A FEASIBILITY STUDY OF THE ADOPTION OF CLOUD COMPUTING IN THE DEVELOPMENT OF INFORMATION SYSTEMS:
AN INVESTIGATION INTO ORGANISATIONS AND IT FIRMS IN TAIWAN

A study submitted in partial fulfilment of the requirements for the degree of

Master of Science in Information Management

at

THE UNIVERSITY OF SHEFFIELD

by

NAN-CHOU CHEN

September 2009
Acknowledgement

First of all, I would like to thank my dissertation supervisor, Professor Angela Lin for her full support and valuable recommendations throughout this project.

Moreover, I really appreciate the wholehearted support from my family for my studies abroad and encouragement from my girlfriend in the face of difficulty. It is their support and encouragement which has enabled me to complete my studies in the UK.

Furthermore, I would like to acknowledge all those who were willing to participate in the interviews: in particular, my friends and ex-colleagues who assisted me by introducing their colleagues to the research project. Their help was invaluable in enabling me to gather a wide variety of useful thoughts on cloud computing for the research.

Finally, I am grateful to staff in the Information Studies Department and various other friends for their help. Also, I would like to thank Rachel for proofreading my dissertation.
Abstract

**Background:** In the last two years, the emergence of cloud computing has been receiving attention and a lot of research and expertise in the field of information and communication technology has been engaged in the discussion of how cloud computing can improve the usage and development of information systems. Therefore, it can be seen that cloud-based application is, generally, becoming a trend in the development of information systems.

**Aims:** In order to assess the feasibility of the adoption of cloud computing in the development of information systems, this study aims to investigate IT professionals’ thoughts on cloud computing, and explore the key factors which may influence cloud adoption in Taiwan’s IT industry.

**Methods:** This study adopted qualitative method and a snowball approach to interviewing the participants: who all work in Taiwan’s IT industry. An interview guide based on previous studies was developed to guide an investigation of cloud adoption. Through the in-depth interviews, the research gathered different thoughts of IT professionals in relation to cloud computing.

**Results:** Based on the theory of diffusion of innovations, the results of data analysis suggest that most IT professionals do not have extensive understanding of cloud computing; and this has influenced the rate of cloud adoption in organisations. In addition, a lack of innovative business models for enterprises has tended to deter the interest in cloud computing on the part of potential adopters. Furthermore, not all of the relative advantages of cloud computing are perceived by the interviewees.
Therefore, it can be seen that the efforts of IT service providers to increase adoption rates are still insufficient. Finally, incentive schemes are a necessary instrument in encouraging organisations to adopt cloud computing.

**Conclusion:** Although there are several obstacles to cloud adoption, the development of cloud computing is expectable and achievable in the next few years. Through the efforts of IT vendors and government support, individuals or organisations will be able to understand cloud computing in depth and uncertainties will diminish.
Table of Contents

Acknowledgement ............................................................................................................. i
Abstract........................................................................................................................... ii
Table of Contents .............................................................................................................. iv
List of Figures .................................................................................................................... vi
List of Tables ..................................................................................................................... vi

1. Introduction.................................................................................................................... 1
   1.1 RESEARCH RATIONALE .................................................................................. 1
   1.2 RESEARCH QUESTIONS .................................................................................. 3
   1.3 RESEARCH AIMS AND OBJECTIVES .......................................................... 4
   1.4 STRUCTURE OF REPORT ............................................................................. 4

2. Literature Review.......................................................................................................... 5
   2.1 WHAT IS CLOUD COMPUTING? ................................................................. 5
      2.1.1 Cloud definition ....................................................................................... 6
      2.1.2 The relevant computing paradigms ...................................................... 7
   2.2 WHY CLOUD COMPUTING? ....................................................................... 10
      2.2.1 Tendencies towards computing in the cloud ........................................ 10
      2.2.2 Current cloud-computing activities ..................................................... 11
   2.3 CHARACTERISTICS OF CLOUD SERVICES ............................................ 12
      2.3.1 Types of cloud services ........................................................................ 13
      2.3.2 Feature Comparison of Cloud Providers .............................................. 16
      2.3.3 Successful cases using cloud services ................................................ 18
   2.4 PROSPECT OF GLOBAL CLOUD MARKETS .......................................... 18
   2.5 THE PROS AND CONS OF CLOUD COMPUTING ................................... 20
      2.5.1 Comparison of cloud-computing attributes ........................................ 21
      2.5.2 The Benefits of cloud services to business ......................................... 22
      2.5.3 Drawbacks of cloud services ............................................................... 24
   2.6 FURTHER IMPLICATIONS FOR IMPLEMENTATION OF CLOUD COMPUTING 25
      2.6.1 Economic concerns .............................................................................. 25
      2.6.2 Business model concerns .................................................................... 26
      2.6.3 Security concerns .................................................................................. 26
      2.6.4 Technical concerns .............................................................................. 27
      2.6.5 Reliability concerns ............................................................................. 28
      2.6.6 Staff expertise concerns ....................................................................... 29
      2.6.7 Political concerns .................................................................................. 29
   2.7 SUMMARY ......................................................................................................... 30

3. Framework for Evaluating Cloud Adoption .............................................................. 32
   3.1 VARIABLES DETERMINING THE RATE OF ADOPTION ............................ 32
      3.1.1 Perceived attributes of innovations ...................................................... 33
      3.1.2 Type of innovation-decisions ................................................................ 34
      3.1.3 Communication channels .................................................................... 35
      3.1.4 Nature of the social system .................................................................. 36
      3.1.5 Extent of change agents’ promotion efforts ........................................ 36
   3.2 STRATEGY SITUATION ANALYSIS ......................................................... 36
      3.2.1 Internal organisational environment .................................................... 37
      3.2.2 Internal information systems environment ....................................... 37
      3.2.3 External micro-environment ............................................................... 39
      3.2.4 External macro-environment .............................................................. 40
   3.3 SUMMARY ......................................................................................................... 41

4. Methodology ............................................................................................................... 42
   4.1 RESEARCH METHOD AND STRATEGY ................................................... 42
4.2  PARTICIPANTS ................................................................. 43
  4.2.1  Snowball sampling ......................................................... 43
  4.2.2  Sampling composition ..................................................... 44
4.3  DATA COLLECTION .......................................................... 46
  4.3.1  Data collection method ................................................... 46
  4.3.2  Data collection instruments .............................................. 46
  4.3.3  Data collection procedure ............................................... 47
4.4  DATA ANALYSIS .............................................................. 47
5.  Results Analysis .................................................................. 49
  5.1  PERCEIVED ATTRIBUTES OF CLOUD COMPUTING .................. 49
    5.1.1  Relative advantage ...................................................... 50
    5.1.2  Compatibility ............................................................. 52
    5.1.3  Complexity ................................................................. 58
    5.1.4  Trialability ................................................................. 59
    5.1.5  Observability .............................................................. 59
  5.2  TYPE OF INNOVATION-DECISIONS ...................................... 60
  5.3  COMMUNICATION CHANNELS ............................................ 61
  5.4  NATURE OF THE SOCIAL SYSTEM ....................................... 62
  5.5  CHANGE AGENTS’ PROMOTION EFFORTS ............................... 63
6.  Discussion ........................................................................... 65
  6.1  LACK OF IN-DEPTH RECOGNITION AND UNDERSTANDING .......... 65
  6.2  LACK OF INNOVATIVE BUSINESS MODELS FOR ENTERPRISES ...... 66
  6.3  EFFORTS OF INFORMATION TECHNOLOGY SERVICE PROVIDERS ... 67
  6.4  EFFECTS OF INCENTIVES .................................................... 68
7.  Conclusions and Recommendations ....................................... 70
  7.1  RESEARCH CONCLUSIONS .................................................. 70
  7.2  RESEARCH LIMITATIONS ................................................... 72
  7.3  SUGGESTIONS FOR FURTHER STUDY .................................... 72
Bibliography ........................................................................... 74
Appendix: Interview Questions ................................................ 80
List of Figures

FIGURE 1-1 Computing paradigm shift - over six distinct phases, computers have evolved from dummy terminals to grids and clouds (Source: Voas and Zhang, 2009) ............... 2
FIGURE 2-1 Pervasive computing environment (Source: Liun et al., 2008) ......................... 9
FIGURE 2-2 Cloud computing architecture (Source: Vaquero et al., 2009; Weinhardt et al., 2009) .............................................................................. 15
FIGURE 2-3 The trend in cloud computing by 2012 (Source: Leavitt, 2009) .......................... 19
FIGURE 2-4 Market-research firm IDC’s predictions of changes in organisations’ use of technology due to cloud computing (Source: Leavitt, 2009) ......................... 20
FIGURE 3-1 Framework for assessing cloud adoption .................................................................. 32
FIGURE 3-2 Types of development decisions (Source: Kang et al., 1990: 24) ......................... 39

List of Tables

TABLE 2-1 Results of a survey of cloud computing activities undertaken by internet users in America (Source: Horrigan, 2008) ................................................................................. 12
TABLE 2-2 Current types of cloud computing activities (Source: Miller, 2008) ..................... 14
TABLE 2-3 Comparison of some representative cloud platforms (Source: Buyya et al., 2008) .................................................................................................................. 17
TABLE 2-4 Cloud computing distinguishing attributes (Source: Melvin B. Greer, 2009: 16) 22
TABLE 2-5 The benefits of cloud computing (Miller, 2008) .................................................. 22
TABLE 2-6 Comparing the cost of different IT infrastructures (Source: Reese, 2009: 14) ... 23
TABLE 3-1 Perceived attributes of innovations (Source: Rogers, 1995) .................................. 34
TABLE 4-1 Details of the managers .......................................................................................... 45
TABLE 4-2 Details of the engineers ......................................................................................... 45
1. Introduction

This chapter aims to outline the feasibility study of the adoption of cloud computing in the development of information systems in Taiwan’s Information Technology (IT) industry, and covers five areas. The first section looks at the history of computing paradigms, after which the motive of the dissertation will be introduced. Then the third area defines the research questions. The following section carries out the research aims and objectives to guide an investigation of cloud adoption. In the final part, the structure of the dissertation is presented.

1.1 Research Rationale

The revolution of digital technologies has changed the way human beings record data and transit information from traditional (e.g. writing) to digital methods. In this day and age, most people tend to use a wide range of technological products to perform a variety of tasks. The invention of computers is the best example of such changes to society.

In terms of the history of computing paradigms, Voas and Zhang (2009) identified six distinct phases (figure 1-1). Obviously, computing infrastructures usually vary with the emerging concepts and technologies. The preliminary phase is that people work in powerful mainframes through the connection of terminals. In the second phase, the widespread usage of stand-alone personal computers enabled people to work on their own computers. In the next phase, people were able to share data stored on computers with others via networks. The invention of the Internet in the fourth phase has placed the entire world at our fingertips and all information can be accessed at
the click of a button. The subsequent phase started to give rise to the concept of an
electronic grid that focuses on a convergence of shared computing power and storage
resources. Cloud computing is a tendency towards scale-out computing and forms
part of the latest phase. Through the Internet, people will be able to use different
portable devices and computers to manipulate applications and access data anywhere.
Although cloud computing is currently at the developmental stage, some companies
are convinced that it is the key to opening the doors to Web 3.0 (Fenu and Surcis,
2009).

