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影響 IaaS 之採用因素－以「政府雲」為例

Factors Affecting the Adoption of IaaS – An Example of G-Cloud in Taiwan

研究生：黃建豪 撰

Chien-Hao Huang

指導教授：黃明蕙 博士

Advisor: Ming-Hui Huang, Ph.D.

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摘要

論文題目：影響 IaaS 之採用因素－以「政府雲」為例

校所組別：國立台灣大學資訊管理學系

研究生：黃建豪（Chien-Hao Huang）

指導教授：黃明蕙 博士（Dr. Ming-Hui Huang）

論文摘要：

本研究首先簡要地說明雲端運算的概念，以及目前雲端運算發展之概況，透過現況的描述帶出所要探討的研究問題，接著闡述何謂 IaaS 與 IaaS 的優、缺點，在經過資訊科技採用、採用因素等相關文獻探討之後，確立了以科技、組織、環境三大構面為基礎的研究架構。

本研究主要為探討科技面的「認知效率提升」與「認知成本節省」、組織面的「對現有 IT 基礎建設的滿意度」與「組織 IT 知識能力」以及環境面的「委外信任度」與「廠商促銷」等因素對組織採用 IaaS 決策之影響，依變數則是採用 IaaS 的意願程度。

透過問卷調查法，本研究以台灣的政府機關正積極規劃建置的「政府雲」（Government Cloud, G-Cloud）做為研究目標，針對政府機關的資訊部門主管進行實證資料的蒐集。研究結果顯示，在研究架構中，科技、組織、環境三大構面，各有一項因素，亦即「認知效率提升」、「組織 IT 知識能力」、「廠商促銷」，對於組織 IT 決策者採用 IaaS 的意願程度，在統計上呈現顯著的影響。

根據研究結果，我們建議 IaaS 服務供應商應加強對公部門潛在客戶的宣傳及教育，在規劃建議時，可強調 IaaS 所能夠在效率提升、改善機關服務品質上所帶來的好處及各項其他勝過傳統硬體基礎建設的優勢。在市場的開拓上，若能從 IT 知識能力較高的機關著手，也會較為容易。此外亦能加強在行銷、促銷活動上的努力，以增加公部門客戶採用 IaaS 的意願。我們也建議未來的研究者，可研究有哪些原因造成了目前公務機關資訊部門主管對於 IaaS 仍裹足不前；另外，也可將更多促成因素（enabling factors）或阻礙因素（hindering factors）以及政府部門獨有之相關組織特色納入研究架構中，或是將研究對象設定為對 IaaS 已有充分認識的資訊部門主管，以獲得對 IaaS 採用影響因素的更全面且更為正確之認識。

關鍵字：雲端運算、基礎架構即服務、政府雲、資訊科技採用

Abstract

In the beginning of this thesis, we introduce the basic concept of cloud computing. Then we talk about the main topic of this research, “Infrastructure as a Service”. We mention its background information, its benefits, and its drawbacks. After carefully examining the literatures, we form the research framework based on TOE framework, which has three major dimensions: Technological, Organizational, and Environmental.

The variables in our research framework are “Perceived Efficiency Improvement” and “Perceived Cost Reduction” in Technological dimension, “Satisfaction with Existing IT Infrastructure” and “IT Knowledge” in Organizational Dimension, and “Agency Trust” and “Vendors' Promotion” in Environmental Dimension. The dependent variable of this research is “Intention to Adopt.”

We use questionnaires to investigate. The subjects are the IT managers who come from the government agency in Taiwan. The research results show that “Perceived Efficiency Improvement,” “IT Knowledge,” and “Vendors' Promotion” have significant impact on the “Intention to Adopt” IaaS.

According to the research results, we suggest that the IaaS service providers should put a high premium on the education of their customers, put more time and effort into promotion activities to improve customers’ willingness to adopt IaaS. Moreover, it is easier to begin with one of the government agencies that have a perceived higher IT knowledge capability.

For future researchers, they can incorporate other enabling factors or hindering factors into their research framework and incorporate more government-specific characteristics into their framework to fit in more with the research context. They also can conduct research on experienced users of IaaS since there may be some inexperienced users being our respondents.

Keywords: Cloud Computing, Infrastructure as a Service, Government Cloud, Information Technology Adoption

1. Introduction

1.1 Research Motivation

Government Cloud, or G-Cloud for short, as implied by the name, is the cloud computing framework implemented by the government agency. Several countries, for instance, the United Kingdom, America, Canada, Singapore, and Japan, have their own G-Cloud projects in progress in the last few years. With G-Cloud, government agencies can reduce the need to build out and manage data centers, reduce IT-related costs, adjust cloud-based resources up and down to meet real-time needs to improve operational efficiencies, improve collaboration by providing employees located anywhere with the application and the data stored in the cloud (Microsoft Corporation, 2010).

Cloud computing refers to the on-demand access to virtualized and scalable IT resources, which can be shared by numerous users, paid for via subscription, accessed over the Internet (or network) anytime and anywhere, and rapidly provisioned and released with minimal management effort or service provider interaction (Mell & Grance, 2009). Retracing the history of PC development, we know that there exists a logical flow from mainframes to PCs to cloud computing, with enhanced user experience, lower costs and smaller equipment (Sourya, 2011).

In “From Mainframe to Cloud: 30 Years of Technology Waves,” we also learn that “the cloud didn’t magically appear after all. And it’s certainly more than a passing fad. It’s the cumulative result of all our past computing experience and it will continue to evolve and mature into the future.” Therefore, cloud computing can be viewed as a new style of computing which evolves from mainframe computer era, pc era, and network era. According to Furht and Escalante (2010), cloud computing has become a significant technology trend, and many experts expect that it will reshape information technology processes and the IT marketplace. The independent research firm Ovum also says in its report that cloud computing has already established itself as the next disruptive technology in the enterprise (Barrett, 2010). In “Executive’s Guide to Cloud Computing (Marks & Lozano, 2010),” cloud computing is said to be a potential innovation that provide the enterprises

and the IT suppliers with a great deal of benefits and have some advantages over the traditional IT solutions. As a whole, we believe that it may present government agency and other corporations with a fundamentally different model of IT operation.

Thanks to the dramatic decline of the cost of computing, networking and storage equipment and the rapid evolvement of other specific underlying technology of cloud computing in recent years, such as virtualization, web service, service oriented architecture and the convenient automated self-serve cloud provisioning technology (Furht & Escalante, 2010), users can take advantage of IT resources just like using electricity or water power. The consumption of IT resources is usually billed on a utility or subscription basis. IT users pay for services and capacity only for what have been used. No capital expenditure is required. (Furht & Escalante, 2010). Furthermore, users can request additional resources on demand and just as easily release those resources when they are no longer needed, that is, IT resources can be easily scaled up or down as needed. As to the service providers, they can leverage the economies of scale by spreading the fixed costs over many customers. IT resources can be shared among a huge amount of users and thus increase utilization rate. Generally speaking, cloud computing can bring benefit to users and providers in many ways, for example, lowering total ownership cost (TCO) (Furht & Escalante, 2010), improving management efficiency, increasing resource utilization rate, having the ability to manage demand peaks, improving financial planning and so forth. It is clear that from our reasoning there should be abundant business opportunities in the industrial value chain above the cloud.

Nevertheless, cloud computing is not without any drawbacks and shortcomings. It is still in its infancy and many aspects of its technology are under development and improvement. As a result, IT users of cloud computing have to afford the risk of some possible technical failure. On the other hand, placing all the data somewhere in the cloud and delegating some or all of the IT-related operation to the cloud service providers is essentially risky because data and machines are not under users' own control. Also, IaaS service providers have to cope with the compelled data disclosure to the government and are subject to certain privacy and data security laws and regulations in many countries (Hogan Lovells, 2010) and thus increase the risk of data leakage. Moreover, even the

famous IaaS service provider Amazon's Web Service (AWS), which "guarantees 99.95% availability of the service" on its webpage, encountered a four-day service shortage in April 21, 2011. This service shortage slowed or shut down a significant number of prominent Internet businesses and renewed doubts about the viability of cloud computing among skeptics (Claburn, 2011). Moreover, service providers may fail to meet the service level agreement in certain circumstances because of some technical problems or natural disasters. Thus, data security, privacy and confidentiality, and service availability become critical issues.

Basically, cloud computing includes Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) (Hurwitz, Bloor, Kaufman, & Halper, 2009). These three terms are used to describe the current ways cloud computing serves its customers. IaaS includes hardware, storage, and networking components, which enables an organization to outsource the equipment used to support its operations. The IaaS customer rents computing resources instead of buying and installing them in their own data center (Hurwitz, Bloor, Kaufman, & Halper, 2009). PaaS offers computing platforms and solution stack (a set of software subsystems) as a service, without the need of buying or managing the underlying hardware and software layer. Its services include programming languages and tools and an application delivery platform hosted by the service provider to support development and delivery of end-user applications (Furht & Escalante, 2010). SaaS enables users to access software such as operating systems and other applications without necessarily downloading or installing them on their systems (Langdon, 2009).

