be controlled and managed by ourselves."* (L4)

> *"In the educational industry, broadly speaking, I think that it is possible to adopt webmail services and online document applications. As for the current UTP resource sharing, I think that cloud computing will not be adopted in the near future. The main barrier to the adoption of cloud computing in the development of information systems is the ability of our developers."* (L2)

### *5.1.3 Complexity*

Complexity is relative to the degree to which cloud computing is difficult to use, recognize and realize. According to Rogers (1995: 242), complexity of an innovation is not positively related to the rate of adoption. Although complexity is not an important factor, data analysis still suggests the potential effort required to adapt to cloud computing. According to the results of the interviews, most of the lecturers think that cloud-computing techniques comprehensively range from hardware to

software. Due to a lack of practice and technical data, they will not be able to realize the relevant techniques and applications.

> *"I think that it may be difficult to learn the techniques of cloud computing. This is mainly because it covers a wide range of IT techniques, leading to barriers to understanding cloud computing being higher."* (L5)

> *"In my opinion, when the existing systems shift to cloud-based infrastructure, system architects and system engineers will be the most important roles because it is up to their ability to develop service can fulfill user requirement. As for UTP, there is no such experts that will will deal with the infrastructure side of things. So it more difficult for us to actually come up with cloud service that is suitable for our university."* (L3)

### *5.1.4 Trialability*

Trialability means that potential adopters can experiment with cloud services on a limited basis (Rogers, 1995: 243). According to the theory of diffusion of innovations, the trialability of an innovation will lead to an increase in the rate of adoption. From the interviews, it is clear that all the interviewees have used cloud services in their daily lives, even though not all of them are aware of the current types of cloud services. For individuals, the data analysis suggests a high rate of cloud adoption.

> *"At present, applications of SaaS are rarely used in the company whereas these are used by individuals."* (L2)

> *"In our company, cloud services are sometimes used for informal activities. For example, we use Google docs to investigate the number of people who are interested in group buy."* (L5)

### *5.1.5 Observability*

Observability is relative to the visibility of successful cases and practices. When an innovation is visible to others, it will help raise the rate of adoption (Rogers, 1995: 244). From the viewpoint of organizations, the interviewees think that there are no significant successful practices which are helpful for increasing the rate of cloud adoption.

*"I think that the adoption of cloud computing may make resource sharing easier and more accessible, but at present, not many universities use cloud computing for their educational resource sharing. I just cannot exactly forecast if it is helpful to the current systems."* (L2)

### 5.2 Type of Innovation-decisions

Rogers (1995: 28) indicates that the type of innovation-decision is a very important influence on the rate of adoption. Generally speaking, the decision on adoption of an innovation is much easier for individuals than organizations. Because of UTP is an educational institution, usually innovations UTP mainly result from Lecturer's and students idea and research. Hence, there are two phases in their innovation-decisions processes. The first phase is usually optional innovation-decision. Innovation ideas will come from students or lecturers who seek to improve the university system. The next phase is collective innovation-decision. They will start doing research will discuss the feasibility of explored solutions, and then they decide to adopt an innovation and present it to UTP management.

*"Generally speaking, the adoption of an innovation results from the students and lecturer's ideas and the promotion of information technology service providers. As for the innovation-decision, it is usually made by the boss. The researchers consist of students and lecturers will evaluate the advantages and disadvantages of the innovation. After that, they will present the results of the survey. Finally, the boss will make a decision."* (L1)

### 5.3 Communication Channels

According to Rogers (1995: 194), communication channels are categorised into mass media and interpersonal. The characteristics of mass media are rapid transmission to a large number of people, the creation of knowledge and the spread of information, and changes of weakly held attitudes. In comparison with interpersonal channels, a two-way exchange of information enables the formation and change of strongly held attitudes. According to the experiences of the interviewees, their information sources on cloud computing are mainly from websites, news and magazines. Only a few participants get cloud-computing information through interpersonal channels.

Obviously, this reflects that their innovation-decision processes are at the knowledge stage (Rogers, 1995: 195).