![Diagram of computing paradigm shift](image)

**Figure 1-1** Computing paradigm shift - Over six distinct phases, computers have evolved from dummy
terminals to grids and clouds (Source: Voas and Zhang, 2009).

In the last year, the concept of cloud computing has been the most widely discussed
issue in the IT industry around the world. Many global IT companies (such as
Google and Microsoft) are actively promoting cloud computing. Rishi Chandra,
product manager for Google Enterprise, clearly declared that “The next 10 years of
innovations are going to be in the cloud. Enterprise software is not going away, but
there is a transition taking place” (Ricciuti, 2008). As a consequence, it could be seen that there is a convergence of tendencies towards computing in the cloud.

Although cloud computing is still relatively new today (Leavitt, 2009), many people have used Internet-based applications in their daily lives which are related to cloud computing. A most common example is Google search engine. By contrast, cloud computing itself is only adopted by a number of Web 2.0 firms (Leavitt, 2009). For this reason, the motive of this study is to undertake an in-depth survey of the attitudes of Taiwan’s organisations and IT departments to this technical innovation and key issues they are concerned about. Therefore, the details of this research will be clearly illustrated in the subsequent sections.

1.2 Research Questions

As the conception of computing in the cloud has emerged, it has brought significant changes to the IT industry (Hutchinson et al., 2009). However, it has not been widely practised in Taiwan. Therefore, this research will survey the diffusion of cloud computing in Taiwan’s IT industry and discuss the relevant questions listed below.

- What is the definition of cloud computing?
- What do IT professionals consider to be the benefits of cloud computing to organisations and the obstacles to implementation of this innovation in Taiwan?
- What are the factors for IT professionals in Taiwan in evaluation of the adoption of cloud computing?
1.3 Research Aims and Objectives

This project aims to investigate IT professionals’ thoughts on cloud computing, and explore the key factors which may influence cloud adoption in Taiwan’s IT industry. To achieve its goal, this research has listed the following objectives for conducting an investigation into the feasibility of adopting cloud computing in the development of information systems.

- To examine the definitions of cloud computing.
- To identify the benefits and drawbacks of cloud computing to business.
- To identify the obstacles to the implementation of cloud computing.
- To investigate the factors influencing cloud adoption in organisations.

1.4 Structure of report

The dissertation is composed of seven chapters. These chapters are briefly described as follows: Chapter 1 introduces the research rationale, and the aims and objectives of this study. Chapter 2 presents a review of the literature in relation to cloud computing. Chapter 3 highlights the framework for evaluating cloud adoption. Chapter 4 illustrates the methodology used to conduct the research. Chapter 5 analyses the collected data and displays the results of the analysis. Chapter 6 discusses the findings and results from the literature and result analysis, and considers how the explored factors may affect cloud adoption in organisations. Chapter 7 concludes the results of the research, and gives recommendations for further study.
2. Literature Review

This chapter explores the key issues in the literature which are relevant to this project, and includes six major sections. The first section reviews the literature on cloud computing in relation to cloud definitions and computing paradigms. The second area examines tendencies towards computing in the cloud and explores the current cloud activities. The third part clarifies characteristics of cloud services, including service types, public and private services, and feature comparison of service vendors. In the fourth area, the prospect of global cloud markets is analysed. The subsequent section identifies the pros and cons of cloud computing. Finally, the barriers to cloud adoption are explored. This study refers to a variety of materials, in order to carry out a thorough and comprehensive literature review in relation to cloud computing.

Resources are mainly drawn from books, academic journals, news and information on the World Wide Web.

2.1 What Is Cloud Computing?

Strictly speaking, the early formulation of cloud computing can be traced back to 1997 (Lijun et al., 2008). Due to the rapid evolution of Information Technology (IT), Cloud Computing has re-emerged and become a fashionable term today. Generally, cloud computing could be roughly defined as provision of a new computing infrastructure or a scale-out computing paradigm shifting the location of the traditional infrastructure to the Internet in order to cut costs for managing resources of hardware and software (Vaquero et al., 2009). In this section, this study will clarify the cloud definitions in depth and review the current cloud services.
### 2.1.1 Cloud definition

The “cloud” is the key to the definition of cloud computing. However, so far, there is no exact definition of the Cloud (Cloud computing, 2009; Introduction to Cloud Computing, 2009; Voas and Zhang, 2009). Also, Vaquero (2009) noted that there are many different definitions of cloud computing. Because it was widely recognised that the cloud is a metaphor used for the Internet and depicted in computer network diagrams (Erdogmus, 2009), a simple explanation of the cloud is an abstraction for the complex cloud-computing infrastructure. In detail, this means that there is a massive group of interconnected computers and servers somewhere on the Internet, as well as internet users who will be able to deal with many kinds of computational matters via the cloud (Miller, 2008: 9).

On the other hand, another further definition of the cloud is that “a cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualised computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers” (Buyya et al., 2008). Vaquero (2009) synthesised a lot of research related to the cloud definition; and he worked out the current conceivable definitions with respect to the Cloud are as follows: First of all, Clouds can be defined as a large pool where there are many easily usable and accessible virtualized resources. Hardware, development platforms and services are examples. Secondly, service users can dynamically reconfigure these resources to scale their infrastructures for an optimum utilization. Thirdly, Infrastructure Providers typically charge service users for the usage of resources in the pool by means of a pay-per-use model.
2.1.2 The relevant computing paradigms

Recently, the up-to-date notion of cloud computing has become a major theme in the IT industry. However, the nature of the conception is not state-of-the-art technology. In fact, cloud computing is formed from various computing paradigms and it aims to provide certain capabilities and deliver IT products as services (Buyya et al., 2008). The relevant computing paradigms are as follows:

- **Network Computing**
  
  In the early 1990s, Network Computing was developed and it radically changed IT infrastructure (Revett et al., 2001). This approach means that applications placed on servers in the network can be accessed remotely by client machines. The evolution of the World Wide Web (WWW) is the best practical example of network computing. On the other hand, network computing contributed to the simplicity of building information systems and the development of electronic business and mobile computing. In addition, the most important benefit lies in reduction of total costs of ownership and operating costs. For these reasons, today, network computing is widely applied to an underlying basis of information systems.

- **Grid Computing**
  
  For most computers in America, on average, only 25 percent of the time of the central processing units is taken up by tasks in hand. Hence, the goal of Grid Computing was to eliminate the geographical boundaries and connect remote computers into a network, in order to combine idle resources of all computers on the grid and to create a virtual supercomputer (Laudon and Laudon, 2006: 190). Similarly, a major goal of cloud computing is to
connect a great number of computers in a data processing centre through the networks, and to create a high-performance computing power with the same technologies, such as distributed computing, parallel computing and cluster computing (Milojicic, 2008).

- Utility Computing (On-demand Computing)

Utility Computing could be defined as a new paradigm for the provision of the grand computing power (Laudon and Laudon, 2006: 191; Buyya et al., 2008). The remote and large-scale data processing centres, such as IBM, HP and Oracle offer utility computing services and these services are available whenever consumers require them. Moreover, these computer utility services are like electricity and gas in that consumers only need to pay for the amount of their usage of computing power. Therefore, companies can reduce the costs of their investment in IT infrastructure by purchasing utility services on demand.

- Pervasive Computing

Pervasive computing refers to an emerging mobile technology. These days, it is plain to see that the wide usage of mobile devices (such as laptop, Netbook, Personal Digital Assistant, Smartphone or some future device) has caused computation to become part of the computing environment (Turban, 2008: 60). Pervasive software is often embedded in these devices and it is designed to automatically adapt to the surrounding computing environment. Through a well-development computing environment, users will be able to easily utilize pervasive software to access data everywhere, without extra effort (Lijun et al., 2008). Figure 2-1 exactly demonstrates
the pervasive computing environment.

![Figure 2-1 Pervasive computing environment (Source: Lijun et al., 2008)](image)

- **Service-Oriented Architecture (SOA)**

  In the last three years, IT professionals have started to pay attention to SOA (or service computing) (Vouk, 2008). Strictly speaking, SOA is a concept similar to Web 2.0 and cloud computing and it provides a network-based way for organisations to integrate different systems conveniently. In detail, the approach of SOA is to follow some principles (such as interoperability, componentization, reuse and standards compliance) for modelling, creating, operating and managing business services (Lijun et al., 2008). In general, these services are published in specific public registries and form a set of network services. As a result, users can discover and subscribe to the Web services they need from public registries and bind services to their own applications through standards protocol (e.g. SOAP - Simple Object Access Protocol).
2.2 Why Cloud Computing?

This section aims to discuss which factors drive an upward trend of cloud adoption in information system development. Moreover, the activities that current cloud users prefer and the way they use them are also mentioned in this section.

2.2.1 Tendencies towards computing in the cloud

The Internet has brought significant changes to our lives in the last ten years. Hutchinson (2009) clearly illustrates that the evolution of the Internet contributes to an always-on, always-connected and device-independent environment. For this reason, it also has had a great impact on the development of information systems. This means that people can connect to a variety of information systems over the Internet via different kinds of computational devices (Laudon and Laudon, 2006: 263). In addition, Hayes (2008) noted that “for most applications, the entire user interface resides inside a single window in a Web browser”; and it is widely recognised that recently web-based applications have become more and more widespread in their use. This is reflected by the development of Web 2.0 and the elimination of traditional conceptions of storing data and running software programmes on each computer you own (Oberhelman, 2007; Buyya et al., 2008; Miller, 2008; Vaquero et al., 2009).

As part of the evolution of cloud computing in the last two years, many renowned companies have begun to engage in the provision of cloud-computing infrastructures and services. Amazon, Microsoft, Google, EMC, VMware, IBM, Sun, Dell, SalesForce.com and Activision are examples of Service Providers and Infrastructure Providers (Klems, 2008). This is mainly due to the fact that the emerging innovation
Information Management 2008-09
Feasibility of Cloud Adoption in Taiwan’s Organisations

has great commercial potential and it reflects a revolution in information systems, as well as the potential to change the whole IT environment and IT market in the next few years (Leavitt, 2009). Therefore, it could be seen that there is an upward trend in computing in the cloud.

2.2.2 Current cloud-computing activities

The report of the Pew Internet and American Life Project (Horrigan, 2008) describes the six types of activities associated with cloud computing listed below (Table 2-1): 56% using webmail services (such as Google mail and Yahoo mail), 41% storing photos and videos online, 29% using online applications (such as Google Documents and Adobe Photoshop express) and 10% paying to store computer files online and backing up hard drives to an online site. In addition, it is reported that 69% of the American internet users have performed at least one, and 40% of them at least two, activities. However, currently, not only are these activities related to cloud computing, but there are also many different types of cloud-computing activities, such as web-based desktops, web-based databases, online project management applications, contact management and Customer Relationship Management (CRM) applications, online bookmarking services, social networks and online groupware (Miller, 2008). As a consequence, from results of the investigation, it can be seen that it is more and more common for people to use cloud-computing services in today’s world.