Knowing all the benefits that cloud computing can bring, the government agency of Taiwan in 2010 announced to take advantage of the most fashionable and cutting-edge cloud computing technology and will invest heavily on it for long-term benefits in the near future, hoping it can help provide the best public services to the citizens and to make better use of each penny derived from the tax revenue during the economic downturn in recent years. However, it is still an early evaluation stage of government's cloud technology adoption. Few people are certain of the feasibility of implementing cloud computing technology to establish a whole new information infrastructure for the government agency. There are many enablers and disablers affecting the

adoption of cloud computing in the government agency. The government has to overcome a lot of difficulties and prepare for the adoption before successfully making good use of this technology.

As one of the three building blocks of cloud computing, IaaS, Infrastructure as a Service, is the basis of its two brothers, PaaS and SaaS, and in combination form the G-Cloud. Only when the government agency has its own IaaS infrastructure can it build a platform or some software services onto it. Subsequently, in the very first beginning, it can be inferred that the government agency is bound to pay more attention to the IaaS services no matter whether it wishes to build a cloud computing environment in-house or rent services from outside service providers.

On account of the background information mentioned above, it intrigues us to figure out the answers for the following question: “What are the important factors affecting the adoption of IaaS in the government agency?” Moreover, even though cloud computing can be expected to be more and more important both in academia and industry, there is still few research conducted from a business perspective up to now. Most of them are bound up with pure technology. We think this topic is interesting and worthy of researching. We hope that we can devote our effort to the academia and complement this field of research and that this thesis can encourage any other future researches.

1.2 Research Objective

Based on the research background and motivation stated above, the objectives of this research, as the title of the thesis suggests, are as follows:

1. To find out the factors that may affect the adoption of cloud computing technology—especially the IaaS part—in government agency, and to understand what issues the policy implementers really concern, informing service providers to improve their products and services so as to increase the adoption rate.
2. To contribute to the academia and serve as a reference document for future researchers who are interested in the relevant topic and thus improve the understanding of cloud computing issues.

2. Literature Review

As the originally technical term “cloud computing” becomes more and more popular in all kinds of media, we have all been hearing about it for the past two or three years. Almost every product or service can be named after “cloud” as long as it has something to do with “network” or “Internet service.”

Some well-known experts, for example, Nicholas Carr (2008), the author of “The Big Switch,” predicted that all computing would eventually evolve into a small quantity of extremely large public clouds. Greg Papadopolous, then Chief Technology Officer of Sun Microsystems, also stated “the technology infrastructure industry will be similar to the energy industry” at Structure 08 conference (Farber, 2008). Some market observers and commentators even have an idea that cloud computing presents a significant technology trend, and is reshaping information technology processes and the IT marketplace. They all somewhat highlighted the potential impact of cloud computing on IT and pointed that the emergence of cloud would represent the next evolution of computing. Meanwhile, governments around the world are also actively looking into cloud computing as a means of increasing efficiency and reducing cost (Jackson, 2009).

Based on the above information, we know that cloud computing has become very popular and received widespread public attention. However, when it comes to cloud computing, everyone’s definitions vary. Some may be correct and some may just describe part of it. As a result, in this chapter we try to clarify and briefly give these terms more precise definitions to avoid ambiguity. To begin with, we specifically make a detailed description of “IaaS,” its definition, merits, and its drawbacks to build a clearer understanding of the concept of IaaS. Besides, in order to build our research framework and link our findings to the existing body of knowledge, we present a review of the literature related to the adoption of information technology and the factors affecting the adoption process to establish the relationships between each variable. Finally, the conceptual variable definition, the research hypotheses, and the full research framework will be presented.

2.1 Infrastructure as a Service (IaaS)

2.1.1 Definition of IaaS

Basically, IaaS refers to the delivery of computer infrastructure through Internet or network. IaaS service providers focus only on hardware provision and charge users on a pay-per-use basis instead of asking for a fixed amount of monthly fee. They also provide the capability for pooled resources to be made available and accessible to anyone, thus increase the equipment utilization rate. With IaaS, the time required to obtain and boot a new server can be reduced to minutes. Users can expand or contract resource allocation quickly and easily as their computing requirements change (Jabber, 2009). Just like Amazon Chief Executive Jeff Bezos told shareholders in 2008: “It doesn’t really make sense for most companies to have their own data centers, just as it doesn’t make sense for most companies to produce their own electric power” (James, 2008), users don’t have to build their own information infrastructure from the scratch anymore.

To give another concise, easy-to-understand definition, IaaS is a provision model in which an organization outsources the IT equipment used to support operations, including storage, servers and networking components. It contains all of the physical and virtual resources used to construct the cloud. Hurwitz et al. (2009) gave IaaS a more precise but perhaps still not so perfect and complete definition in their book. They described IaaS as the delivery of computer hardware, including servers, networking technology, storage, and data center space, as a service. They also mentioned that IaaS may include the delivery of operating systems and virtualization technology to manage the resources.

2.1.2 Benefits of IaaS

IaaS has a lot of advantages. Just to name a few here.

First of all, the complicated details of the operation are hidden to the customers and the hardware resources are packed as a form of service rather than viewed as independent machines. Therefore, the customers can make use of IaaS service with minimum knowledge of the technical

details behind, and they don't have to worry about some operation and maintenance problems. Moreover, because IaaS service providers can take charge of almost everything, customers can relieve the burden on IT professionals. IT staff no longer has to worry about server updates and other computing issues. They can focus on duties that matter, rather than being maintenance staff (Velte, Velte, & Elsenpeter, 2009). In short, abstracting the hardware resources in the cloud with virtualization simplify some previously hard-to-understand technical details and customers can shift the maintenance workload and the risk of operation to the service providers.

Secondly, according to Marks and Lozano (2010), cloud computing offers a way to reduce IT infrastructure costs through a combination of capital expense avoidance, better utilization of virtualized commodity computing capacity, and reduced operational costs by requiring fewer internal IT resources to focus on commodity infrastructure needs.

Thirdly, IaaS services can be easily scaled down or scaled up according to the customers' requirement. This feature offers customers a great deal of flexibility allowing them to adjust their usage in peak time when processing loads are greatest. If users no longer need the IT resources, the capacity is released back to the cloud pool for others to draw from (Marks & Lozano, 2010). As a result, the government agency can easily cope with the peak time requirement and don't need to prepare full capacity for sudden influx of demand any longer.

Fourthly, the pricing mechanism is more elastic. IaaS customers can use IaaS services on a pay-per-use basis, that is, they pay only for the resources they use. It is much like the concept that we pay for the electricity, water supply, gas, and telephone. Users don't have to build a power plant or a reservoir themselves before making use of electricity and water. Thanks to this pricing mechanism, they can access very expensive data center resources through a rental arrangement and thus preserve capital for the business (Langdon, 2009). Comparatively speaking, when outsourcing to managed services (e.g. Application Service Provider) or using an internal IT infrastructure, users typically have to pay a fixed amount of money (Reese, 2009).

Last but not the least, by sharing computing power among multiple users, utilization rates are

generally greatly improved, because cloud computing servers are not sitting dormant for lack of use. The centralization of the data centers can also economize the use of electricity power for cooling and the operation of machine, avoid redundant IT investments, and thus reduce a huge amount of operation cost. Moreover, economies of scale through volume operations can reduce infrastructure costs significantly (Rittinghouse & Ransome, 2009). This may be the most important reason why the government agency wants to take advantage of IaaS if the government supervisors decide to build a private or hybrid cloud, because hardware resources can be shared among the government units and thus be used efficiently. On the other hand, if they want to choose a public cloud IaaS service, they may enjoy almost all the benefits mentioned above. However, just like what every other things in the world, cloud computing is a double-edged sword. Users also have to face the dark side of cloud computing. We will talk about it in the next section.

2.1.3 Drawbacks of IaaS

In fact, IaaS is not so perfect, it also have some disadvantages and limitations.

Firstly, the security and availability of the cloud applications are two of the major issues (Ahson & Ilyas, 2010). Once adopting, IaaS users will lose a degree of control over their sensitive information because it is stored on a remote server. If someone accessed the data illegally, IaaS users will not know for sure and may even have to depend on third party to ensure the security and the privacy of the information (Velte, et al., 2009). So there is inevitably a privacy risk in putting one's data in someone else's hands. Moreover, although there may be a service level agreement between service providers and their users, and the service providers are boasting over and over that their services are with a high availability, something undesirable and unpredictable is always happening. In short, IaaS services are not reliable all the time, at least for the time being.

Secondly, since the IaaS service providers may be located at somewhere on the earth geographically disparate from the IaaS customers, the transmission of data is seriously affected by the quality of Internet connection. Ahson and Ilyas (2010) stated that since IaaS services are

accessed through the network, the latency could be significant. A significant portion of the time will be spent waiting for the remote servers to respond. Therefore, latency is sometimes inevitable. If users always want to obtain the data without any delay, IaaS may not be the best choice for them.

Thirdly, the lack of standard will also increase the risk of early adoption. From the competition of specification of DVD, browsers, and operation systems of smart phone, we learn the importance and relevance of standards, for they can guarantee to some extent that certain services are of portability, integration and interoperability. Lakshmanan (2009) stated that for the cloud to be embraced by enterprises there should be less fear on vendor lock-in by using proprietary platforms. The primary need to overcome that fear is aligning to industry wide standards. However, at the moment there is still not a unified standard.