> *"The information sources for cloud computing are mainly the technology magazines, online news and advertisements, and the website of service vendors, such as Microsoft. Moreover, colleagues may talk about cloud computing. However, it is not common because most of us are not familiar with it and there is no chance to practice."* (L4)

> *"I had learned a little bit of the relevant information from the external training institute. Most people acquire the relevant information from websites and communities online."* (S1)

### 5.4 Nature of the Social System

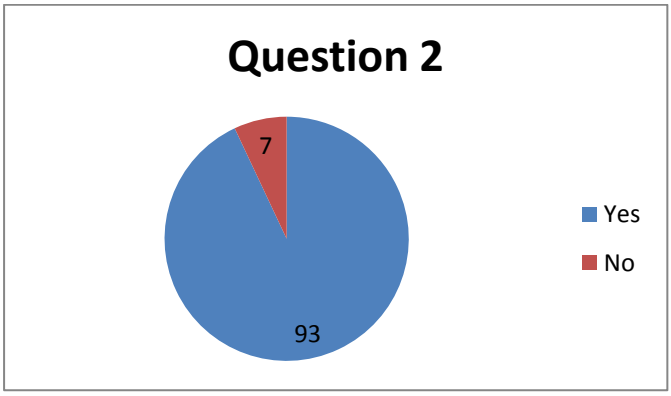
In the theory of diffusion of innovations (Rogers, 1995: 23), the social system means that many interrelated units work for a common goal. Broadly speaking, the social system has a wide range of influence on diffusion of innovations, and covers several key issues: social structure, system norms, opinion leaders and change agents, types of innovation-decisions and consequences of innovations. From the interview results, data analysis suggests that educational institution should have a consensus of collaboration for cloud computing.

> *"I think that the development of cloud computing in universities should have a relationship with the Ministry of higher Education. In fact, as a whole, every universities should adopt cloud computing. For example, the success of Google as a strong search engine is mainly because there are many kinds of people who engage in the development of the search. Similarly, in order to achieve the success of cloud computing, this should be carried out through the collaboration of vendors universities across the country. Therefore, this large plan needs an appropriate leader to help implement it. In my opinion, the government should be the leader because it has enough resources and power to manage this plan."* (L1)

### 5.5 Survey Results

The surveys are conducted among 100 IT students in UTP. Below are the results from the online survey. The results are only collected from students who state that he/she is taking ICT program. The survey is made up of 5 questions, from which only 4 questions are relevant to be discussed for this research.

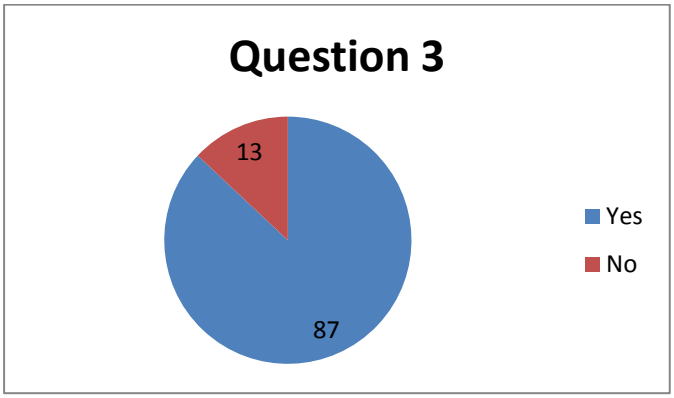
**Question 2** - Do you have basic understanding about cloud computing?




The result shows that 93 respondents out of 100 respondents understand about cloud computing.

The data analysis suggests that 93% of respondents understand what is cloud computing and their responds will be invaluable because of the knowledge about cloud computing that they have.

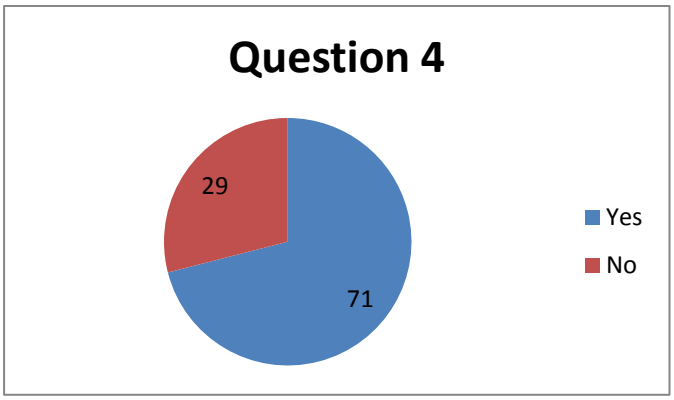
**Question 3** - Do you have basic understanding about resource sharing?




The result shows that 87 respondents out of 100 respondents understand about resource sharing.

The data analysis suggests that 87% of respondents understand what is resource sharing and their responds will be invaluable because of the knowledge about resource sharing that they have.