On the other hand, the Pew Internet and American Life Project indicates that 34% of participants have been away from home or work and used laptops to go online (Horrigan, 2008). This means that internet users are able to access these online services easily via the mobile computer or phone. Not only can people go online by
using different mobile devices, but the various business purposes of the Internet are also apparent. For example, LaMonica (2009) reports that Hohm is a free web-based application of home-energy management built by Microsoft and by means of this cloud-computing application people can monitor and conserve electricity and natural gas. This example of the new business related to residential energy management clearly represents that there is great potential for using the Internet in association with cloud computing in the future.

![Cloud Computing Activities](image)

<table>
<thead>
<tr>
<th>Groups of cloud activities</th>
<th>All internet users</th>
<th>Those who use a laptop to connect WiFi away from home or work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use webmail services (e.g. Gmail, Hotmail or Yahoo Mail)</td>
<td>56%</td>
<td>64%</td>
</tr>
<tr>
<td>Store personal photos online (e.g. Flickr, Picasa or Facebook)</td>
<td>34%</td>
<td>44%</td>
</tr>
<tr>
<td>Use online application (e.g. Google Docs)</td>
<td>29%</td>
<td>38%</td>
</tr>
<tr>
<td>Store personal videos online (e.g. Youtube)</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Pay to store computer files online</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>Back up hard drive to an online site</td>
<td>5%</td>
<td>9%</td>
</tr>
</tbody>
</table>

Table 2-1 Results of a survey of cloud computing activities undertaken by internet users in America (Source: Horrigan, 2008).

### 2.3 Characteristics of Cloud Services

It is widely recognised that Service Providers (SPs) view software services as their business basis and they make these accessible to Service Users via Internet-based interfaces. Currently, Infrastructure Providers (IPs) struggle to build the large data centres called “Cloud Centres” for the provision of the cloud-computing infrastructure required to host services. Therefore, cloud services can be defined as a business model provided by IPs. Cloud services with general purpose data-centre capacity are elastic, scalable and cost-saving. SPs could choose their optimum
feasibility of Cloud Adoption in Taiwan’s Organisations

2.3.1 Types of cloud services

In terms of business models of cloud computing today, there are three common kinds of cloud services, namely, Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) (Leavitt, 2009; Vaquero et al., 2009). From Figure 2-2, it is obvious that each type of cloud service is located in a different layer of the architecture. The different purposes and capabilities of components are as below.

- **Software as a Service (SaaS)**

  According to Melvin B. Greer (2009), SaaS is an approach of one-to-many model, which means that multiple users or organisations use the same application via a Web browser, using, for instance, word processors and excel processors. Google Apps are the best example in the software-as-a-service area. In general, many people recognise what SaaS is because of its actual and easy-to-use interfaces (Weinhardt et al., 2009). As a result, SaaS is the typical business application of cloud computing representing potential interest (Vaquero et al., 2009). Table 2-2 below shows examples of SaaS.

<table>
<thead>
<tr>
<th>Types of Cloud Services</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Online calendar applications</td>
<td>Google Calendar, Yahoo! Calendar, Windows Live Calendar, Apple MobileMe Calendar</td>
</tr>
</tbody>
</table>
### Table 2-2 Current types of Cloud Computing activities (Source: Miller, 2008).

<table>
<thead>
<tr>
<th></th>
<th>Activities</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Online scheduling applications</td>
<td>Presdo, Windows Live Events</td>
</tr>
<tr>
<td>3</td>
<td>Online planning and task management applications</td>
<td>Voo2Do, TracksLife, HiTask, Tudu List</td>
</tr>
<tr>
<td>4</td>
<td>Event management applications</td>
<td>Event Planning and Workflow management</td>
</tr>
<tr>
<td>5</td>
<td>Contact management and CRM management applications</td>
<td>Salesforce.com, AppleMobileMe Contacts, BigContacts, Zoho CRM</td>
</tr>
<tr>
<td>6</td>
<td>Project management applications</td>
<td>AceProject, Basecamp, Project Drive</td>
</tr>
<tr>
<td>7</td>
<td>Web-based word processors</td>
<td>Google Docs, ajaxWrite, iNetWord</td>
</tr>
<tr>
<td>8</td>
<td>Web-based spreadsheets</td>
<td>Google spreadsheets, EditGrid, eXpresso</td>
</tr>
<tr>
<td>9</td>
<td>Web-based databases</td>
<td>Dabble DB, QuickBase, MyWebDB</td>
</tr>
<tr>
<td>10</td>
<td>Web-based presentation applications</td>
<td>Google Presentations, Presentation Engine</td>
</tr>
<tr>
<td>11</td>
<td>Online file-storage and -sharing services</td>
<td>Amazon S3, Microsoft Office Live Workspace</td>
</tr>
<tr>
<td>12</td>
<td>Online bookmarking services</td>
<td>Del.icio.us, Yahoo!MyWeb</td>
</tr>
<tr>
<td>13</td>
<td>Online photo-editing applications</td>
<td>Adobe Photoshop Express, Snipshot</td>
</tr>
<tr>
<td>14</td>
<td>Photo-sharing communities</td>
<td>Flickr, Picasa Web Albums, dotPhoto</td>
</tr>
<tr>
<td>15</td>
<td>Web-based desktops</td>
<td>ajaxWindows, eyeOS, Desktoptwo, StartForce</td>
</tr>
<tr>
<td>16</td>
<td>Web-based communication tools</td>
<td>Gmail, Yahoo!Mail, Windows Live Hotmail, meebo</td>
</tr>
<tr>
<td>17</td>
<td>Social networks</td>
<td>Facebook, Myspace</td>
</tr>
<tr>
<td>18</td>
<td>Online groupware</td>
<td>Google Sites, ProjectSpaces, Nexo, AirSet</td>
</tr>
<tr>
<td>19</td>
<td>Blogs and Wikis</td>
<td>Blogger, WordPress, Wikispaces, Zoho Wiki</td>
</tr>
</tbody>
</table>

- **Infrastructure as a Service (IaaS)**

  The layer of IaaS includes a large set of computing resources, such as storage capabilities and computing power. The development of virtualization makes it easier for IPs to dynamically manage and
reconfigure these resources as demanded by consumers (Leavitt, 2009; Weinhardt et al., 2009). Nevertheless, pay-per-use and subscription pricing are the most important features of IaaS. For example, Elastic Compute Cloud (EC2) and Simple Storage Service (S3) offered by Amazon allow many enterprises to run their applications on this platform and exchange data with their business partners, suppliers and external parties via secure and trusted connections (Melvin B. Greer, 2009).

![Cloud computing architecture](Source: Vaquero et al., 2009; Weinhardt et al., 2009)

- **Platform as a Service (PaaS)**

  From the aspects of technology and business, the layer of PaaS focuses on the provision of value-added services, which make it easier for developers to write applications and upload them into cloud without worrying about effects upon the growing usage of applications (Weinhardt et al., 2009). In
other words, PaaS could be viewed as a tool of cloud-computing system development. Google Apps Engine is a typical example of PaaS.

As mentioned above, SaaS, PaaS and IaaS are usually offered and managed by various cloud vendors and directly obtained from the open market (zur Wirtschaftsinformatik). Due to the fact that a variety of consumers use the same cloud resources, these clouds are called public clouds. In contrast, private clouds refer to an enterprise’s internal usage of cloud service. The reasons for firms to adopt private clouds are mainly associated with the management, cost and security of clouds (Grossman, 2009). In this case, the organisation may establish its own cloud or outsource to a third party to operate. As a consequence, there are two options for IT infrastructure (Reese, 2009).

2.3.2 Feature Comparison of Cloud Providers

Today, IT departments very commonly outsource their software requirements to application service providers (ASPs). This is a multitenant business model for the delivery and management of applications and computer services from a remote data processing centre (Laudon and Laudon, 2006: 205). In order to ensure the quality of services, formal service-level agreements (SLAs) are essential to ensure the expected services and computing responsibility between consumers and IT vendors (Turban, 2008: 546). Similarly, SLAs for cloud services are also necessary and important. In addition, there is noticeable debate in relation to choice of appropriate services and vendors. Therefore, feature comparison of cloud vendors is relatively important. In order to compare the differences in cloud platforms, Table 2-3 shows the features of five service providers.
Based on the comparison above, it can be seen that each service provider focuses on different types of cloud services. This study briefly analyses the key points in evaluating the cloud offerings. In addition to service type, programming framework is a most crucial factor in adoption of computing services, especially for organisations. Some companies have their own applications developed with specific programming languages and this raises the issues of compatibility of systems and effort of introducing a new system. For example, Amazon EC2 only enables users to run Linux-based applications. For this reason, organisations have to spend much time and money on modifications or even creating a new system if they intend to switch from their own Windows-based applications to Linux-based applications. The second vital feature is user access interface. A convenient, friendly and rich interface can
allow a user to easily manipulate and maintain a system.

2.3.3 Successful cases using cloud services

Up to now, cloud computing has not been widely applied in the IT industry (Leavitt, 2009). However, there are a few successful real cases, which help to make apparent the services that can be provided. According to Chaganti (2008a), Amazon Web Services (AWS) is a typical cloud computing provider and it has four major services, namely, Storage, Computing, Messaging and Datasets. As for Amazon Elastic Compute Cloud (EC2), the New York Times used this service successfully to deal with terabytes of archival data in less than 36 hours (Gottfrid, 2008). From this case, it can be seen that the strong and rapid computing capacity is an important feature of cloud computing. In terms of Amazon Simple Storage Service (S3), SmugMug is an example of an online photo storage application that stores a great amount of data on S3: approximately more than half a petabyte. Hence, this company cuts costs by around $1 million (Chaganti, 2008a). In this day and age, it is widely recognised that it is getting more and more common for people to store data in networks. However, certain crucial issues such as reliability, simplicity, scalability and inexpensive pricing should be addressed (Chaganti, 2008b). On the other hand, it is apparent that “organisations raise important issues that require extensions and revisions of previous foundational work on commitment, norms, strong paraconsistency, and model checking” (Hewitt, 2008).

2.4 Prospect of Global Cloud Markets

Cloud computing reveals the next-generation application architecture (Hutchinson et al., 2009) and there will be a sea change in computing in the coming years (King,
2008). Merrill Lynch, a global financial services company, estimates that by 2011 the volume of cloud computing market opportunity is expected to be worth $160 billion (figure 2-6) (Klems, 2008). This accounts for business and productivity applications and online advertising at $95 billion and $65 billion respectively. Also, Morgan Stanley stated that cloud computing is one of the prominent technology trends (Buyya et al., 2008). From the viewpoint of organisations, the trend in cloud computing will have a great impact on the adoption of information systems. Weinhardt (2009) states that “Current trends in cloud computing lean heavily toward the business world: companies seem increasingly motivated to focus innovative business models on various aspects of cloud computing”.

![Figure 2-3 The trend in cloud computing by 2012 (Source: Leavitt, 2009)](image)

On the other hand, the level of maturity of cloud-computing technologies has an important impact on the market. Gartner’s analysis predicts that cloud application
infrastructure technologies will take seven years to become mature. From 2007 to 2011, the first phase is that an increasing number of cloud providers will explore potential interest within the market through a variety of business activities. During the period, the market will begin to mature and be dominated by particular cloud vendors. The second phase is from 2010 to 2013. In this period, more and more organisations will consider the adoption of cloud computing and this will contribute to them changing their ways of using technology and achieving market consolidation. Figure 2-4 below shows the differences in technical usage between 2008 and 2012. By 2015, due to mainstream critical mass, commoditization will be a natural outcome of competition and technological advance (Ferguson, 2008; "Gartner Says Cloud Application Infrastructure Technologies Need Seven Years to Mature", 2009).