2.2 TOE Framework

To systemize IT related issues and researches for better understanding and explanation, Tornatzky and Fleischer (1990) proposed a new theoretical model called “Technology - Organization - Environment Framework (TOE Framework)” to describe the organizational components that affect the firm’s adoption decisions. The main idea of TOE framework was that the process by which a firm adopts and implements technological innovations is influenced by some factors that can be categorized into three dimensions: technological context, organizational context, and environmental context (Tornatzky and Fleischer, 1990). The technological context is about the characteristics of the available technology to an organization, including the benefits, innovativeness, system complexity, and so forth. The organizational context describes the characteristics or state of a company, such company size, organizational architecture, financial resources, human resource, and so on. The environmental context talks about the entire situation outside the organization, including the industry status, economic conditions, the government and all the stakeholders. There were many researchers developing their research models based on TOE framework to probe into many kinds of research questions related to the adoption of different information technologies. The

most representative and famous example is the research that Iacovou et al. conducted in 1995. They investigated the relationship between the adoption and effect of electronic data interchange (EDI) in small-and-medium-sized enterprises based on TOE framework. The three dimensions used in their study are perceived benefits (technological context), organizational readiness (organizational context), and external pressure (environmental context). The finding of this research shows that external pressure has a significant impact on the adoption electronic data interchange (EDI) in small-and-medium-sized enterprises. Kuan and Chau (2001) also applied TOE framework in their study. In their research, perceived direct benefit and perceived indirect benefit are in the technological context; perceived financial cost and perceived technical competence are in the organizational context; perceived industry pressure and perceived government pressure are in the environmental context. Their research finding shows that all of the factors except for perceived indirect benefit have a significant effect on the adoption decision of EDI. TOE framework provides scholars and researchers with a very useful and explanatory tool for information technology acceptance issues.

2.3 Factors Affecting the Adoption of Information Technology

Whenever there is an introduction of a new IT product, the issue of adoption arises both in the academia and the industry. Academics want to know the reasons why people will or won't adopt certain IT product and want to know the factors affecting the adoption behavior to predict the future behaviors of the users. Practitioners seek some ways to take advantage of the new business opportunity, to investigate if there exists any possibility for themselves to cut down the cost or increase the profit, or to see if it worthy of considerable investments. Needless to say, without carefully considering all the major potential factors that may affect the adoption process might lead to a miserable failure.

Inspired by the TOE framework and other theory models mentioned in the previous section, we found that the TOE framework can fit in with our research well because what we are trying to

research is the relationships among IaaS (technology), government agency (organization), and IaaS vendors (environment). Almost every factor that we can think of can be catogorized into one of them. As a result, we decide to classify the factors affecting the adoption of IaaS into three categories: technological factors, organizational factors, and environmental factors. Each of these three dimensions will be explained in detail respectively in following sections.

2.3.1 Technological Factors

The analyst Poon (2009) said that enterprise adoption of cloud computing is held back by myriad security issues, such as fears about data privacy and safety, and questions about regulatory compliance in a cloud environment. Just like we have said in previous sections, cloud computing technology is a double-edged sword. Although IaaS can benefit users in many ways, there are still many problems unsolved hence hampers the growth and the adoption of IaaS, for example, security of information, availability of the service, and so on. We define the “technological factors” as the factors that lie in IaaS technology itself that may influence users’ adoption decision.

In some well-known technology acceptance models, for example, TAM and TPB, technological factors such as “ease-of-use” or “usefulness” are frequently discussed. In the diffusion of innovations theory proposed by Roger (1995), he posited that if an innovation offers advantages over the existing situation; is compatible with existing beliefs and needs; is easy to use; can be trialed; and its results are observable, then it is more likely to be rapidly adopted. Needless to say too much, when it comes to the adoption of a certain technology, it is indispensable to talk over the technology itself. Therefore, we know that technological factors are the must-have ingredients of our research framework.

2.3.2 Organizational Factors

In 1990s, many researchers focused their studies on interaction between organization and technology. They were interested in how to successfully implement an information system or how

to take advantage of certain information technology in order to create a competitive advantage for the organization.

For example, according to the well-known Leavitt's (1964) Diamond, everything in an organization is connected, and changing one piece can impact another. If someone wants to introduce something into an organization, he or she must consider all of those interconnected pieces in the first place. Leavitt's Diamond is based on the principle that an organization has four major components that are all interdependent: Structure, Tasks, Technology, and Individual & Roles. Whether the users can benefit from a certain technology or not depends on how well their organizations fit into the mold, that is, the structure, tasks, and people of the organization must match the technology. Yap (1986) also suggests that organizational factors may determine the use of information technology or the use of information technology may influence the organization, or some combination of both.

Moreover, the report from the Yankee Group conducted in 2010 stated that the obstacles frequently mentioned by people who are involved in IaaS initiatives in addition to the security issues include "Migrating existing data and applications to the cloud could be costly and difficult," "Employee resistance," "Lack of measureable business benefits," and so on. These obstacles usually come from the inner part of the organization or at least have something to do with it. In view of the above, we can assert that there must be some organizational factors affecting the adoption of IaaS.

2.3.3 Environmental Factors

The organizations adopt technology in order to adapt to the environment and face the challenge from the environment. According to Laudon and Laudon (2005), the interaction between information technology and organizations is complex and is influenced by many mediating factors. One of the mediating factors is its surrounding environment. Organizations must respond to legislative and other requirements imposed by government, as well as the actions of customers and competitors. Therefore, it seems reasonable to consider environmental factors in the context of the

IT adoption of organizations. For example, Tan, Nah, Iacovou, and Kim (2003) incorporate environmental factors that might influence the adoption of e-marketplaces by small organizations into their research model and think that environment factors play a significant role in adoption decisions. Gemino, Mackay, and Reich (2006) also suggested that researchers can expand their research about the executive's decisions about website adoption for explanatory power by including variables from different contexts, including environmental and organizational characteristics. Drawing on the above literatures, we include environmental factors in our research framework as well.

On the other hand, when talking about the important issues of information technology that impact organizations significantly in recent years, it is certain that Enterprise Resource Planning (ERP) system will be mentioned. IaaS has a lot in common with ERP. For example, ERP sets the stage for effective supply chain management, customer relationship management, and electronic commerce, while IaaS provides the foundation for PaaS and SaaS. Both technologies are aiming at cutting cost and improving efficiency for the adopter organizations. ERP systems consolidate all business operations into a uniform and enterprise-wide system environment; IaaS has the potential to amalgamate the entire IT infrastructure by centralizing all the computing, storage, and networking facilities. Moreover, the implementation projects of both technologies are long-term, large-scale, and high-risk projects that involve complicated technology, may influence all the processes of the adopter organization, and usually cost a huge amount of money. Therefore, we think that ERP might be a good analogy for IaaS. Since there are still not many researchers studying the successful factors for the adoption of IaaS, we would like to borrow the research findings from the study of ERP.

Among the critical success factors of ERP reported in many researches, some of them are vendor's experience, vendor's support, and use of consultants. Some practitioners agree that these factors are as much important as ERP software itself for a successful implementation. Based on this analogy, we can infer that IaaS may not be successful without vendor's support. Thus, we think that

vendors should also play one of the important roles in environmental context in our research framework.

2.4 Conceptual Definition of Key Variables and Research Hypotheses

In this section, we would go through the details inside each block of our conceptual research framework, namely technological factors, organizational factors, and environmental factors. After carefully examining past researches to find out the factors that might mostly influence the intention to adopt IaaS, we choose six seemingly more relevant and more important factors to construct six corresponding hypotheses because it is impossible to exhaustively enumerate all the factors due to some research limitations. For simplicity, these hypotheses are grouped into three main categories according to the TOE framework. We would also like to talk about the factors presented in each dimension, their conceptual definitions, and the reason why we choose them. Finally, we will postulate six hypotheses respectively based on our arguments.

2.4.1 IaaS Adoption

Adoption is often associated with the decision to accept and use something new, such as ideas, artifacts or product (Roger, 1995). But this seems to be a generalized definition that can be applied to almost every kind of innovation. However, from this definition, we know that adoption should involve the notion of "accepting (agree or approve)" and "using (implement)" certain innovation.

According to the works studying the relationship between organization characteristics and IT adoption by Thong and Yap (1995), the authors defined adoption as using IT to support business. This definition is still not very accurate for our research because it does not distinguish the different stages of using some information technology, which usually have many different stages of adoption.

Since our research focus is mainly on the adoption decision of infrastructure as a service, which may be a new efficient instrument that can help one company to operate a business and thus need a certain amount of investment, by the actual implementers or decision makers of government's

policy, we specifically define the adoption in this thesis more precisely as “the level of acceptance of the decision makers in the government agency to invest and implement the new IaaS technology to support business” by incorporating these two definitions mentioned above so that it can fit in with our research scenario.

