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BCOR 접근법을 이용한 클라우드 컴퓨팅 도입의 의사결정 요인에 관한 연구

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A Study on Decision Making Factors of Cloud Computing Adoption Using BCOR Approach

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■ Abstract ■

With the continuous and outstanding development of information technology(IT), human being is coming to the new computing era which is called cloud computing. This era brings lots of huge benefits also at the same time release the resources of IT infrastructure and data boom for man. In the future no longer, most of IT service providers, enterprises, organizations and systems will adopt this new computing model. There are three main deployment models in cloud computing including public cloud, private cloud and hybrid cloud; each one also has its own cons and pros. While implementing any kind of cloud services, customers have to choose one of three above deployment models. Thus, our paper aims to represent a practical framework to help the adopter select which one will be the best suitable deployment model for their requirements by evaluating each model comprehensively. The framework is built by applying the analytic hierarchy process(AHP), namely benefit-cost-opportunity-risk(BCOR) model as a powerful and effective tool to serve the problem. The gained results hope not only to provide useful information for the readers but also to contribute valuable knowledge to this new area. In addition, it might support the practitioners' effective decision making process in case they meet the same issue and have a positive influence on the increase of right decision for the organization.

Keyword : Benefit-Cost-Opportunity-Risk(BCOR) Model, Cloud Computing, Analytic Hierarchy Process(AHP)

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1. Introduction

These days, the trend of adopting cloud computing over the traditional model (server-client) among the enterprise, organization, and other units for serving their needs is increasingly popular. In spite of using any kind of services or applications of cloud computing, the user has to select one of three deployment models to implement. These are public cloud, private cloud and hybrid cloud. Depending on the specific requirements, the particular context along with the capability of each organization, they will have different selection result. The issue is how can they choose which one is not only the best match but also profitable, plus advantages delivery for their IT and business strategy. In the unstably developing period of cloud computing nowadays, most of enterprises are not well-equipped with cloud computing knowledge, so this issue is not easy to handle for them. Because of that, in this paper, we present a practical framework highlighting the different aspects and characteristics of cloud computing, namely in benefit, cost, opportunity and risk side. The framework will provide a better understanding of the challenges, chances also obstacles of cloud computing environment, especially for three deployment models of the cloud. Thus, the purpose of this paper is to apply the framework to support the organization in the decision making of which type of deployment models should to be chosen when adopting cloud computing. By using the framework, we give the practitioners a logical and systematic approach to solve the above problem, also help them to save the effort at the same time. The developed framework which is built from many distinct points of views hopes to suggest a holistic assessing for gaining the best solution for this issue.

2. Literature Review

2.1 The BCOR Analysis

"The Analytic Hierarchy Process (AHP) is a general theory of measurement" [27] which depends on the values and judgments of individuals and groups. It has been widely applied to multi-criteria decision making, planning and resource allocation, conflict resolution, and also prediction problems in many fields.

The core of the AHP is structuring a hierarchy to model the problem, as well as using pairwise comparison to evaluate the alternatives. "AHP provides decision makers with a way to transform subjective judgments into objective measures" [31].

AHP has been developed to various kinds of technique, for example the Analytic Network Process (ANP), which is a generalization of the AHP; BCOR analysis while still retaining the core characteristics of the AHP.

In BCOR analysis, the strategy is to construct separate costs, benefits, opportunities and risks hierarchies with the highest level including the overall objectives of the organization and the same alternatives at the lowest level. Then, by taking the BCOR ratio for each alternative, the alternative with the highest ratio would be the optimal choice. In addition, the practitioners should pay attention to costs and risks case when performing the evaluation. They have to consider which one is more costly or risky instead which is less costly or risky.

In addition, the practitioner can apply different forms of BCOR analysis flexibly according to the organization goals and the issues essence, for example just BC, BCO (more positive consideration), BCR (more negative evaluation) or BCOR (more holistic judgment for future) [26].

Some typical example of BCOR can be listed such as choosing the best house, allocating resources for an R&D program, selecting a portfolio for a corporation [27, 28] decision by the US congress on China's trade status [29].

In academic research and study area, there are several papers applied BCOR analysis for solving the practical problems or suggesting the new applications. Kengpol and O'Brien [18] integrated BC model, the decision-making effectiveness model and a common criteria model for selecting Time Compression Technologies (TCT) to help the firm achieve rapid product development like rapid prototyping. Another application was case study in Hong Kong [35]. The authors used BC analysis to check whether the concurrent engineering could be implemented in the specific Electronics Company or not. Tummala et al. [36] also used BC again for an evaluation of success factors in implementing ISO 14001 based EMS and deciding whether to implement it or not. Besides, the trend to combine BCOR with different methods is pretty popular [39]. For example, Erdogmus et al. [7] used the ANP together with BCOR and multiactors for evaluating high-tech alternatives. Or the other interesting study is that the researchers created an ANP framework including BCOR with approximately 50 various factors for finding the best policy in offshore outsourcing from policy maker's perspective [34].