![Pie charts showing technical usage comparison between 2008 and 2012](image)

Figure 2-4 Market-research firm IDC’s predictions of changes in organisations’ use of technology due to cloud computing (Source: Leavitt, 2009)

### 2.5 The Pros and Cons of Cloud Computing

On-premises software refers to applications such as Windows-based software ("On-premises software") which are installed and run on a local single computer. In addition, it is the major approach to traditional information system development. By
contrast, off-premises computing services, such as web-based applications, are located at a remote place and owned by particular organisations, (Melvin B. Greer, 2009). The fact that off-premises computing is gaining in popularity today, encourages the conception of cloud computing. In the following section, firstly, this study will distinguish the attributes of cloud computing compared to traditional computing and identify the advantages and disadvantages of cloud computing.

### 2.5.1 Comparison of cloud-computing attributes

As mentioned above, today’s Internet environment and a convergence of new and complex technologies contribute directly to the transition from traditional computing to cloud computing. This shift to computing in the cloud is transforming the delivery and acquisition of IT products and service contracts with SPs (Melvin B. Greer, 2009: 15). In short, the innovation reveals that there is a tendency towards off-premises computing services, instead of on-premises software products. To compare cloud with traditional computing, Table 2-4 below presents the distinguishing attributes of cloud computing from four different aspects. First of all, cloud computing enables consumers to rent services they need, rather than investing in ownership of IT infrastructures. Secondly, the pay-per-use pricing model is cheaper than traditional fixed IT expenses. Thirdly, it is convenient for end-users to use various devices to access services placed on the Internet, even when they are away from the home or office. Finally, cloud-computing infrastructure is more scalable, elastic, dynamic and multitenant than that of traditional computing.

<table>
<thead>
<tr>
<th></th>
<th>Traditional Computing</th>
<th>Cloud Computing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition model</td>
<td>Buy assets and build technical architecture</td>
<td>Buy service (aka “rent”)</td>
</tr>
<tr>
<td>Business model</td>
<td>Pay for fixed assets and Administrative overhead</td>
<td>Pay based on use</td>
</tr>
</tbody>
</table>
2.5.2 The Benefits of cloud services to business

Strictly speaking, cloud computing is a theoretical conception of technology. However, cloud service is the practical implementation of cloud computing. It thus becomes apparent that there is a certain overlap between the benefits of cloud computing and cloud services. In order to clarify the differences, first of all, Table 2-5 briefly identifies the overall advantages offered by cloud computing (Miller, 2008: 24).

<table>
<thead>
<tr>
<th>Categories</th>
<th>The benefits of cloud computing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital costs</td>
<td>Lower-cost computers</td>
</tr>
<tr>
<td></td>
<td>Lower IT infrastructure costs</td>
</tr>
<tr>
<td></td>
<td>Lower software costs</td>
</tr>
<tr>
<td>Capacity</td>
<td>Increased computing power</td>
</tr>
<tr>
<td></td>
<td>Improved performance</td>
</tr>
<tr>
<td></td>
<td>Unlimited storage capacity</td>
</tr>
<tr>
<td>Reliability</td>
<td>Increased data safety</td>
</tr>
<tr>
<td></td>
<td>Fewer maintenance issues</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Improved compatibility between operating systems</td>
</tr>
<tr>
<td></td>
<td>Improved document format compatibility</td>
</tr>
<tr>
<td>Ease of use</td>
<td>Instant software updates</td>
</tr>
<tr>
<td></td>
<td>Latest version availability</td>
</tr>
<tr>
<td></td>
<td>Easier group collaboration</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Universal access to documents</td>
</tr>
<tr>
<td></td>
<td>Removes the tether to specific devices</td>
</tr>
</tbody>
</table>

Table 2-5 The benefits of cloud computing (Miller, 2008)

As for the benefits of cloud services to business, firstly, cost saving is the primary and most important financial benefit (Reese, 2009: 13). This is mainly because of the usage-based pricing model. In terms of organisations, it helps them reduce their capital expenses and barriers to entry (Grossman, 2009). Table 2-6 below clearly reports that the cost of cloud services is quite low compared to other IT
Secondly, due to the fact that less than 50 percent of the total capacity of IT resources in enterprises is used (Leavitt, 2009), IPs concentrate on enabling consumers to scale up their capacity on demand and to enjoy the same economies of scale by means of using cloud services (Grossman, 2009). In short, a large scale, general-purpose data centre should offer more availability than an in-house IT infrastructure. As a consequence, this contributes to consumers increasing the efficiency of their operations and business continuity, especially for small or midsize companies.

The third advantage is relative to agility of implementation which makes it easier for IT professionals to develop cloud applications quickly and deploy them instantly. Simultaneously, developed or revised cloud-based applications can be used by hundreds or thousands of users in different locations all over the world (Melvin B. Greer, 2009: 19). Equally importantly, this ability shortens time to market, as it eliminates the wait for the organisational deployment of hardware and software sign-off (Vile and Liddle, 2009: 156).

Fourthly, perceived ease of use greatly encourages an increase in user adoption rates and customer satisfaction rates. Generally speaking, the operating interfaces of cloud

<table>
<thead>
<tr>
<th></th>
<th>Internal IT</th>
<th>Managed Services</th>
<th>Cloud Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital investment</td>
<td>$40,000</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Setup costs</td>
<td>$10,000</td>
<td>$5,000</td>
<td>$1,000</td>
</tr>
<tr>
<td>Monthly service fees</td>
<td>$0</td>
<td>$4,000</td>
<td>$2,400</td>
</tr>
<tr>
<td>Monthly staff costs</td>
<td>$3,200</td>
<td>$0</td>
<td>$1,000</td>
</tr>
<tr>
<td>Net cost over three years</td>
<td>$149,000</td>
<td>$129,000</td>
<td>$106,000</td>
</tr>
</tbody>
</table>

Table 2-6 Comparing the cost of different IT infrastructures (Source: Reese, 2009: 14)
applications look like browser web based applications or windows based applications. Both interfaces tend to be intuitive and easy to use (Melvin B. Greer, 2009: 19).

Finally, most service providers do not call for contracts, which in turn makes users more disposed to adopt cloud services as needed to develop systems and expand their businesses. Also, vendors can benefit greatly from the wide usage of service users, in the form, for example, of advertising revenue (Leavitt, 2009). Strikingly, it can be seen that its inherent flexibility is a key factor in cloud adoption, especially for the SaaS model ("Cloud Computing Research Shows Flexibility a Factor in SaaS Adoption", 2009).

### 2.5.3 Drawbacks of cloud services

In contrast with the benefits discussed earlier, cloud computing and cloud services both suffer from certain disadvantages. First of all, one significant drawback is relative to bandwidth in that cloud services are often remote and rely on the Internet. Therefore, any lack of constant and high-speed Internet connections leads to cloud applications not being able to work well (Miller, 2008: 28; Leavitt, 2009). To address this problem, service users and entrepreneurs could upgrade the speed of their broadband. From the viewpoint of business, cloud services can help save money on hardware and software. However, remediation of latency may result in higher bandwidth costs (Leavitt, 2009).

The second important disadvantage is that the performance of off-premises applications is not as fast as on-premises software. Moreover, another drawback related to cloud applications is that features may be limited (Miller, 2008: 29; Melvin...
B. Greer, 2009: 46). Take Google Docs as an example. Its functionalities are quite basic in comparison with Microsoft Office. In addition to the three major disadvantages, further crucial issues, such as security and reliability, require in-depth discussion (Grossman, 2009).

2.6 Further Implications for Implementation of Cloud Computing

As discussed earlier in the previous section, the drawbacks present the indisputable fact that there are significant barriers to the widespread adoption of cloud computing. In addition to the obvious disadvantages, there are other challenges to cloud computing on the horizon. Further issues related to the evolution of cloud computing fall into the following groups:

2.6.1 Economic concerns

For individual users and organisations, economic issues have an extremely vital effect upon their decision whether or not to adopt cloud computing (Reese, 2009: 13). The preliminary capital investment is the first point that consumers need to consider. Some enterprises may already have their own IT assets, and hence they stress this matter in particular. Moreover, ongoing costs must be involved in the consideration of cloud adoption. For service providers, in order to attract many customers and increase cloud adoption rates, a reasonable pricing structure is relatively important, especially for the current, difficult economic climate (Leavitt, 2009).
2.6.2 Business model concerns

Before the shift to computing in the cloud, companies must decide upon updates to their business models and how cloud computing can help them make money (Miller, 2008). Obviously, innovative business models will contribute to companies adopting cloud computing (Tsai, 2009; Weinhardt et al., 2009). Moreover, another significant requirement for firms is selection of cloud services that are fit for purpose. For instance, one benefit of SaaS is to enable companies to expand their businesses appropriately (Melvin B. Greer, 2009).

2.6.3 Security concerns

As we know, in today’s society, the privacy of personal information and the confidentiality of business and governmental information are always an important issue, particularly as new technologies are developing. As Leavitt (2009) noted in his reviews of cloud computing research, most people worry about security. Generally speaking, the security issues relate to technological changes, data regulations, compliance, policy making and law making. Additionally, of course, service users, service providers and governments should share responsibility for the improvement of cloud security. Service vendors, on their part, have to engage in enhancing the algorithm of data encryption, in order to ensure that data, network and host are secure (Reese, 2009: 100).

Service users should also require more vigilance, in the face of potential security risks. IT departments are usually wary of data control, particularly if they outsource their data centres to cloud service providers. This is mainly because the cloud platform on which their data is hosted may be located anywhere around the world
and none of that organisation’s staff works there (Leavitt, 2009). This means they are unable to see or touch the equipment, to say nothing of governing their data. In most cases, solutions to security problems do not lie in security technologies but in regulatory and standards compliance (Reese, 2009: 103).

On the other hand, because of the obligation that cloud service providers must guarantee the quality of their services, better and clearer policies and practices would be helpful for consumers in assessing potential security risks they face (Hewitt, 2008; Fenu and Surcis, 2009; Melvin B. Greer, 2009: 42). However, sometimes, the potential risks regarding privacy and confidentiality may not be solved by changes in policies and practices. The government should appropriately change the existing laws or make new laws (Melvin B. Greer, 2009: 42).