2.4.2 Technological Factors

1. Perceived Efficiency Improvement

According to the research “Perceived usefulness, perceived ease of use, and user acceptance of information technology” conducted by Davis (1989), he defined perceived usefulness as the degree to which a user believes that using a particular system would have a positive use-performance relationship. On the other hand, relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes (Roger, 1995). These are two very similar terms and they are both somewhat ambiguous. In this research, we combine both meanings to form two more complete enabling variables.

After our survey and judgment of the benefit of IaaS in the previous section of this chapter, we know that governments around the world view cloud computing as a means of increasing efficiency. Evidently, IaaS can improve efficiency by reducing management complexity, improving resource utilization, consolidating hardware, and in many other ways. For example, IaaS users don’t need to spend much time making a purchasing plan, placing an order, waiting for the component to arrive, and then setting it up in the data center. IT staff no longer has to worry about server updates, maintenance problems, and other annoying issues. IaaS users can set up a cloud infrastructure in a relatively short period of time and can add capacity into it in minutes. Briefly speaking, IaaS can save users a great amount of money and let users to focus more on the core business that can enhance their service efficiency and quality. We think it is reasonable to infer that people tend to have more intention to adopt IaaS if they consider it helpful. Therefore, we decide to incorporate the most prominent characteristic of IaaS,

improving efficiency, into our research framework as one of the technological determinants. We specifically define “Perceived Efficiency Improvement” as “Having better IT infrastructure service quality, more hardware choice, higher resource utilization rate, and more elastically scalable IT infrastructure, all of which enable users to focus on their core business, boost their working efficiency, and lead to greater organizational performance.”

This argument leads to the following hypothesis:

H1: The degree of “Perceived Efficiency Improvement” is positively related to the degree of IaaS adoption.

2. Perceived Cost Reduction

Cost reduction may be one of the most obvious benefits that IaaS can bring. IaaS can meet the technological and budgetary needs of diverse organizations and has the potential to greatly reduce the costs of IT infrastructure, for example, savings in power, cooling, space, and manpower. That is to say, IaaS can economize the use of electricity power for cooling and the operation of machine, avoid redundant IT investments, and thus reduce a huge amount of operation cost. Moreover, its pricing mechanism enables users to access very expensive data center resources through a rental arrangement and thus preserve capital for the business. This advantage can lead to a great deal of cost saving, which usually means higher revenue. In a research called “Cost and Service Capability Considerations on the Intention to Adopt Application Service Provision Services,” the research results show a dominant effect of cost savings consideration on ASP adoption intention (Yao Y., et al., 2010). Besides, many other relevant or analogous researches also indicate that cost saving have a significant effect on the intention to use. As a result, we believe that, as a matter of course, “Perceived Cost Reduction” can be a key factor affecting the adoption of IaaS technology. We specifically define “Perceived Cost Reduction” as “Lowering the upfront cost in the initial stage, maintenance cost, including power, space, cooling, and manpower, and the administrative burden.”

This argument leads to the following hypothesis:

H2: The degree of "Perceived Cost Reduction" is positively related to the degree of IaaS adoption.

2.4.3 Organizational Factors

1. Satisfaction with Existing IT Infrastructure

In organizational computing, IT infrastructure always requires a huge amount of capital and a long period of time to implement. Chau and Tam (1999) claimed that an organization would not consider adopting a new technology unless a need, such as a performance gap, was recognized. A performance gap may result from a low satisfaction level with existing computer systems, unacceptable price/performance ratio of the existing systems or inability to serve the organization's new needs. Conversely, whenever the current systems satisfied the needs of the organization, the propensity to change should be lower. Therefore, it stands to reason to state that a company satisfied with its existing IT infrastructure tends to retain its existing equipment and has no reason or low intention to adopt IaaS. We specifically define "Satisfaction with Existing IT Infrastructure" as "The satisfaction level with existing IT infrastructure includes users' perception, the price/performance ratio of the existing systems, the ability to serve the organization's new needs and so on." It is anticipated that the satisfaction with existing IT infrastructure will negatively influence the intention to adopt IaaS.

This argument leads to the following hypothesis:

H3: The degree of "Satisfaction with Existing IT Infrastructure" is negatively related to the degree of IaaS adoption.

2. IT Knowledge

IT knowledge means the basic knowledge and awareness of IT innovation. Many researches, for example, "E-Commerce Adoption in Brunei Darussalam: A Quantitative Analysis of Factors

Influencing Its Adoption" (Looi, 2005) and "How Information Technology Capabilities Influence Organizational Innovation: Exploratory Findings From Two Case Studies" (Tarafdar & Gordon, 2005), found that overcoming the lack of knowledge of the innovation will lead to greater likelihood of adopting the innovation. IT knowledge also stands for different aspects of an organization's base of IT resources. These resources influence and determine the organization's ability to convert IT assets and services into strategic applications, and to mobilize and deploy IT based resources with other resources and capabilities. The more IT knowledge an organization has, the more probability for it to make use of new information technology to strengthen its business competencies. Therefore, we assert that IT knowledge has a positive influence on the intention to adopt new information technology. We expect that "IT knowledge" has a positive relationship with the intention to adopt IaaS.

This argument leads to the following hypothesis:

H4: The degree of "IT Knowledge" is positively related to the degree of IaaS adoption.

2.4.4 Environmental Factors

1. Agency Trust

Although IaaS may bring organizations many benefits, it can't be implemented automatically without the vendors' help. The success or failure of an IaaS initiative may depend heavily on the vendors' experience, technical expertise, trustworthiness, and so on. Moreover, IaaS in itself is the practice of turning over all or part of an organization's IT infrastructure to an outside vendor, that is, we can view IaaS as a special form of IT outsourcing (ITProPortal.com, 2011). The management of a company should take into account the risk of property infringement and contract management before making any decisions related to IT outsourcing. If an organization doesn't trust outside vendors, it is impossible for it to outsource. In "An empirical study of information outsourcing from user perspective" (Jung-Ya Hung, 2008), the author stated that the supplier-customer relationship, namely "agency trust," has a positive

influence on IT outsourcing. Thus, we believed that the experience interacting with IT vendors might influence the decision of IaaS adoption. We specifically define "Agency Trust" as "The level of mutual trust between users and vendors, which is related to the past experience in cooperation" in our research.

This argument leads to the following hypothesis:

H5: The degree of "Agency Trust" is positively related to the degree of IaaS adoption.

2. Vendors' Promotion

According to the research result of "A Study on the Factors that Influence Enterprises' Decision to Adopt New Information Technology—Based on ADSL" (Uen-Yu Chuang, 2002), we know that vendors' promotion would influence the decision making of adoption of certain information technology, especially when the technology is still new to the market. Besides, Shuo-Bo Xu (1997) also stated in his study, "A study on factors affecting the adoption of Intranet and benefits", that the promotion activities and incentives provided by vendors may influence positively the adoption of Intranet technology. It is natural to infer that vendors' promotion activities, such as advertising campaigns, planning proposals, and discount, would have more or less influence on buyers' intention to consume. Therefore, we believe that vendors' promotion may play an important role in our research and has a positive influence on the adoption decision of IaaS. "Vendors' Promotion" here includes vendors' marketing and promotion, vendors' planning proposals, and their sales promotion.

This argument leads to the following hypothesis:

H6: The degree of "Vendors' Promotion" is positively related to the degree of IaaS adoption.

The conceptual definition of key variables in our research is summarized in Table 2-1.

Dimension	Concept	Expected Effect	Conceptual Definition	Source of Definition
Technological	Perceived Efficiency Improvement	Positive	Having better IT infrastructure service quality, more hardware choice, higher resource utilization rate, and more elastically scalable IT infrastructure, all of which enable users to focus on their core business, boost their working efficiency, and lead to greater organizational performance.	Perceived usefulness, perceived ease of use, and user acceptance of information technology (Davis, 1989) ; Diffusion of innovations (Roger, 1995)
	Perceived Cost Reduction	Positive	Lowering the upfront cost in the initial stage, maintenance cost, including power, space, cooling, and manpower, and the administrative burden.	Perceived usefulness, perceived ease of use, and user acceptance of information technology (Davis, 1989) ; Diffusion of innovations (Roger, 1995)
Organizational	Satisfaction with Existing IT Infrastructure	Negative	The satisfaction level with existing computer systems includes users' perception, the price/performance ratio of the existing systems, the ability to serve the organization's new needs and so on.	Organizational adoption of open systems: a "technology-push, need-pull" perspective (Chau & Tam, 1999)
	IT Knowledge	Positive	The basic knowledge and awareness of IT innovation.	E-Commerce Adoption in Brunei Darussalam: A Quantitative Analysis of Factors Influencing Its Adoption (Looi, 2005)
Environmental	Agency Trust	Positive	The level of mutual trust between users and vendors, which is related to the past experience in cooperation.	An empirical study of information outsourcing from user perspective (Jung-Ya Hung, 2008)
	Vendors' Promotion	Positive	The activities that vendors use to encourage users to believe in the value or importance of something they provide.	A Study on the Factors that Influence Enterprises' Decision to Adopt New Information Technology—Based on ADSL (Uen-Yu Chuang, 2002)
	Intention to Adopt		The level of acceptance of the decision makers in the government agency to invest and implement the new IaaS technology to support business.	Diffusion of Innovations (Roger, 1995) CEO Characteristics, Organization Characteristics and Information Technology Adoption in Small Business (Thong & Yap, 1995)

Table 2-1: Conceptual Definition of Key Variables

2.5 Research Framework

According to the above discussion and our inferential thinking, the refined research framework is depicted as follows. The detailed information of this research framework will be explained in the next chapter.