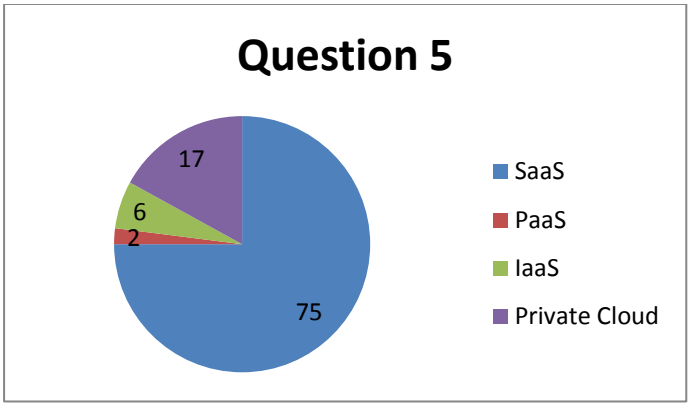
**Question 4** - Do you want UTP to adopt cloud computing to replace current UTP' resource sharing system?




The result shows that 71 respondents out of 100 respondents agreed to adopt cloud computing service for UTP resource sharing.

The data analysis suggests that 71% of the respondents think it is better to adopt cloud computing for UTP resource sharing based on their experience with current resource sharing and their knowledge about cloud computing.

**Question 5** - What type of cloud computing that are you interested to be implemented in UTP?




The result shows that 75 respondents opted to implement SaaS type cloud, 2 opted for PaaS type cloud, 6 opted for IaaS type cloud and 17 opted for private cloud.

The data analysis suggests that 75% of the respondents want software as a service cloud type in UTP, while 2% of the respondents want platform as a service cloud type to be implemented. 6% of the respondents want internet as a service cloud type and another 17% want private cloud to be implemented.

# CHAPTER 6
# DISCUSSION

This chapter focuses on discussion of the findings and results from this research and the literature review. Further, the key factors in relation to effects of cloud adoption in organizations are explored and presented.

## 6.1 Lack of in-depth recognition and understanding

According to the interview data, it is found that a lack of in-depth recognition and understanding with respect to cloud computing is the first and the most important factor in the feasibility of cloud adoption. From an overall perspective, this factor is relevant to the cloud definition, types of cloud services and staff expertise.

First of all, from the interviews, it is obvious that the definitions of cloud computing that various IT professionals gave are quite different and the features of cloud computing that they described are not exactly the same. Therefore, this finding supports the demonstration that the definition of cloud computing is unclear and incomplete (Buyya et al., 2008; Vaquero et al., 2009; Voas and Zhang, 2009). Furthermore, the uncertain definition will lead to IT professionals not being able to explore new practical applications for the usage of cloud computing (Vaquero et al., 2009).

In terms of cloud services, it is apparent that most of the current cloud service vendors, such as Google mail and Facebook, do not require contracts with the internet users (Leavitt, 2009); and hence all interviewees have experience of using the cloud activities. However, data analysis suggests that only a few of the interviewees are aware of the differences between SaaS, PaaS and IaaS. This finding reflects that most of them do not have extensive understanding of cloud computing. Moreover, the interview data shows that at present mass media is the major communication channel for diffusion of innovations. This means that a lack of the relevant information may lead to IT professionals not being able to understand cloud computing in depth.

On the other hand, the interview results also reflect that organizational managers would be concerned about staff expertise if they decided to adopt cloud computing. Similarly, Tsai (2009) mentioned that a lack of appropriately skilled IT

professionals is a barrier to cloud adoption. Also, Hutchinson (2009) noted that IT professionals always have to tackle new challenges, in the face of innovation. Therefore, if they achieve in-depth recognition and comprehension of cloud computing, this will help increase the feasibility of cloud adoption in the development of information systems.

### 6.2 Efforts of Information Technology Service Providers

According to Miller (2008: 24), the advantages of cloud computing are relative to capacity, reliability, compatibility, ease of use and flexibility. However, the interview data reflected differences in the perceived benefits of cloud computing. So far, only flexibility, ease of use and capacity has been fully. Overall, according to the data analysis, the advantages of cloud computing are perceived to a greater extent by individuals than by enterprises.