2.6.4 Technical concerns

The key to speeding up diffusion of cloud computing is in the maturation of cloud technologies. As mentioned in the previous section, the speed of broadband and performance of web-based applications should be improved. In addition, for cloud computing to mature, it also requires interoperability to address the problems associated with dependencies and standardisation (Fried, 2009; Tsai, 2009). Ideally, consumers should have the ability to bring cloud applications back to their own information systems or move them from one cloud vendor to another offering lower costs or a greater range of cloud services (Grossman, 2009). However, so far, current cloud computing platforms have no standardisation of application program interfaces and platform technologies (Melvin B. Greer, 2009: 163). This being the case, enterprises have to entirely depend on the support of specific cloud providers. If organisations intended to move the existing systems to another vendor, this would
oblige them to spend extra money on reforming systems. As a result, recently, there
has been an online document dedicated to fulfilling interoperability. It clearly points
out the following six principles of an “Open Cloud” on which technical suppliers and
communities should collaborate ("Open Cloud Manifesto", 2009):

1. Open collaboration and the appropriate use of standards are necessary for
cloud providers to tackle the barriers to adoption of cloud computing.
2. To avoid monopolising the cloud computing industry, Cloud providers must
let customers have choice of different vendors, instead of locking them into
particular platforms.
3. Cloud providers have to follow the existing standards, but not duplicate or
reinvent them.
4. The judicious and pragmatic consideration of the creation of new standards as
needed is necessary.
5. All community efforts associated with the open cloud should mainly depend
on customer needs and should completely satisfy real customer requirements.
6. To avoid conflicts and overlaps, cloud-computing standards organisations,
advocacy groups, and communities should collaborate and coordinate.

2.6.5 Reliability concerns
Due to the fact that reliability has a great impact on cloud adoption, consumers
should take care of the two key issues related to transparency and service quality.
First of all, transparency means that the capabilities of cloud services must be audited
by third parties (Leavitt, 2009). To achieve the goal, service vendors must provide
reliable systems to ensure that customers can check who has access to their data and
keep unauthorized personnel from retrieving information (Vile and Liddle, 2009:
On the other hand, Leavitt (2009) points out the problem that vendors cannot always offer round-the-clock cloud services. This leads to the issue of reliability that consumers are very concerned about. To address this problem, vendors must establish a sound operating environment for their cloud services. A sound environment reflects how good the disaster recovery plan of the service provider is and whether its cloud service is indeed reliable (Reese, 2009).

### 2.6.6 Staff expertise concerns

As always, employees working in the IT environment have to address various challenges, in the face of innovation (Hutchinson et al., 2009). Therefore, a lack of relevant IT professionals in organisations presents a current barrier to cloud adoption (Tsai, 2009). Technology suppliers and service providers should be responsible for provisioning cloud training activities, such as consultant services, technical seminars and training courses. Furthermore, the provision of development and testing tools for adoption of cloud computing is also important; in particular, these help developers create cloud applications rapidly (Hutchinson et al., 2009).

### 2.6.7 Political concerns

If cloud computing can bring great benefits to business and our lives, we may need to consider whether the government should shoulder responsibility for adding impetus to the evolution of cloud computing. Gordon Brown, the Prime Minister of the United Kingdom, declared that “The digital revolution is changing all our lives beyond recognition and today we shall set out how Britain must change with it” (Brown, 2009). Along these lines, the UK government will invest in information and communications industries and aim for accelerated digital development. From this
example, it is apparent that government support affects the innovation of technology.

2.7 Summary

The review of the literature has covered the important issues in relation to cloud computing. At the beginning of the review, it focuses on the definition of the cloud and the understanding of the attributes of the relevant computing paradigms associated with the cloud. In the second section, this study discusses reasons for the current tendencies towards cloud computing, and looks at the popular cloud activities in America. From the preliminary review of cloud computing, it can be seen that cloud computing is both a developing concept and a set of existing computing paradigms. Further, and most importantly, it has become integral to our lives.

In the third section, the characteristics of cloud services are discussed and compared. Public cloud offers three types of cloud service: SaaS, PaaS and IaaS. Among these services, the cloud applications of SaaS are becoming more and more popular for people in dealing with their daily jobs, at the expense of on-premises applications. The other two services are not as widely used as SaaS. However, examples of successful practice have proved the benefits of cloud computing. Due to the fact that some well-known companies have succeeded in the strategy of cloud adoption, the fourth section looks at the global cloud market. According to evidence from the review, it can be seen that positive predictions for the future of the cloud market have been made by the professional analysts.

In order to gain further understanding of cloud computing, the fifth section highlights the inherent advantages and disadvantages of this innovation, as well as its benefits to business. Because of the low rate of cloud adoption in organisations today, the
sixth section discusses the barriers to adoption of cloud computing. These critical issues relate to economy, business models, security, technology, reliability, staff expertise and policy.
3. Framework for Evaluating Cloud Adoption

This chapter builds the research framework for assessing the feasibility of adoption of cloud computing in development of information systems, and mainly covers the following areas: the variables determining the rate of adoption, strategy situation analysis and personal cognition. The first part reviews the literature on diffusion of innovations with regard to the variables determining the rate of adoption. The second area points out four dimensions in relation to strategy situation analysis. In order to achieve the goal of the project, the 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 organisations.

![Framework for assessing cloud adoption](image)

Figure 3-1 Framework for assessing cloud adoption

3.1 Variables Determining the Rate of Adoption

As Rogers (1995: 216) noted in his theory of diffusion of innovations, “the diffusion of an innovation is an uncertainty-reduction process”. In order to explore the factors
in relation to diffusion of innovations, the theory discusses many key issues involved in the uncertainty-reduction process. It mainly covers the following crucial matters: the generation of an innovation, the formation of an innovation-decision, attributes of innovations and rates of adoption, diffusion network, innovativeness and categories of adopter, innovations in organisations and the promotional efforts of change agents. Although many important issues involves in the theory, this research chiefly focuses on the discussion about variables determining the rate of adoption.

According to Rogers (1995: 10), diffusion is defined as the process consisting of the innovation, communication channels, time and the social system, and the display of the process is a wave shaped S-curve divided into three phases. In the first diffusion phase, the rate of adoption grows slowly. To a certain extent, the adoption rate takes off in the second phase. With time passing by, the rise in the percentage of adoptions becomes more and more stable in the third phase. In the subsequent sections, this study will discuss the relative variable determining the rate of adoption.

3.1.1 Perceived attributes of innovations

As discussed in the previous chapter, it is obvious that cloud computing is an innovation of technology that has been gradually applied in IT industry and become an emerging technology. As Rogers (1995: 11) noted in his theory of diffusion of innovations, “an innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption”. Also, the innovation implies changes of product, process, position and paradigm (Tidd et al., 2005: 10). On the other hand, Rogers (1995: 207) indicates that the innovation has five perceived attributes which are viewed as the key to explaining the variance in the rate of adoption. These
perceived attributes of innovations are as follows:

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative advantage</td>
<td>The degree to which an innovation is perceived as being better than the idea it supersedes</td>
</tr>
<tr>
<td>Compatibility</td>
<td>The degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of potential adopters</td>
</tr>
<tr>
<td>Complexity</td>
<td>The degree to which an innovation is perceived as relatively difficult to understand and use</td>
</tr>
<tr>
<td>Trialability</td>
<td>The degree to which an innovation may be experimented with on a limited basis</td>
</tr>
<tr>
<td>Observability</td>
<td>The degree to which the results of an innovation are visible to others</td>
</tr>
</tbody>
</table>

Table 3-1 Perceived attributes of innovations (Source: Rogers, 1995)

Rogers offers a sound theoretical basis for evaluating the rate of cloud adoption. In general, the ways to measure the degree of these attributes often refer to the practical benefits of an innovation to individuals, organisations, the economy and the society. Therefore, in order to address this topic, the previous chapter has analysed the benefits and drawbacks of cloud computing through the medium of the relevant literature.

### 3.1.2 Type of innovation-decisions

According to Rogers (1995: 206), the type of innovation-decision has an impact on the rate of adoption. In general, the innovation-decision is made by an individual or an organisational decision-making unit. However, an individual-optional decision enables an innovation to be adopted more rapidly compared to other types. In other words, the number of people who are involved in the formulation of an innovation will influence the rate of adoption. Therefore, the following three types of innovation-decisions will be used to evaluate the rate of cloud adoption (Rogers, 1995: 372):
1. Optional:
   An individual decides to adopt or reject an innovation.

2. Collective:
   Most members of an organisation decide to adopt or reject an innovation.

3. Authority:
   A relevant individual who owns power, status or technical expertise in an organisation decides to adopt or reject an innovation.

3.1.3 Communication channels
An innovation-decision process takes the form of sequential stages, including (1) the acquisition of knowledge, (2) persuasion, (3) decision making, (4) implementation, (5) confirmation (Rogers, 1995: 162). The five stages above help to identify the roles of different communication channels, including (1) interpersonal or massive media and (2) local or cosmopolite sources. For example, massive media is more important than interpersonal at the knowledge stage. This is mainly because that massive media enables a large number of people to acquire information or knowledge more rapidly, leading to changes in weakly held attitudes. By contrast, at the persuasion stage, interpersonal can provide a two-way exchange of information and persuade someone to change a strongly held opinion. Further, local or cosmopolite sources also cause different effects at each stage. Take English as an example. As we know, the global language is English, and hence English materials are relatively more plentiful than others. For these reasons, Rogers (1995: 207) points out that communication channels are related to the rate of adoption.
3.1.4 Nature of the social system

A social system is a set of interrelated units that concentrate on addressing problems, in order to achieve a common goal (Rogers, 1995: 23). The units of the social system consist of individuals or organisations, and hence the norms of the system depend on the number of units. The more units involved in the system, the faster the rate of adoption. Furthermore, the degree of network interconnectedness also affects an innovation’s rate of adoption. Based on the theory, this study will try to discuss the appropriate way to diffuse cloud computing and who should be the opinion leaders. For example, should the government or leading firms be responsible for impetus to diffuse cloud computing?

3.1.5 Extent of change agents’ promotion efforts

The extent of change due to agents’ promotion efforts is the final variable determining the rate of adoption. Rogers (1995: 208) indicates that an increase in agents’ efforts will not always get greater payoff from a given amount of the activity unless the innovation is adopted by from 3% to 16% of opinion leaders and continues to spread at a certain rate. As discussed in the second chapter, Google, Microsoft, Oracle and Amazon are agents of change. Therefore, this project will try to assess their promotional efforts in Taiwan.

3.2 Strategy Situation Analysis

Before the move into an innovation, an appropriate information strategy and plan can help an organisation adapt to change (Davenport and Prusak, 1997: 47). Therefore, in the judicious and pragmatic consideration of an innovation it is relatively important for organisations to develop a strategy. In order to achieve strategic benefits, Daft
(1998: 289) states that managers can focus on the following types of changes: technology, product and service, strategy and structure, and people and culture. In addition, an assessment of the current status of an organisation in relation to the new strategy is quite helpful in planning a strategy. Based on these points above, this project focuses on evaluating the four dimensions of situation analysis with respect to the adoption of cloud computing. The key issues of these dimensions are explained and listed below:

3.2.1 **Internal organisational environment**

As Rogers (1995: 133) states that the innovation-development process starts with needs or problems, it can be seen that the first step of situation analysis is to identify the organisational needs. According to Goffin and Mitchell (2005: 3), the need for innovation and market change are usually driven 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 organisations to understand individual value chains (Laudon and Laudon, 2006: 92). This methodology aims to analyse a variety of primary activities and support activities, including business processes and structures in an organisation. After ascertaining needs, the next stage is to identify the different characteristics of the internal organisational environment which may affect the strategy of cloud adoption. The scope of the assessment includes strategy, structure, systems, style, staff, skills and superordinate goals (Chaffey and Wood, 2005: 294).