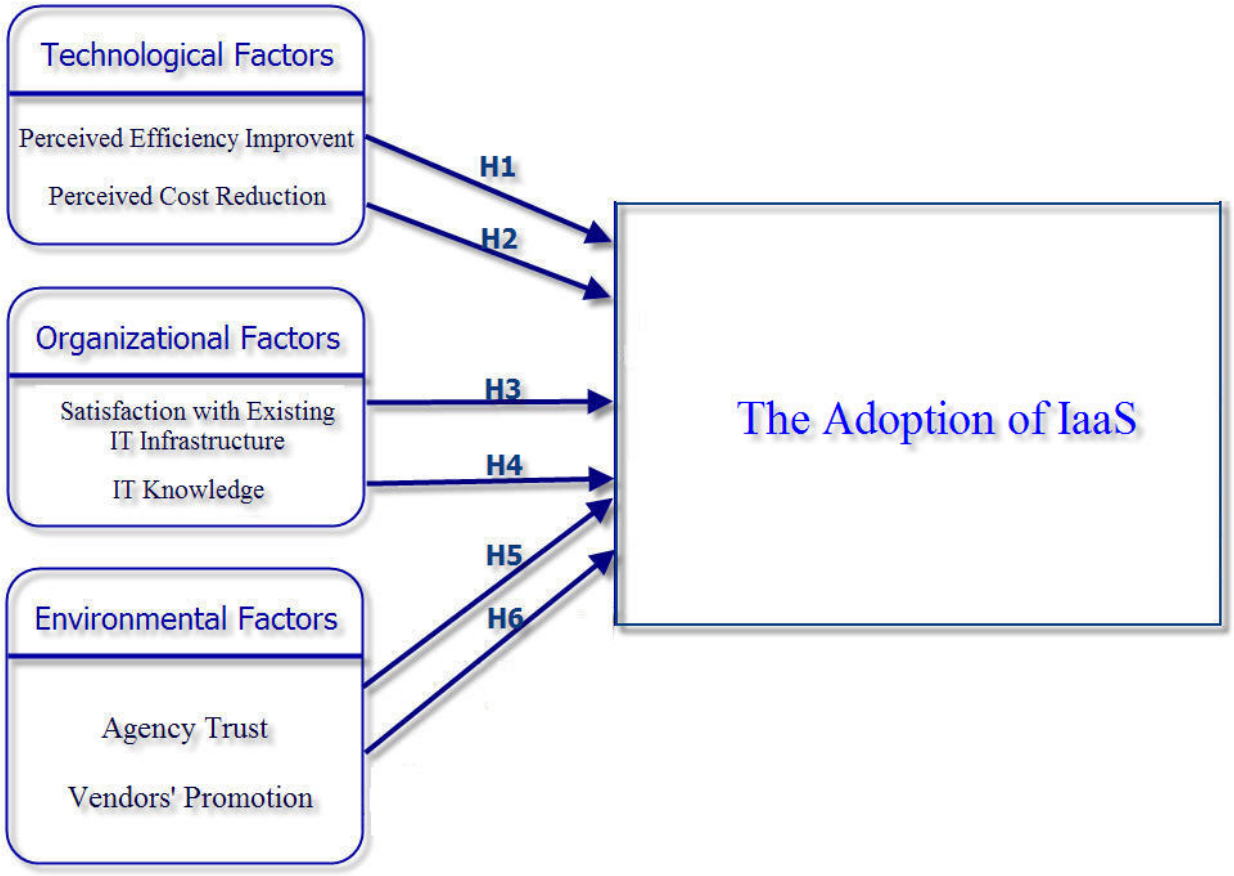

Figure 2-1: Research Framework

3. Research Methodology

3.1 Research Design

3.1.1 Sample

To answer the research questions, a quantitative approach was applied. The proposed model was tested via a survey with a sample size of 186. The subjects were drawn from a complete agency list published by Taiwan government at its portal website (http://www.gov.tw/). In general, it is those top-level senior IT managers that have the power to make decisions for their subsidiary divisions. For this reason, we chose the major IT decision makers at division chief level or higher from the list.

To prevent our subjects from confusion, we design one short but all needed information inclusive introduction page right before the questionnaire to make sure that all our subjects know the following information: The background, definition, benefits (advantages), drawbacks (disadvantages), and classification of IaaS.

To focus more on our main research question, we would like to introduce a research assumption here: these decision makers rationally make their decisions and without the imperative intervention of their supervisors. The reason why we make this assumption is that some of the decisions in the government agency are affected solely by the top-level policy makers, and their subordinates may just follow the policy in reality. Indeed, some researchers also stated that adoption of IT may be encouraged by management (Leonard-Barton & Deschamps, 1988) or even mandated (Moore & Benbasat, 1991). Unfortunately, the policy makers in some cases are not those who really understand all the facets of certain technology, and thus the decisions are poorly made. Based on the track record, the government agency sometimes made wrong adoption decisions to invest a lot in some under-used, never-implemented, or used in a short term then scraped technology. From the working experience as a public servant, we know that the upper middle-class IT managers in the IT division in the government agency are the ones most familiar with the technological details. As a result, in order to answer one of our research questions “Is it the right time to adopt IaaS

technology?" we must know what the actual implementers are really thinking about to obtain an impartial, objective, and true answer. This notion also affects how we choose the subjects in this research.

3.1.2 Operational Variable Definition and Measurement

To operationalize the constructs in our research framework, we adapt the items from the instruments used in other studies or popular IT periodicals with similarity of context. These items for each construct had been under strict development and used widely and frequently in many related researches. The content validity of the constructs is deemed acceptable by many experts and each of the items presents high reliability or internal consistency. Therefore, we believed that the usability of these items is out of question. For example, the items from one of the source of our questionnaire, "Organizational adoption of open systems: a 'technology-push, need-pull' perspective," have a reported reliability of at least 0.7 in its original study. As a result, we think that it is appropriate to use these items in our research.

The operational definitions and the sources of definitions of each variable are given in Table 3-1. Please refer to the appendix A of the thesis for the detailed questionnaire.

Dimension	Concept	Operational Definition	Source of Definition
Technological	Perceived Efficiency Improvement	1. More choices for hardware and software. 2. Better utilization of IT resources. 3. Promoting flexibility and integration. 4. Increased IT infrastructure service quality.	Organizational Adoption of Open Systems: A "Technology-Push, Need-Pull" Perspective (Chau & Tam, 1999)
	Perceived Cost Reduction	5. Reduced upfront cost. 6. Reduced maintenance cost. 7. Reduced maintenance effort.	This Research

Dimension	Concept	Operational Definition	Source of Definition
Organizational	Satisfaction with Existing IT Infrastructure	1. Serve the needs. 2. Good price/performance ratio.	Organizational Adoption of Open Systems: A "Technology-Push, Need-Pull" Perspective (Chau & Tam, 1999)
		3. Level of satisfaction as a whole. 4. Joyful using experience. 5. Considering functions useful. 6. Considering convenient. 7. Willingness to use.	The Impact of Knowledge Management System on User's Satisfaction in a Governmental Organization (Yung-Feng Hsu, 2006)
	IT Knowledge	1. We have very little knowledge how Internet and electronic commerce (Change to IaaS) can help to improve my business and increase our sales. 2. We do not have the technical knowledge and skills to start using Internet and electronic commerce (Change to IaaS). 3. We have very good understanding about how Internet and e-commerce (Change to IaaS) can be used to help to improve my business profit.	E-Commerce Adoption in Brunei Darussalam: A Quantitative Analysis of Factors Influencing Its Adoption (Looi, 2005)
Dimension	**Concept**	**Operational Definition**	**Source of Definition**
Environmental	Agency Trust	1. Based on experience, I think vendors are trust worthy. 2. Based on experience, I think vendors can provide service with decent quality. 3. Based on experience, I think vendors can meet users' demands. 4. Based on experience, I think vendors can reliably comply with the agreement.	An Empirical Study of Information Outsourcing from User Perspective (Jung-Ya Hung, 2008)
	Vendors' Promotion	1. Vendors' marketing activities. 2. Vendors' planning proposal. 3. Vendors' offering of a preferential price.	A Study on the Factors that Influence Enterprises' Decision to Adopt New Information Technology─Based on ADSL (Uen-Yu Chuang, 2002)
Dimension	**Concept**	**Operational Definition**	**Source of Definition**
Dependent Variable	Intention to adopt	1. How likely is it that your company intends to have an Internet website within the next 6 months? 2. How likely is it that your company intends to have an Internet website within the next 12 months? 3. How likely is it that your company intends to have an Internet website within the next 18 months?	Executive Decisions About Website Adoption in Small and Medium-Sized Enterprise (Gemino, Mackay & Reich, 2006)

Table 3-1: Operational Definition of Variables

As to the measurement, we measured all these factors and the adoption level of IaaS using 5-point Likert scale (strongly disagree=1, strongly agree=5). In order to discover the intention of the decision makers in the government agency to adopt IaaS, we measure it by using a combination of three items introduced by Tan and Teo (2000) in their research. They used three items on a five-point Likert-type scale. The items look like this: “How likely is it that your company intends to….1) within the next 6 months; 2) within the next 12 months; 3) within the next 18 months.” The responses are weighted by 3/6, 2/6, 1/6 respectively. As to the details of the questionnaire, please refer to the end of the thesis to view the actual questionnaire items used in this research.