On the other hand, the theoretical disadvantages of cloud-computing are entirely the same as those arising from the interviews, and include bandwidth and latency, concerns over privacy and confidentiality, limited functionalities and slow performance compared to on-premises software (Miller, 2008; Grossman, 2009; Leavitt, 2009; Melvin B. Greer, 2009). In addition to the disadvantages mentioned above, the results of the interviews reflect other potential problems that have a great impact on the adoption of cloud computing. Firstly, the data suggests that the interviewees are concerned about stability, reliability, interoperability and the development plan. An unstable and unreliable system or technique will raise the barriers to adoption of cloud computing (Leavitt, 2009; Reese, 2009). In addition, interoperability is important for organizations because standardization of systems will enable them to switch their systems from a platform or service vendor to another type (Grossman, 2009: 163; Melvin B. Greer, 2009). Therefore, the change agents are struggling to overcome these problems and thereby eliminate the barriers to the adoption of cloud computing. Further, it is necessary for change agents to establish an information relationship, in order to convince their customers that their technology and services are stable and reliable.

### 6.3 Effects of incentives

Through the interviews, the interviewees reflect that industry collaboration can help the development of cloud computing. However, there is an argument about who should assume leadership in the diffusion of cloud computing. Some consider that the Ministry of Higher Education should be responsible for the promotion of cloud computing whereas others think that it is better for the leaders of the IT industry to take on this role.

### 6.4 Cloud Computing Benefits to Education

Cloud computing has been known to be a very promising system to any business organization because of its flexibility, scalability, and efficiency. But cloud computing benefits to education field?

- ✓ Cloud computing in a way offers schools, colleges or universities or any other educational institute a low cost system with the capability of high computing system. All they need is a stable internet connection, and they will get decent performance like they are having high-end computers and program.
- ✓ Students, teachers, and lecturers can share their work, educational materials, and lecture materials without having to use paper. Eliminating the use of paper effectively reduce cost of constantly buying paper and help environment become greener.
- ✓ IT support and administrator have their job lesser and easier because job such as software licensing issues, software updates, hardware update, IT security management will no longer need to be done as it all will be manage by cloud provider, thus making IT department have more control towards their IT resources.
- ✓ Critical and confidential data will be stored centrally in the cloud, meaning that there will be less threat of data theft by laptop and flash drive.
- ✓ Cloud computing can actually be used in underdeveloped country and create a way for teachers in those country to be able to teach students or children who would normally do not have access to education.

# CHAPTER 7
# RESEARCH CONCLUSION

It seems that a lot of works need to be done to adopt cloud computing for UTP Educational Resource Sharing. The main concern would be the lack of knowledge and information regarding cloud computing. From overall perspective, the adoption of cloud computing in UTP is expectable and achievable, it is just that UTP do not have the expert to actually handle the adoption and making sure the adopted technology can deliver what it is expected to. UTP should make efforts to adopt cloud computing as this technology shows great promise as cloud computing has been proven to drastically enhance the learning capability of students in educational institution that implement cloud computing. Cloud computing also has been reported to actually help educational institution with limited budget to scale with current educational demands and trend without having to spend so much money to obtain the required IT resources.

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# APPENDICES

## A. Interview Question Set

Below are interview question set that has been used while conducting the in-depth interview for the qualitative research method. Following are the questing set for the research interview.

- How well is your knowledge / expertise in cloud computing?
- How well is your knowledge in current UTP resource sharing system?
- Describe in your own word the definition of cloud computing.
- Do you think that we can replace our current resource sharing with cloud computing? If yes, what are the things needed to ensure the adoption can be done smoothly?
- What are the benefits and disadvantages of using cloud computing that you can think of?
- Have you ever use any type of cloud services?
- What type of cloud services that already available in UTP?
- Do you think that with our current expertise, cloud adoption can be done in UTP?
- Do you know any university that adopt cloud computing?
- What are the factors that UTP management consider in accepting an innovation?
- How the decision of accepting the innovation is be made in UTP?
- From where do you gain information or knowledge about cloud computing?

## B. Survey Question Set

1. Survey Form

Questionnaire

This survey is about cloud computing implementation into current UTP Educational Hardware and Software Resource Sharing.

1. Please state your program of studies: _____
2. Do you have basic understanding about cloud computing?
   a. Yes
   b. No
3. Do you have basic understanding about resource sharing?
   a. Yes
   b. No.
4. Do you want UTP to adopt cloud computing to replace current UTP' resource sharing system?
   a. Yes
   b. No.
5. What type of cloud computing that are you interested to be implemented in UTP?
   a. SaaS (i.e. Google Docs and Google mail)
   b. PaaS (i.e. Google Apps Engine and Salesforce CRM system)
   c. IaaS: (i.e. Amazon EC2)
   d. Private cloud

THANK YOU