3.2.2 **Internal information systems environment**

The dimension of the internal information systems environment involves reviewing
the current sophistication of IS usage within a company (Chaffey and Wood, 2005: 296). Moreover, for organisations, the ability to reform the existing systems or build a new one is another issue. Generally speaking, there are two approaches to the transition: internal IT infrastructure and support, and outsourcing to managed services (Reese, 2009: 11). On the other hand, organisations must evaluate the spending and effort required for cloud adoption in advance. To address this problem, this study adopts the feature-oriented reuse method (FORM), which is based on the featured-oriented domain analysis (FODA) feasibility study, to evaluate the transition.

In detail, the method of FODA emphasizes the feature model which relates the results of domain analysis to requirements analysis (Kang et al., 1990: 21). The feature model is used to negotiate the capabilities of application with users or to evaluate the possibility of reusing software products. To integrate with the method of FORM, it focuses on using the feature model to develop reusable domain artefacts (Kang et al., 1998: 145). In order to identify the goal of reusability, FODA explores four factors that enable IT experts easily to develop generic and reusable components for many applications (Kang et al., 1990: 23). On the other hand, the factors listed below also represent the types of development decisions. Figure 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.

1. Capabilities:
   The capabilities of applications satisfy the end-user’s requirements.

2. Operating environments:
The operating environments mean the software or hardware environment in which applications are used and operated.

3. Domain technology:
The application domain technology means the specific knowledge (e.g. avionics domain know-how) 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.

![Diagram showing the relationship between Capabilities, Operating Environments, Domain Technology, and Implementation Techniques.]

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

### 3.2.3 External micro-environment

The external micro-environment reconsiders the current IS capabilities and external information needs (Chaffey and Wood, 2005: 306). This research adopts Porter’s five competitive forces model to assess the core competence of cloud computing and observe the impact of micro-environment on a company (Porter, 2004: 306; Chaffey and Wood, 2005). The five forces are as follows:

1. Threat of substitutes:
To evaluate whether cloud computing will be able to help individuals or organisations generate new products or services.

2. Bargaining power of customers:
   To evaluate whether use of cloud services has the potential to continue increasing in popularity

3. Power of suppliers:
   To evaluate how suppliers will be able to promote cloud computing more efficiently and persuade organisations to adopt it.

4. Threat of new entrants:
   To evaluate whether the barriers to cloud computing will become much lower and lead to an increasing number of potential entrants appearing.

5. Extent of rivalry between existing competitors:
   To evaluate whether the appearance of cloud computing will result in competitive changes to the IT market.

3.2.4 *External macro-environment*

The final dimension is the external macro-environment with regard to the social, legal, economic, political and technology development (Chaffey and Wood, 2005: 309). Similarly, Avison and Fitzgerald (2006: 32) also mentioned four points to evaluate whether a proposed system is feasible. First of all, a feasible system should be built legally. Secondly, the organisational and social acceptance of proposed systems is important. The third point is to discuss whether technology is available to develop a proposed system. Finally, the economic issue involves discussion of cost saving and marketing. This project will evaluate whether these aspects mentioned above will have a positive or negative impact on the evolution of cloud computing.
3.3 Summary

As mentioned in the earlier section, Figure 3-1 shows the three models in the research framework for evaluating cloud adoption. The first model of variables determining the rate of adoption is mainly based on the theory of diffusion of innovations. Through the criteria of the rate of adoption, it makes it easier for the researcher to identify the factors that have a great impact on cloud adoption. Moreover, the model of strategy situation analysis looks at the current situation in organisations from multiple points of view. Therefore, it is used to gather the considerations of the interviewees in reality, and to analyse compatibility of cloud computing. In terms of the model of personal cognition, the study will not focus on this because personal cognition could cover a wide range of issues. Therefore, for the purposes of this research, personal cognition refers to the considerations of the interviewees based on their work experiences and personal recognition of cloud computing.
4. Methodology

This chapter addresses the main considerations. The first section focuses on the research method and strategy used in the study. The second section explains the sampling approach employed in the study and how participants were selected. In the third section, the data collection details are presented, including method, instruments and procedure. The final section describes how the collected data was analysed.

4.1 Research method and strategy

For the purpose of the study, qualitative method, which is often referred to as an inductive approach, was employed to conduct the research. “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”, said Neuman (2006: 157). Through the interviews, this study will be able to understand the thoughts of the interviewees with respect to cloud computing, as well as the pros and cons of cloud computing. Furthermore, the researcher will understand the barriers to adoption of cloud computing.

“Qualitative researchers emphasize the social context for understanding the social world. They hold that the meaning of a social action or statement depends on the context in which it appears”, said Neuman (2006: 158). Therefore, through the interviews, the researcher can comprehend in depth the awareness and experiences of the interviewees in relation to cloud computing, and explore the factors which may
have a great impact on the adoption of cloud computing. This study recognises that, whilst the main focus is cloud computing, the personal experiences of the participants are also important. The research will make a detailed assessment of the feasibility of the adoption of cloud computing in the development of information systems by means of the observation and analysis of the interviews.

The researcher has previously worked in Taiwan’s IT industry, and this experience will be helpful to gaining further understanding of the thoughts of the interviewees. Furthermore, a major benefit of qualitative research is that, by means of in-depth interview, barriers are eliminated and extremely comprehensive data can be collected for the study.

4.2 Participants

This section explains the method used in the study and the criteria for selecting subjects. Furthermore, it supplies background details about the interviewees.

4.2.1 Snowball sampling

Snowball sampling is a form of convenience sampling which is adopted in this dissertation. Neuman (2006: 223) noted that the explanation of snowball sampling is that “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“. Similarly, referrals enabled the research to get a representative sample through an interconnected network of people or organisations (Bryman, 2004: 100). Due to the fact that cloud computing may have a great impact on the IT industry, snowball sampling in the study is mainly used to investigate IT professionals from different kinds of
Taiwanese organisations. In facilitation of the research, personal friendship plays an important role. With this approach to sampling, the researcher will make initial contacts with friends and ex-colleagues who are working in an IT department of organisations or IT firms, and then use the referrals to establish contacts with their colleagues. After that, the researcher will ask for their agreement to the interviews. In addition, participants in the study should have more than three years work experience in Taiwan’s IT industry. This is mainly because sophisticated IT experience is helpful for the evaluation of cloud adoption.

### 4.2.2 Sampling composition

To ensure some homogeneity of social background, all participants for this research were selected from the population of IT professionals employed by organisations in Taiwan. Of the twenty subjects with at least three years experience in the IT industry, nineteen completed all questions within the research: fourteen were male and five were female. Participants were drawn from ten different companies and work for either an IT firm or an IT department of an organisation and they focus on the provision of IT services for the different types of customer. For example, most of their companies engage in providing software services, such as accounting applications, human resource (HR) management systems and the design of websites. Moreover, the nineteen participants involved in this research have been further categorised by their job titles, for the reason that job functions may affect their considerations of the adoption of cloud computing in the development of information systems. Eight are classified as managers and eleven as engineers. The following two tables report details of the participants which helped the researcher analyse the collected data.
### Table 4-1 Details of the managers

<table>
<thead>
<tr>
<th>Code</th>
<th>Job Title</th>
<th>IT Seniority</th>
<th>IT Service Type</th>
<th>Responsibilities</th>
</tr>
</thead>
</table>
| M1   | Senior manager | 27 years     | Software        | • Managing the company  
                   |                |              |     • Developing business strategy                   |
| M2   | Middle manager | 19 years     | Software        | • Managing system development                        |
| M3   | Senior manager | 16 years     | Software        | • Managing projects  
                   |                |              |     • Managing system development                   |
| M4   | Middle manager | 11 years     | Transportation  | • Managing projects  
                   |                |              |     • Managing system development                   |
| M5   | Middle manager | 9 years      | Software        | • Managing projects  
                   |                |              |     • Managing system development                   |
| M6   | Middle manager | 9 years      | Software        | • Managing system development                        |
| M7   | Middle manager | 7 years      | Banking         | • Managing projects  
                   |                |              |     • Dealing with system design                    |
| M8   | Middle manager | 6 years      | IT Security     | • Managing projects  
                   |                |              |     • Managing system development                   |

### Table 4-2 Details of the engineers

<table>
<thead>
<tr>
<th>Code</th>
<th>Job Title</th>
<th>IT Seniority</th>
<th>IT Service Type</th>
<th>Responsibilities</th>
</tr>
</thead>
</table>
| E1   | Senior engineer | 20 years     | System integration | • Dealing with system design  
                   |                |              |     • Dealing with system integration               |
| E2   | Senior engineer | 10 years     | Transportation  | • Developing applications  
                   |                |              |     • Maintaining system                            |
| E3   | Senior engineer | 7 years      | Aerospace       | • Dealing with system design  
                   |                |              |     • Developing applications                       |
| E4   | Senior engineer | 6 years      | Telecommunication | • Dealing with system integration                   |
| E5   | Senior engineer | 6 years      | IT Security     | • Dealing with system design  
                   |                |              |     • Developing applications                       |
| E6   | Senior engineer | 6 years      | Banking         | • Dealing with system design  
                   |                |              |     • Developing applications                       |
| E7   | Senior engineer | 5 years      | Telecommunication | • Dealing with system design                   |
| E8   | Senior engineer | 5 years      | Aerospace       | • Dealing with system design  
                   |                |              |     • Developing applications                       |
| E9   | Engineer        | 5 years      | Software        | • Developing applications                           |
| E10  | Senior engineer | 4 years      | Software        | • Dealing with system design  
                   |                |              |     • Managing projects                            |
| E11  | Senior engineer | 4 years      | System integration | • Dealing with system integration              |
| E12  | Engineer        | 3 years      | Software        | • Developing applications                           |
4.3 Data Collection

The section describes data collection for the qualitative research. First of all, it will look at the data collection method, and then illustrate the instruments used and the process of data collection.

4.3.1 Data collection method

The interview is widely employed in qualitative research and is also the main source of data in this dissertation (Bryman, 2004: 319). Indeed, the study adopts the in-depth interview approach for collection of data. According to Taylor and Bogdan (1998), the definition of in-depth interview means “repeated face-face encounters between the researcher and informants directed toward understanding informants’ perspectives on their lives, experiences or situations as expressed in their own words”. Therefore, this data collection method enables the researcher to investigate the broader research questions and to understand the interviewees’ specific experiences in depth. In terms of the method for interviewing the participants, telephone interview is employed in this study. This is mainly because 95% of the interviewees could be reached conveniently by telephone (Neuman, 2006: 300). Moreover, Skype, which is a free internet telephone program, makes it easier for the researcher to interview the participants in faraway places and reduces the costs of the interviews.

4.3.2 Data collection instruments

The two main data collection instruments, used in the study for conducting the interviews, were the interview guide and digital recorder. The former was designed by means of the strategy situation analysis model and sent to the participants before
the interviews. The latter was used to record the content of the interviews and the interview recordings were used for this research only. Additionally, the purpose of the interview guide was to give the interviewees a conceptual framework with respect to the research topic, and to help the research systematically analyse collected data.

4.3.3 Data collection procedure

The data collection procedure of the study started with a few friends and ex-colleagues of the researcher. Then the interviewees introduced other participants to take part in the research. Among these subjects, some were managers, and others were engineers. For this reason, some interview questions varied according to the job of the interviewee. On the other hand, there was a problem in that the participants might not have a clear basic concept of cloud computing. In order to address this problem, a document written by Trend Micro Corporation was enclosed with the interview guide in the mail in order to support the subjects in their understanding of cloud computing. During the period of the interviews, the research also explained the meanings of the specific terms to the interviewees when necessary.