3.1.3 Data Collection Method and Result

A survey instrument was created to test the model of IaaS adoption for this study. The data were collected by a questionnaire mailed to the IT section managers of 186 agencies. The questionnaire that we used was divided into five parts. The first three parts are the technological dimension, the organization dimension, and the environmental dimension, respectively. The fourth part is the dependent variable — the intention to adopt. The last part is the personal information of the respondent.

In addition to preparing the stamped addressed envelopes for our questionnaire respondents to reply, we provide the questionnaire website address in the cover letter, which is served as a complement approach to completing to questionnaires and might be helpful to improve the response rate.

In two weeks, 65 responses (40 from mail, 25 from Internet) are returned. However, the response rate was far lower than we expected. Therefore, we started a second round questionnaire collection by carrying out a reminder call or paying a visit directly to those who had not responded. Additional 46 (25 from mail, 21 from Internet) questionnaires were collected in the second round. To sum up, we received 111 responses in the end and the final response rate was 59.677%.

4. Research Results

4.1 Descriptive Statistics

4.1.1 Descriptive Statistics of Sample

The characteristics of the sample are shown in the following Table:

GENDER		
	Frequency	Percent
Female	12	10.8
Male	99	89.2
Total	111	100.0

AGE		
	Frequency	Percent
30 and below	4	3.6
31-40	12	10.8
41-50	52	46.8
51 and above	43	38.7
Total	111	100.0

EDUCATION		
	Frequency	Percent
Technical College and below	7	6.3
University	33	29.7
Graduate School and above	71	64.0
Total	111	100.0

SENIORITY		
	Frequency	Percent
Not available	4	3.6
5 and below	1	0.9
6-10	10	9.0
11-15	22	19.8
16-20	32	28.8
21-25	28	25.2
26-30	9	8.1
31 and above	5	4.5
Total	111	100.0

JOB LEVEL		
	Frequency	Percent
Not Available	8	7.2
1-5 (Mandate)	0	0.0
6-9 (Junior Rank)	63	56.7
10-14 (Senior Rank)	40	36.0
Total	111	100.0

Table 4-1: Descriptive Statistics of Sample

Firstly, in terms of gender, 12 (10.8%) are female and 99 (89.2%) are male. It is evident that most of the respondents are male. As mentioned earlier, our target respondents are mostly top-level IT managers. Therefore, we can infer that the number of male IT managers in government agency

was far more than that of female IT managers. We may further attribute this phenomenon to the different inclination to choose college major due to gender differences and the glass ceiling in the work place faced by women.

Secondly, as to the age of the respondents, 3.6% of the respondents were 30 and below; respondents between 31 to 40 years of age comprised 10.8% of the population; 46.8% of the respondents were between 41-50 years of age; and 38.7% were 51 years and above. It is reasonable because the target examinees of our research are no other than those IT managers who have the power to give orders and make decisions, whom are usually above certain age. On the whole, about 85% of the respondents are 41 years and older.

Thirdly, 64.0% of the respondents had a master or PhD degree; 29.7% of the respondents had a bachelor degree; the rest of them receive at least technical college education. Therefore, it can be inferred that the respondents of our survey were prominent intellectuals and had better ability to understand the issues addressed in this study.

Fourthly, the last part is the seniority and job level distribution. Because the respondents of our survey were IT managers in the government agency, which were inherently a hierarchical organizational structure, it is not surprising that most of them had a seniority of more than 16 years and their job level was at least above junior rank.

4.1.2 Descriptive Statistics of Survey Questions

There are 27 survey questions in our questionnaire. It is indispensable to make an analysis of the skewness and central tendency, for example, mean, standard deviation, and variance, of each question to make the data better understood before conducting credible reliability analysis, validity analysis and hypothesis testing. Table 4-2 illustrated the descriptive statistics and the reliability of the survey questions.

Survey Question	Minimum	Maximum	Mean	Std. Deviation	Variance	Cronbach's Alpha	N of Items
	Statistic	Statistic	Statistic	Statistic	Statistic		
Perceived Efficiency Improvement 1	1	5	3.87	.676	.457	**.717**	4
Perceived Efficiency Improvement 2	3	5	4.00	.618	.382		
Perceived Efficiency Improvement 3	2	5	4.03	.579	.336		
Perceived Efficiency Improvement 4	2	5	3.65	.642	.412		
Perceived Cost Reduction 1	2	5	3.49	.933	.870	**.777**	3
Perceived Cost Reduction 2	2	5	3.62	.763	.583		
Perceived Cost Reduction 3	1	5	3.72	.855	.730		
Satisfaction with Existing IT Infrastructure 1	1	5	2.14	.749	.561	**.881**	7
Satisfaction with Existing IT Infrastructure 2	1	4	2.54	.711	.505		
Satisfaction with Existing IT Infrastructure 3	1	4	2.34	.707	.500		
Satisfaction with Existing IT Infrastructure 4	1	4	2.31	.685	.469		
Satisfaction with Existing IT Infrastructure 5	1	5	2.35	.746	.557		
Satisfaction with Existing IT Infrastructure 6	1	4	2.11	.562	.315		
Satisfaction with Existing IT Infrastructure 7	1	4	2.06	.592	.351		
IT Knowledge 1	1	5	2.86	.952	.906	**.847**	3
IT Knowledge 2	2	5	3.77	.774	.599		
IT Knowledge 3	1	5	3.27	.953	.908		
Agency Trust 1	1	5	3.21	.865	.748	**.894**	4
Agency Trust 2	1	5	3.35	.759	.575		
Agency Trust 3	1	5	3.38	.751	.565		
Agency Trust 4	1	5	3.36	.711	.505		
Vendors' Promotion 1	2	5	3.18	.741	.549	**.820**	3
Vendors' Promotion 2	2	5	3.39	.703	.494		
Vendors' Promotion 3	1	5	3.37	.808	.653		
Intention to Adopt 1	1	5	2.48	.796	.634	**.900**	3
Intention to Adopt 2	1	5	2.98	.853	.727		
Intention to Adopt 3	1	5	3.50	.943	.889		
			Overall Reliability			.779	27

Table 4-2: Descriptive Statistics of Survey Questions

From the descriptive statistics of survey questions listed above, we can understand that the respondents believed IaaS technology may be useful and can lower the total cost of ownership of IT infrastructure because the means of the questions measuring “Perceived Efficiency Improvement” and “Perceived Cost Reduction” are all above 3.49, that is, between “neither agree or disagree” and “agree”. As to the “Satisfaction with Existing IT Infrastructure,” it seems that the respondents are not very satisfied with the existing IT infrastructure they are using. In our research hypotheses, we expect that lower satisfaction with the existing IT infrastructure result in a higher intention to adopt IaaS. We will examine this in the hypothesis testing section later. Besides, the respondents believed that their organizations have enough IT knowledge to implement IaaS, they also have a not so bad experience with vendors in their previous IT projects, and they may view vendors’ promotion as an important reference when making decisions.

Moreover, from the “Intention to Adopt,” we know that most of them won’t adopt IaaS within 12 months. However, they agree that they may adopt IaaS after 12 months, or more specifically, within 18 months. Generally speaking, it shows that most of the IT managers in the government agency may still hesitate over adopting IaaS technology. In a short term, they may tend to wait and see.

From the rightmost column in Table 4-2, we know that the reliability of the survey questions in our questionnaire is very good. The reliability statistics are all higher than 0.7. The reliability of the dependent variable, “Intention to Adopt,” is as high as 0.9. In addition, the overall reliability of the questionnaire is close to 0.8. It shows that the questionnaire has high internal consistency reliability and can be a good instrument to measure.

4.2 Correlation Analysis

Table 4-3 below is the summary of correlation analysis. All of the directions of relevance are as predicted in our research hypothesis. However, two of them, “Perceived Cost Reduction” and “Satisfaction with Existing IT Infrastructure” are not significant and the correlation coefficient of

"Agency Trust" is relatively lower than we expected. Besides, it is worth pointing out that three of the correlations in our research framework are significant at the 0.01 level (2-tailed). They are "Perceived Efficiency Improvement," "IT Knowledge," and "Vendors' Promotion." These are the evidence that there is indeed a linear dependence relationship between these three independent variables and the dependent variable, "Intention to Adopt."

	Correlation Coefficient	Direction and Degree of Relevance	Significance	P Value
Perceived Efficiency Improvement	0.372	Low positive correlation	Significant	**0.000****
Perceived Cost Reduction	0.115	Low positive correlation	Not significant	**0.230**
Satisfaction with Existing IT Infrastructure	-0.137	Low negative correlation	Not significant	**0.150**
IT Knowledge	0.365	Low positive correlation	Significant	**0.000****
Agency Trust	0.194	Low positive correlation	Significant	**0.041***
Vendors' Promotion	0.438	Moderate positive correlation	Significant	**0.000****

Table 4-3: Summary of Correlation Analysis between IVs and DV

4.3 Hypotheses Testing

4.3.1 Regression Analysis

Results of the regression of intention to adopt IaaS on the independent variables are shown in Table 4-4. The results reveal an adjusted R square of 0.312, which suggest 31.2% of variance can be explained by the predictors in our research model. Three variables are significant: "Perceived Efficiency Improvement," "IT Knowledge," and "Vendors' Promotion." It is interesting to notice that "Perceived Cost Reduction" has a negative relationship with "Intention to Adopt," which is opposite to the results of correlation analysis stated above and inconsistent with our research hypotheses. We will try to give it a good explanation in chapter 5.

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	-.762	.685		-1.113	.268
Perceived Efficiency Improvement	.383	.160	**.227**	2.393	.019
Perceived Cost Reduction	-.162	.101	**-.147**	-1.604	.112
Satisfaction with Existing IT Infrastructure	-.110	.117	**-.077**	-.941	.349
IT Knowledge	.347	.113	**.262**	3.066	.003
Agency Trust	.119	.098	**.107**	1.210	.229
Vendors' Promotion	.418	.099	**.355**	4.237	.000
R	R Square	Adjusted R Square		Std. Error of the Estimate	
.591[a]	.350	.312		.61887	

Table 4-4: Results of Multiple Regression Analysis

4.3.2 Results of Hypotheses Testing

Table 4-5 summarizes the results of all hypothesized relationships tested according the analyses illustrated in this chapter. As to the further implication, we will also talk about it in the next chapter.

Hypothesis	Hypothesized Relationship	Accept or Reject
Perceived Efficiency Improvement → Intention to Adopt	Positive	Accept
Perceived Cost Reduction → Intention to Adopt	Positive	Reject
Satisfaction with Existing IT Infrastructure → Intention to Adopt	Negative	Reject
IT Knowledge→ Intention to Adopt	Positive	Accept
Agency Trust → Intention to Adopt	Positive	Reject
Vendors' Promotion → Intention to Adopt	Positive	Accept

Table 4-5: Results of Hypotheses Testing

5. Discussion and Implications

5.1 Discussion of the Results

5.1.1 Technological Factors

In recent years, the national development policy put much emphasis on how to reform and how to innovate the government to make it more efficiency-oriented. Therefore, it goes without saying that the IT managers in the government agency would seek any means to boost their efficiency and quality of service to conform to the requirement of the merit system.

Unsurprisingly, the "Perceived Efficiency Improvement" has a positive, although relatively low, and significant relationship with intention to adopt IaaS as we expect. It shows that once the IT managers in the government agency perceive the efficiency improvement that IaaS can bring, they would be more willing to adopt IaaS. We can infer that the IT managers would view IaaS as a useful means for them to enhance the efficiency and quality of service of their departments. As a result, it stands to reason to accept the first hypothesis of our research.

According to the research result, it seems that the relationship between "Perceived Cost Reduction" and "Intention to Adopt" is not found to be significant, thereby rejecting the second hypothesis of our research. It is totally different from the findings of previous researches and our anticipation. We think that we may attribute it to the differences between the research contexts. The examinees of previous researches came from private enterprises. On the contrary, we choose all our examinees from public sectors.

In Taiwan's government agency, although the funding is being reduced year by year and the cost reduction can also be regarded as a very important indicator of performance, the importance of cost reduction, in fact, may not be as important as efficiency improvement. It is because that the public sectors are not like for-profit organizations where managers care about and attach much importance to each penny invested. When facing cost pressures, managers in the private enterprises would tackle with it carefully because it has something to do with their own performance and salary and would even threaten their career. In contrast, managers in the public sectors would not be very

cautious since their jobs tenure is guaranteed by the country and do not have as much pressure as those who work for a private enterprise, thus they tend to do as much as they can just based on the amount of the financial support.

Besides, the effect of cost reduction cannot always show instant results. Top-level managers in the government agency may not pay too much attention to the achievement in cost reduction like who in the private enterprises do. As a result, IT managers in the public sectors may want to seek a way to obtain distinguished results in a short term to manifest their achievements at least before the next rotation of their jobs.

5.1.2 Organizational Factors

Although Chau and Tam (1999) asserted that the organization would be less likely to adopt the new technology unless the existing systems appeared to be unsatisfactory, we don't see any evidence in our data analysis that support this hypothesis that lower "Satisfaction with Existing IT Infrastructure" would lead to higher intention to adopt IaaS. The only thing confirmed is that there seems to be an insignificant low negative relationship between these two variables.

We think that it can also be attributed to the difference of research contexts. After thinking over the results of data analysis, we speculate that there is a great chance the decision makers of previous IT infrastructure may be the same people as the respondents of the questionnaires. In previous researches, the subjects are usually ordinary IT users. Nevertheless, the subjects in our research are those who make decisions and hence tend to be satisfied with their own previous decisions no matter they will adopt IaaS in the future or not. Therefore, this can explain why the relationship between "Satisfaction with Existing IT Infrastructure" and "Intention to Adopt" is found to be insignificant.

Better knowledge and awareness of IT innovation results in higher intention to adopt IaaS. The research result is consistent with our hypothesis and in accordance with the research findings of Tarafdar and Gordon (2005) that the different aspects of IT capability do indeed affect an

organization's ability to innovate and influence the innovation process in different ways. Based on these evidences, we think that it is reasonable to accept this hypothesis.

5.1.3 Environmental Factors

Conventionally, IT managers in the government agency usually have relied on certain IT solution vendors for suggestion for a long time. IT managers and these vendors may build strong mutually beneficial relationships under the table with each other and do not intend to do anything to jeopardize their relationships.

In our study, we found that agency trust has no significant effect on the intention to adopt IaaS, which is different from what we have predicted. We think that it might be attributed to our failure to give the correspondents a correct reference when they fill in the questionnaires. For example, maybe the IT managers indeed have a very good experience of cooperation with vendors or these vendors really can provide decent IT services and keep their promises. However, these vendors may not be those who provide IaaS services because not all the vendors provide IaaS service. As a result, we may attribute it to the design bias of our research. We hope future researchers can avoid such negligence.

In addition to "Agency Trust," the other environmental factor in our research framework is "Vendors' Promotion." As we expected, we reconfirm the fact that promotion is really an effective tool to influence consumers' behavior in our research.

5.2 Limitations

Just like all other previous researches, our study is conducted in an imperfect real world and thus has a number of limitations.

Firstly, because the questionnaires were sent by post mail to the subjects, we cannot be definitely sure that the ones who fill in the questionnaires are the subjects we intend to test. To conduct a field research with subjects distributing throughout the country is time-consuming. If we

conduct a face-to-face survey, it would cost a considerable amount of time and money.

Secondly, we know that sufficient response rates are important for surveys. Although we have tried our best to collect data, due to some constraints, for example, manpower, time, and money, the response rate is actually not enough for strict academic requirement. According to the suggestion from the reviewers, 85% will be optimal and can best explain the characteristics of the population. We hope this can be improved in future researches.

Thirdly, since IaaS is still in its initial stage, not all of our subjects have real experience of using IaaS. Some of them might use an analogy or imagination to fill in the questionnaire and thus inevitably cause so-called intervention bias.

Fourthly, maybe the decision making process, especially the project about huge amount of money, is far more complicated than we think. For example, the decisions may be made by a group of IT managers or after going through numerous lengthy meetings. Therefore, our survey methodology may be too simplified to conform to the real situation.

Fifthly, the quality of the questionnaire still leaves much to be desired. Due to the time constraint, we didn't have enough time to design all the items in each dimension and test their reliability and validity respectively ourselves. As a result, we adopted the existing items and made some slight changes only. This limitation deteriorates the quality of our research and affects our choice of the variables to form the research framework. We sincerely hope that future researchers can pay attention to this and won't make the same mistake.

Sixthly, since it is impossible to exhaustively enumerate complete factors affecting the intention to adopt IaaS in reality and many of the researchers are still looking for the best way to figure out the answer of this study, the six factors we chose might inevitably have some personal biases or logic error. However, all to the good, this study is just an exploratory research. In the early evaluation stage of G-Cloud, it can still be considered to be worth referencing.

5.3 Implications and Suggestion

According to the above discussion of the research result and research limitations, we would like to make some suggestions. First of all, we suggest that the IaaS service providers should put a high premium on the education of their customers, especially the IT managers in the public sectors, about the benefits and advantages to improve the efficiency and quality of service of their departments. If they want to expand their IaaS market, it is easier to begin with one of the government agencies that have a perceived higher IT knowledge capability. Moreover, it is worthwhile to put more time and effort into promotion activities to improve customers' willingness to adopt IaaS.