4.4 Data Analysis

For this dissertation, the framework built in the previous chapter is the basis for data analysis. In the process of data analysis, the study begins with coding qualitative data. According to Neuman (2006: 461), there are three stages of coding qualitative data, including open coding, axial coding and selective coding. In the first stage, the interview data is examined and condensed into categories based on the framework. In the second stage, this study will organise the reduced codes and link them, in the
light of analytic memos. In the final stage, the researcher will identify and select data from the processed codes and place them into categories of the framework in relation to variables determining the rate of adoption of innovations. After data analysis, in the subsequent chapter, the key factors influencing cloud adoption by organisations will be discussed.
5. Results 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. Further, the interview transcripts are cited to display the considerations of the interviewees in reality.

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. Extent of change agents’ efforts

5.1 Perceived Attributes of Cloud Computing

According to Rogers (1995: 206), the five perceived attributes are considered as independent variables and used to explain 49% to 87% of the variance in the rate of an innovation. Therefore, in order to evaluate the rate of cloud adoption, this section will use the perceived attributes to analyse the interview data.
5.1.1 Relative advantage

Relative advantage is taken as a significant indicator whether the benefits of the adoption of an innovation to individuals or organisations exceed those of the previous idea. Generally speaking, before potential adopters decide to adopt an innovation, they tend to analyse what specific type of the relative advantages is important to them (Rogers, 1995: 216). Therefore, it is essential for IT professionals to seek information about the relative advantages of the adoption of cloud computing. Through the interview data, analysis of the following perceived benefits and drawbacks are presented:

- The advantages:

  From the viewpoint of IS capabilities, it is plain to see the relative advantage of cloud computing. 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. Finally, higher performance and larger online storage capacity are also important reasons for using cloud-based applications.

  "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 provided by a third party. Moreover, take Google mail as an example; you save your mails on the Internet without downloading them to your disk, and then you can access the information anywhere via"
“You can access Gmail service anywhere. This enables the internet 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.” (E6)

- The disadvantages:

  By contrast, there are also some significant drawbacks of cloud computing. The first one is relative to bandwidth. Obviously, this drawback has a great impact on the speed of internet access. 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). Finally, document format compatibility is a problem influencing the usage of cloud-based applications.

  “The main disadvantage of cloud computing is relative to the convenience of the usage of Internet and bandwidth.” (E4)

  “There is no doubt that the performance and functionalities of on-premises are faster and more complete than off-premises applications. By contrast, as for Google docs, its support to the advanced functionalities may have some problems. Furthermore, the main important point for documents is compatibility. Also, the rate of cloud adoption depends on the popularity of
the Internet. In fact, not all computer users can be always online. Once we could not connect to the Internet; more than half of the computer capabilities were unavailable. As far as I know, few of my colleagues still connect to the Internet via the method of dial connect.” (M4)

“As for security, it depends on the type of users. For most users, they may worry about the privacy of personal information and the confidentiality of business due to negative news reports. 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.” (M3)

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 to which cloud computing is perceived as consistent with the current situation in organisations is exhibited from four different aspects:

- Internal IS environment:

  The internal IS environment relates to reviewing the current sophistication of IS usage within a company. In order to evaluate the feasibility of cloud adoption, this study focuses on the following two points. First of all, through the interviews, it is apparent that the definitions of cloud computing that the various IT professionals gave are quite different.
“Cloud computing is that the remote servers provide computing power and practical services. Further service providers may charge users.” (M5)

“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.” (E11)

“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.” (E10)

“Cloud computing is like a regular service located somewhere and users can access its resources of computing power through the Internet.” (E2)

Secondly, based on the experiences of the interviewees, this research focuses on the prediction of the efforts to transform the 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. In this research, the interviewees were questioned about potential efforts involved in transition from the four aspects. From an overall perspective, data analysis suggests that the adoption of cloud computing will have a great impact on the development of information systems: in particular, in terms of implementation techniques. Moreover, the interviewees think that well designed development
toolkits can ease the maintenance and development of information systems.

“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.” (M2)

“I think that the effect of cloud computing on coding is more serious than others. When techniques are changed, you need better development toolkits to support the transition. If the development toolkits did not provide adequate capabilities, engineers would have to spend more time on the development process.” (E3)

“Sophisticated toolkits would make it easier for software companies to develop and maintain systems.” (M1)

- Internal organisational environment:

  Internal organisational environment mainly focuses on business level assessment (Chaffey and Wood, 2005: 294). From the results of the interviews, it could be seen that cloud computing has received attention from organisations: in particular IT companies 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 and this
may be the direction of our products. We have started to make strategy for SaaS, but we have not found an appropriate practical opportunity for the implementation of cloud computing.” (M1)

“In our company, we have already adopted google mail and google docs to manage mail and share documents with others.” (M5)

On the other hand, the interviewees think 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 governance of IS systems is also important. To compare with our current systems: these can be controlled and managed by ourselves. On the other hand, the financial system usually needs a round-the-clock environment. Therefore, it is a crucial issue whether cloud vendors can assure the quality of their services.” (M2)

“In the banking industry, broadly speaking, I think that it is possible to adopt webmail services and online document applications. As for the internal financial systems and the development techniques, 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.” (M7)
External micro-environment

In terms of the external micro-environment, it is necessary to review IS capacity and information needs. According to the results of the survey, most interviewees have experiences of using cloud services and they think that the future trend is towards cloud computing, especially for individuals. Moreover, the widespread use of mobile devices contributes to the evolution of cloud computing. Obviously, cloud services have already brought significant changes to our lives: and will continue to do so in the future.

“Cloud computing will be a trend in the IT industry because users can enjoy powerful processing ability and unlimited storage without building their own systems and investing in hardware devices.” (E1)

“I feel that cloud computing will become a trend in the global IT market. This is inevitable, particularly in multimedia applications used around our lives. This is because these services need a large capacity of storage and computing power.” (M1)

“For individuals, cloud computing will be a trend. In my opinion, the concept of Google everywhere can be expressed as the future trend. Today, not only can computers connect to the Internet, but it is also possible to use mobile phones to access cloud services. In fact, the usage of mobile phones is higher than that of computers. Because of the wide usage of mobile phones, these services will become a commodity in our lives.” (M4)
Moreover, some interviewees are also concerned about over dependency caused by interoperability. Take JAVA programming language as an example. Because of its interoperability, Java-based systems can be run on the different operating systems. Therefore, standardisation is essential.

“I hope that cloud computing can develop standardisation and avoid over depending on a specific provider. This would enable us to switch systems from ‘A’ platform to ‘B’ platform.” (M6)

- External macro-environment

In order to explore the possible factors which may influence the future evolution of cloud computing, it is necessary to evaluate the external macro-environment, such as social, legal, economic, political and technology development (Chaffey and Wood, 2005: 309). The data analysis suggests that maturity of technology is the key factor because most interviewees are much concerned about whether systems are stable. Moreover, they also think that other factors may affect the development of cloud computing at certain levels. The growth of the IT market, the support of the government or the leaders in IT industry, and legal constraints are examples.

“The success of iPhone is mainly because of the adoption of cloud services. Through the interface of iPhone, users can easily connect to the Internet and enjoy cloud services. Also, this has changed the traditional way of using applications to acquire information. As a consequence, I think that cloud computing would be able to increase the growth of the IT market, in
particular the profitability of the mobile market should be higher than that of the traditional computer market.” (E8)

“Personally, I think that the mobile market will grow rapidly in the near future. In time, everyone will own a smart phone and use it to access cloud services and to deal with daily jobs, instead of using computers. When it happens, this means that the age of cloud computing is coming.” (M8)

5.1.3 Complexity
Complexity is relative to the degree to which cloud computing is difficult to use, recognise and realise. According to Rogers (1995: 242), complexity of an innovation is not positively related to the rate of adoption. Although complexity is not a decisive factor, data analysis still suggests the potential effort required to adapt to cloud computing. According to the results of the interviews, most of the engineers 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 realise the relevant techniques and applications. In some developers’ opinion, better toolkits would enable them to learn cloud-computing techniques more easily.

“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.” (E5)

“In my opinion, when the existing systems shift to cloud-based infrastructure, system architects and system engineers will deal with the infrastructure side of
things. For example, the Microsoft .NET Framework offers a parallel computing platform in terms of ease-of-use and scalability. This will contribute to software developers being able to develop applications much more easily and to fulfil user requirements.” (E8)

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. By contrast, only one company in the survey has formally started to adopt cloud services as its internal IS system. However, it is interesting that some cloud services, such as google docs, have been informally used in organisations.

“At present, applications of SaaS are rarely used in the company whereas these are used by individuals.” (E9)

“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.” (E6)

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 organisations, 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 help reduce complexity of the development in information systems. However, at present, cloud computing has not been applied in the development of financial systems. I just cannot exactly forecast if it is helpful to the current systems.” (M2)

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 organisations. Therefore, this section identifies what types of innovation-decisions the companies of the interviewees need to make. According to the interview data, it is apparent that the most common type is contingent innovation-decision. Because of the project-oriented or customer-oriented strategy, innovations of these companies mainly result from customer requests. Hence, there are two phases in their innovation-decisions processes. The first phase is usually authority innovation-decision. In order to find an adequate IT solution, managers will ask members of a project team or an organisation to seek information. The next phase is collective innovation-decision. Managers and engineers will discuss the feasibility of explored solutions, and then they decide to adopt an innovation. Therefore, it can be seen that contingent innovation-decisions are choices made only after the prior innovation-decision (Rogers, 1995: 372).
“Basically, when an innovation may be helpful to our products, our managers usually start to evaluate its feasibility, and then we assign some engineers to experiment the new technology in depth. After that, we will have a meeting to discuss the results of the experiment. Finally, we will decide to adopt or reject the innovation. However, sometimes, customers may have an innovation request for a project. In this situation, we have to do it.” (M3)

“Generally speaking, the adoption of an innovation results from the customer requirements and the promotion of information technology service providers. As for the innovation-decision, it is usually made by the boss. Then, he will ask us to seek information and evaluate the advantages and disadvantages of the innovation. After that, we will report the results of the survey. Finally, the boss will make a decision.” (M6)

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.” (M5)

“I had learned a little bit of the relevant information from the external training institute. In fact, I think that there is a lack of in-depth training courses associated with cloud computing in Taiwan. Most people acquire the relevant information from websites and communities online.” (E8)

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 companies should have a consensus of collaboration for cloud computing.

“I think that the development of cloud computing should have a relationship with the government. In fact, as a whole, everyone should share know-how to build up the development of 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 and people in the different industries. 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.” (M8)

5.5 Change Agents’ Promotion Efforts

According to Rogers (1995: 208), the variability of change agents’ promotion efforts also affects the rate of adoption. In the theory, the broad definition of a change agent means teachers, development workers, consultants and salespeople. In this study, the change agent is defined as information technology service providers, such as IBM and Microsoft. Moreover, in order to evaluate change agents’ promotion efforts, the sequence of change agent roles will help this study identify the current role of change agents in the process of introducing cloud computing. The seven roles are as follows: 1) To develop a need for change, 2) to establish an information-exchange relationship, 3) to diagnose problems, 4) to create an intent in the client to change, 5) to translate an intent to action, 6) to stabilize adoption and prevent discontinuance, 7) to achieve a terminal relationship. From the results of the survey, data analysis suggests that the current roles of Taiwan’s change agents are to develop a need for change or to establish an information exchange relationship.

“I mainly gain information about cloud computing from the Internet, such as news and blogs. Moreover, Taiwan’s Sun Microsystems also sent promotion documents to me.” (M3)
“Service vendors had been to our company to introduce the concept of cloud computing and promote its relative products.” (M7)

“Sun Microsystems had a seminar that enabled more people to recognise and realise the benefits of cloud computing. This campaign contributed to people having a basic concept of cloud computing. Moreover, if there were examples of successful practice in place, it would help to persuade customers to adopt cloud computing.” (E6)
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 organisations 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 (data analysis - 5.1.1). As discussed in the earlier chapter of the literature review (Vaquero et al., 2009), all of the following features are included: remote services, located anywhere, a massive group of interconnected computers, enjoying the resources of storage and computing power and the usage of the Internet. 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 (data analysis – 5.1.4). However, data analysis suggests that only a few of the interviewees are aware of the differences between SaaS, PaaS and IaaS (data analysis - 5.1.4). 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 (data analysis - 5.4). 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 organisational managers would be concerned about staff expertise if they decided to adopt cloud computing (data analysis – 5.1.2). 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 Lack of Innovative Business Models for Enterprises

From the results of the survey, most interviewees think that cloud computing will become a future trend in the development of information systems and its market will grow in the next few years (data analysis – 5.1.2). To compare with the literature study of the prospects of a global cloud market, the interview results support the prediction that cloud computing will be the next-generation application architecture
(Ferguson, 2008; "Gartner Says Cloud Application Infrastructure Technologies Need Seven Years to Mature", 2009). According to Rogers (1995: 224), an innovation which is incompatible with cultural values will have a low rate of adoption. Hence, this means that raising common consciousness could help increase the rate of cloud adoption.

Moreover, the interview data show that some Taiwanese organisations have focused attention on cloud computing (data analysis - 5.1.2). This is in keeping with Weinhardt’s (2009) finding that more organisations are beginning to seek information about the benefits and drawbacks of cloud computing. However, the data analysis raises the important issue that there are no innovative business models and practices for enterprises to follow (data analysis – 5.1.5). Similarly, Tsai (2009) noted that a lack of innovative business models can block the adoption of cloud computing. Additionally, Leavitt (2009) also states that best practices can reduce uncertainty and fear in potential adopters: which explains why most companies are taking a wait-and-see attitude. As a result, this study finds that a lack of innovative business models for enterprises is an important factor in decreasing the feasibility of cloud adoption.

6.3 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 have been fully endorsed (data analysis 5.1.1). 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 (data analysis 5.1.1), 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 toolkits (data analysis – 5.1.2). 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 organisations because standardisation 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.

6.4 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 Taiwanese government 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 (data analysis - 5.4). Recently, Taiwan’s public sector has collaborated with Microsoft on the Networked Communications Program (NTP) (Tseng, 2009). Such schemes illustrate that it is vital that the necessary incentives are put in place to speed up the rate of cloud adoption by organisations (Rogers, 1995: 219).
7. Conclusions and Recommendations

The purpose of this chapter is to draw conclusions from the research. Moreover, the research limitations are mentioned in the second section. Finally, the research will make some suggestions for further study.

7.1 Research Conclusions

With the rapid growth of the demand for use of the Internet, it becomes more and more common for people to access the online resources via computers or mobile devices. Concurrently, this phenomenon reveals drawbacks of the current information systems, such as lack of data portability, limitations of on-premises software and insufficiency of computing power. In order to address these problems, the concept of computing in the cloud is now being offered. Moreover, the emerging computing infrastructure, based on the existing technology, has been implemented and applied in some international companies. Although most internet users have experience of cloud activities, the unclear and incomplete definition of cloud computing restricts their understanding of its effects on information systems.

From the mass media, it is apparent that some IT service providers in Taiwan are actively promoting cloud computing today. They make efforts to introduce the advantages of this innovation; whereas, the interview data reflects that most IT professionals are not aware of its benefits to businesses and organisations. This is mainly because the relative advantages of cloud have become apparent to computing IT professionals from their experiences in using the free cloud services: not from formal training courses or advanced materials associated with cloud computing.
On the other hand, from the business point of view, the vendors’ efforts in terms of individual users are plainly visible. By contrast, for organisations, it is apparent that there are certain barriers to adoption of cloud computing in the development of information systems. As a consequence, service vendors should pay more attention to development of innovative business models. Equally importantly, maturity of the technology, higher quality of cloud services and well established practices could help raise the rate of the adoption of cloud computing in the development of information systems.

From an overall perspective, the development of cloud computing is expectable and achievable. The external environment suggests that many renowned companies, such as Microsoft, Google and Sun Microsystems, are struggling to overcome difficulties in the diffusion of cloud computing. Additionally, the prediction of global cloud markets suggests an upward trend in off-premises applications and an increasing profitability of cloud markets. Furthermore, the collaboration between the IT service vendor provider and Taiwan’s government is enhancing confidence in cloud adoption as well as reducing the uncertainty surrounding cloud computing.

In conclusion, IT service providers should make efforts to offer innovative business models for enterprises and adequate solutions to compatibility problems. Moreover, enhancement of personal recognition and understanding of cloud computing will enable IT professionals to make in-depth evaluation of compatibility between the current IS infrastructure and cloud computing, and to consider how organisations can benefit from the adoption of cloud computing. Furthermore, government support or industrial collaboration can also encourage organisations to adopt cloud computing.
7.2 Research Limitations

Due to the fact that cloud computing is a developing concept and is not widely applied in Taiwan’s companies, it is difficult to identify a company that has adopted cloud computing in the development of information systems for the purpose of specific research. Another research constraint is that most IT professionals in Taiwan have not enough experience in the implementation of cloud computing. This leads to the inability of the research to focus on the advanced issues. Furthermore, a lack of complete and in-depth literature and studies limited the range of the research. Because of these limitations, this study focuses on evaluating the degree to which cloud computing has been diffused.

On the other hand, the changes brought about by cloud computing influence various kinds of business activity, such as manufacturing, banking and telecommunications. As the research was conducted by means of qualitative methodology, its range was limited to a small group. It would be quite difficult to cover all kinds of organisations. Also, the findings of the survey could not represent the opinions of all IT professionals in Taiwan.

7.3 Suggestions for further study

With the development of cloud computing, the research constraints may become different. Therefore, the following suggestions for further study are expressed below.

First of all, investigation of the feasibility of the adoption of cloud computing could focus on the policy and strategy of IT service providers. An in-depth comparison of
their strategies and policies could identify the factors which influence their customers in the adoption of cloud computing.

Secondly, it would be possible to evaluate whether cloud computing is feasible, from the viewpoint of the end-user. The researcher could select specific cloud-based applications to investigate the extent to which cloud computing affects the internet users’ day-to-day behaviours in using on-premises and off-premises applications.

Thirdly, if the rate of cloud adoption increased to a certain level, the researcher could concentrate on a specific company and investigate strategies and benefits relevant to its adoption of cloud computing; and the feasibility of cloud adoption could also be evaluated through advanced research.

**Word Count: 16,510**
Bibliography


Jun 2009]

http://www.sei.cmu.edu/programs/pls/sw-product-lines_05_03.pdf [Accessed 03 May 2009]

*Cloud Computing* [Online]. Sun Microsystems.  


Horrigan, J.B. (2008). “Cloud computing” takes hold as 69% of all internet users have either stored data online or used a web-based software application. Report No.


http://news.zdnet.co.uk/software/0,1000000121,39667244,00.htm [Accessed 27 Jun 2009]


Murugesan, S. *Cloud Computing: IT's Day in the Sun?* [Online].  


"On-premises software" [Online]. Wikipedia.  


Appendix: Interview Questions

Interview Guide

Cloud computing is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet. Users need not have knowledge of, expertise in, or control over the technology infrastructure in the "cloud" that supports them. (Source: Wikipedia - Cloud computing, 2009)

I. Personal cognition

1. Do you know about cloud computing or cloud services? If yes, please briefly give your definition of them and interpret the sources of the relative information.

   - SaaS: Software as a Service
   - PaaS: Platform as a Service
   - IaaS: Infrastructure as a Service

2. The cloud service is the implementation of cloud computing. As an end-user, have you ever used the following cloud activities? If yes, please indicate the advantages and disadvantages.

   - Use webmail services (i.e. Google mail, Yahoo mail and Hotmail)
   - Use online applications (i.e. Google document)
   - Store personal photos or videos online (i.e. Youtube, Flickr)
   - Use online storage service (i.e. MSN SkyDrive)

II. Internal IS environment (for engineers)

1. Do you know about the following concepts related to cloud computing? Please try to describe whether cloud-computing techniques are complex to understand, from the viewpoint of the developer.

   - Pervasive Computing
   - Network Computing
   - Utility Computing
   - Grid Computing
   - Service-Oriented Architecture (SOA)
2. What type of services might your company adopt firstly?

- SaaS (i.e. Google Docs and Google mail)
- PaaS (i.e. Google Apps Engine and Salesforce CRM system)
- IaaS: (i.e. Amazon EC2)
- Private cloud

3. If your company adopted cloud computing in the development of information systems, would there be any benefits to the operation of the company?

4. If the company transformed the existing systems to cloud-based systems, to what extent will you be involved in the transition?

- Capability feature
- Operating environment
- Domain technology
- Implementation technique

5. What internal factors does the company need to consider if they adopt cloud computing?

III. Internal organisational environment (for managers)

1. According to past experiences, how do your company usually make strategy in the face of an innovation? What attitude does the company adopt towards innovation?

2. How does your company usually evaluate the benefits resulting from adoption of an innovation?

3. According to the current status of your organisation, is it possible to adopt cloud computing? If yes, please try to interpret what benefits your company will expect.

4. What type of services might your company adopt firstly?

- SaaS (i.e. Google Docs and Google mail)
- PaaS (i.e. Google Apps Engine and Salesforce CRM system)
- IaaS: (i.e. Amazon EC2)
- Private cloud
5. What internal factors does the company need to consider if they decide to adopt cloud computing?

**IV. External micro-environment**

1. Please try to analyse the future trend on the demand for cloud computing or cloud services, from the viewpoint of end-users?
2. How do information technology service providers promote cloud computing and assist the companies in the adoption of this innovation?
3. From the viewpoint of information systems development, what opportunities does cloud computing present to IT business?
4. To what extent may cloud computing affect competition in the marketplace of the IT industry?
5. Does cloud computing increase or decrease barriers to entry to a market sector?

**V. External macro-environment**

1. What factors may have a positive or negative impact on the evolution of cloud computing?
   - Economic
   - Legal constraints
   - Political
   - Technological

2. If cloud computing offers great benefits to the IT industry, do you think that external training institutes or the Government have the responsibility to promote it? Or should it be done by the leading companies in the IT industry?