For future researchers, we would like to suggest them to incorporate more other enabling factors or hindering factors into their research framework, for example, perceived risk or implementation complexity, to test whether these factors can negatively affect the intention to adopt IaaS. Besides, since there may be some inexperienced users being our respondents, future research can be conducted on experienced users of IaaS. Furthermore, a better sampling plan is also recommended. They can separate the samples of central government agencies from those of local government agencies since their decision powers might be totally different. This may be very important for future researchers to answer the related questions more correctly. The items of the questionnaire should also be chosen or designed more carefully. For example, they can add some negative items or adapt items from more suitable resources. Lastly, future researchers could consider incorporating more government-specific characteristics and thinking of more IaaS adoption scenarios for government agencies into their framework to fit in more with the research context. According to some studies, managers from public sectors perceive more emphasis on rules, channels, and procedures, and more constraints on authority. For instance, they can respectively talk about the adoption of different types of IaaS, that is, public IaaS, private IaaS, or hybrid IaaS. Different types of IaaS may lead to totally different results. Therefore, we suggest that they must take this factor into account in their studies.

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Appendix A (Questionnaire)：

懇請貴單位

「負責維運 ***或*** 執掌業務 ***或*** 進行決策

與**電腦硬體**有關之**資訊部門或相關部門主管**」填寫本問卷

謝謝您的幫忙！

敬啟者 鈞鑒：

這是一份學術研究的問卷，本問卷之目的在於瞭解**貴單位進行決策與資訊設備購置** 或 **部署** 或 **維護有關之部門主管**對於政府部門引進雲端運算中「基礎設施即服務」（IaaS）之相關意見，並希望找出各項因素與欲採用意願之間的關連性，以提供給學術界及實務界做為參考。

首先，非常感謝您願意於公忙之餘撥冗填寫本問卷，也煩請您於填答之前能夠詳細***閱讀下一頁之簡短說明文字***，您的意見將對本研究具有極為重要且寶貴的助益，衷心感謝您善意的協助。

所有填答內容僅供學術研究用途，決不對外公開，敬請安心填答。若對於我們的研究結果感興趣者也歡迎來信告知，我們將會提供簡要的報告與研究結果供您參考，非常感謝您的協助，謝謝。

敬祝　身體健康 萬事如意

國立台灣大學資訊管理學研究所
指導教授：黃明蕙 博士
研究生：黃建豪　　敬上

（填答過程中如有任何疑問，歡迎來信至 max.ntu@gmail.com）

※雲端運算中「基礎設施即服務（IaaS）」 簡介：

雲端運算是近幾年來資訊相關產業與報章雜誌上最夯的用語，已有許多資訊大廠推出雲端運算相關之服務，服務的類型可分為許多種，其中較為普遍的分類包括了SaaS、PaaS、IaaS 三種，例如：Google 提供的「Google Docs」服務，讓使用者能夠透過網路，存取並編輯各種文件，無需花時間於電腦上安裝並定期更新軟體，或是花大錢購買軟體授權，是目前一般使用者較為常用的一種「軟體即服務」（SaaS）的代表；以網路書店及拍賣聞名的 Amazon，近年來也藉由雲端運算的各項技術，提供使用者CPU 運算資源及儲存空間，亦即所謂的「基礎設施即服務」（IaaS），該服務包含了虛擬化且標準化的**伺服器、網路設備、記憶體、儲存設備、CPU、資料中心**等，讓企業用戶以購買現成服務的方式取代傳統冗長的購買、安裝、測試、上線的過程，並能夠依據自己的使用量來付費，此外，使用者無須為了符合尖峰時段的需求，花費大量金錢購置平時很有可能閒置的硬體資源，不但可以降低採購成本，亦可減少在維護上所耗費的心力，達到節省 IT 總持有成本的目的。由上述的兩個例子可知，對於使用者而言，雲端運算的概念即為透過網際網路，快速而簡便地取得恰好符合需求的 IT 資源與服務，並採具有彈性的收費方式來計價。

本研究所要探討的重點鎖定在雲端運算中的「基礎設施即服務」（IaaS）上，由於上述的諸多好處，使得許多企業趨之若鶩，政府機關也積極評估考慮，紛紛探索是否能以 IaaS 的形式取代現有的資訊基礎設施架構。而業界按照提供者與使用者的所屬關係，將雲端運算分為三種模式，首先為「公有雲」，使用者所需的服務由獨立的第三方雲端供應商提供，並與其他若干企業用戶共同使用雲端運算環境，此模式能夠享有雲端運算中最完整的好處，包括了靈活度、高效能、節省成本等，但相對地也必須面對資料安全的風險、服務是否穩定以及是否具備令人滿意的服務水準等問題；若企業對於資料安全性、服務可靠性及 IT 可監控性的要求較高，則可考慮獨力建構僅供企業內部成員使用的「私有雲」，雖能有效避免使用公有雲所帶來的負面影響，但也相對地喪失了雲端運算所帶來的某些優勢，例如：無法有效降低 IT 的總持有成本與所需之維護心力；至於所謂的「混合雲」則為前述二者兼而有之的型態。

＝問卷開始＝

以下問卷項目中之「貴單位」指的是您所服務的機關，例如：衛生署、北區國稅局、台南市政府等，而非您所在之部門；「IT 基礎建設」則是泛指貴機關目前所使用的運算設備、儲存設備、網路設備等硬體設施。

本研究的目的主要是為了調查政府部門的資訊決策者對於「基礎設施即服務」（IaaS）之意見，問卷中所有問題均無標準答案，請您依照自己的看法填答即可。

第一部份、科技因素

問題編號		非常不同意	不同意	普通	同意	非常同意
	您認為導入 IaaS. . .					
1	能夠提供貴單位更多在 IT 基礎建設的軟硬體上之選擇。	□	□	□	□	□
2	能夠有效提升貴單位的 IT 資源利用率。	□	□	□	□	□
3	能夠提升貴單位在 IT 基礎建設上的彈性（例如：滿足組織在尖峰時刻的需求、因應需求而可動態調整硬體資源使用量等）。	□	□	□	□	□
4	能夠加強貴單位 IT 基礎建設的服務品質。	□	□	□	□	□
5	能夠讓貴單位節省大量（相對於傳統的機房或資料中心）IT 基礎建設上的初期鉅額投資成本。	□	□	□	□	□
6	能夠讓貴單位節省大量（相對於傳統的機房或資料中心）營運成本	□	□	□	□	□

	（例如：人力、電費、冷卻等）。	
7	能夠減輕貴單位對於 IT 基礎建設的管理負擔。	□ □ □ □ □

第二部份、組織因素

問題編號		非常不同意	不同意	普通	同意	非常同意
1	整體而言，貴單位目前使用中的 IT 基礎建設符合公司的需求。	□	□	□	□	□
2	整體而言，您對貴單位目前使用中的 IT 基礎建設在價格與性能上的比值(price/performance)感到很滿意。	□	□	□	□	□
3	整體而言，您對貴單位目前的 IT 基礎建設感到很滿意。	□	□	□	□	□
4	整體而言，您對貴單位目前的 IT 基礎建設的使用經驗感到很愉快。	□	□	□	□	□
5	整體而言，您很認同貴單位目前的 IT 基礎建設所提供的功能。	□	□	□	□	□
6	整體而言，您覺得在您的工作上，使用貴單位目前的 IT 基礎建設是很便利的。	□	□	□	□	□
7	整體而言，您很願意去使用貴單位目前的 IT 基礎建設。	□	□	□	□	□
8	貴單位對於應該如何採用 IaaS 提升行政效能與為民服務的品質，所知道的相關知識並不算多。	□	□	□	□	□

9	貴單位目前尚不具備採用 IaaS 所需要的相關知識與技能。	□ □ □ □ □
10	貴單位對於採用 IaaS 所能帶來的好處很瞭解。	□ □ □ □ □

第三部份、環境因素

問題編號		非常不同意	不同意	普通	同意	非常同意
1	根據過去的經驗，您認為委外廠商是可以信賴的。	□	□	□	□	□
2	根據過去的經驗，您認為委外廠商會提供良好服務。	□	□	□	□	□
3	根據過去的經驗，您認為委外廠商會配合使用者的需求。	□	□	□	□	□
4	根據過去的經驗，您認為委外廠商會確實履行其承諾。	□	□	□	□	□
5	IaaS 廠商的行銷推廣，會增加貴單位的採用意願。	□	□	□	□	□
6	IaaS 廠商的規劃建議採用，會增加貴單位的採用意願。	□	□	□	□	□
7	IaaS 廠商的優惠促銷，會增加貴單位的採用意願。	□	□	□	□	□

第四部分、採用意願

問題編號		非常不同意	不同意	普通	同意	非常同意
1	貴單位有意願在未來的六個月內導入 IaaS。	□	□	□	□	□
2	貴單位有意願在未來的十二個月內導入 IaaS。	□	□	□	□	□
3	貴單位有意願在未來的十八個月內導入 IaaS。	□	□	□	□	□

第五部分、基本資料（請打勾或填寫）

性別：□（1）男 □（2）女

學歷：□（1）專科及以下 □（2）大學 □（3）研究所及以上

年齡：□（1）30 歲及以下 □（2）31－40 歲（3）41－50 歲 □（4）51 歲及以上

現職單位：_____

公職年資：_____年

職等：_____職等

問卷到此結束，衷心感謝您的填答！

懇請您利用本問卷所附之回郵信封，將問卷投遞郵筒內寄回，謝謝您！