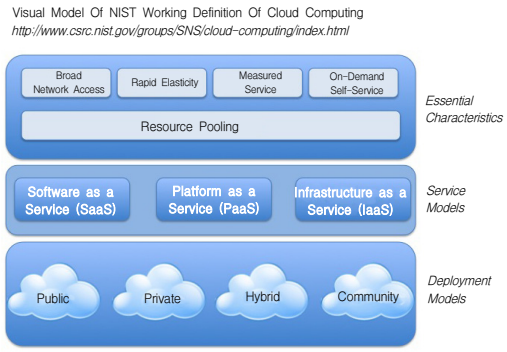
2.2 Cloud Computing

Cloud computing is not a new technology in IT. Instead, it is a model for providing IT services to meet a certain requirements. Simply understanding, it is a new way to organize and operate the resource in the Internet environment by the widespread adoption of several existing technologies [38] such as virtualization, service-oriented architecture (SOA) [42], autonomic computing [32] and gird computing [3]. The unique contribution of cloud computing that differentiate it to the other innovation in IT is helping to delivery IT applications and services to the user anytime, anywhere, any computer. That is the reason why some scholars refer to it as a public utility like water or electrical power [42].

"After the dot-com bubble, Amazon played a key role in the development of cloud computing by modernizing their data centers" [40]. To date, cloud computing is still an evolving paradigm with the participation of many giants in IT such as Google, Microsoft, IBM, Yahoo, Zoho, and Salesforce, etc. There is no common definition for cloud computing concept in scientific literature [37, 25]. Here is one of definition which is descriptive and easy to understand.

"… cloud computing is an emerging computational model in which applications, data, and IT resources are provided as services over the Web (so called "cloud")" [6].

According to NIST [24], cloud computing contains five essential characteristics, three service models and four deployment models (see [Figure 1]). "This working seems to have captured the commonly agreed aspects of cloud computing" [19].



[Figure 1] Visual Model of NIST Working Definition of Cloud Computing

Currently, the issues related to cloud computing like definition, features, underlying technologies, benefits, risks, challenges and chances are continuously explored and refined to give a comprehensive and unified picture for cloud computing in the future.

3. Research Model

There are a number of methodology for decision making support, but the Analytic Hierarchy Process (AHP) emerges as the most popular and prominent methodology by its effectiveness and ease of use. Among many different approaches of the AHP, Benefit-Cost-Opportunity-Risk (BCOR) method has been selected to use as the research methodology. Because cloud computing is still in its developing and perfecting process, BCOR is really a good choice to consider the issue in this paper. It could allow us to judge in a more careful and comprehensive way, due to containing cloud computing potentials and instability. Moreover, it seems there is no existing study addressing the same problem and applying the same methodology in cloud computing research area. Therefore, it is the necessity and the helpfulness, also one of the motivations to perform this research.

The hierarchy from each dimension : benefit, cost, opportunity and risk can be seen in <Appendix A>~<Appendix D> respectively.

3.1 Benefit Hierarchy

Benefit hierarchy for selecting the optimal deployment cloud model (see <Appendix A>).

Operational Definition

The hierarchy for benefit aspect contains four levels, from general criteria to specific criteria, respectively, and the lowest level is the alternatives. The benefit model considers which advantages, or utility that the adopter can be beneficial from implementing one of three alternatives. The first (highest) level includes five fundamental benefit criteria. From these criteria, they break into more particular sub-criteria in second level for the ease of evaluation for the practitioners. Continuously, certain sub-criteria that need to be defined more clearly are structured into smaller concerns in third level. But it just happens in some criteria, not at all. That why we see some criteria or sub-criteria having sub-level while the others don't have.

① Economic. This criterion may be one of the basic and most important benefit of cloud computing. It refers to the efficiency in economic aspect when implementing the specific deployment model. Namely, it has two sub-criteria.

a : TCO (Total cost of ownership)/Investment. This sub-criterion represents costs for setting up and maintaining a cloud [20]. It consists of hardware, software, IT resources to manage the application and any internal char-

ges from firm's IT department for hosting the application or appliance. Although there is a separated hierarchy for evaluating cost, it is better to have a general consideration from viewpoint of economic benefit of TOC.

b : Energy/Power. Although it is an issue that people almost don't pay much attention, it isn't minor when deciding to adopt cloud computing. It concerns about the energy management and cost for providing an adequate power, cooling … for the system. In Hamilton's research [11], he pointed out that the cost of powering and cooling accounts for 53% of the total operational expenditure. There will be the big difference in energy benefit between three deployment forms of cloud computing.

② Independence/Managerial. The second main criterion refers to the independence or freedom of the organization from managerial perspective after applying cloud computing. It contains the self-reliance in two things below.

a : Data control. It is about the management privilege of the users on their own data

b : Corporate policies. Each organization also has its own rules in operating and managing IT, doing business, even though in organizational scope or some unique regulations. This sub-criterion refers to the managerial benefit in case the leaders can govern their agency regulatory.

③ Satisfaction. This third general criterion focuses on the beneficial side of feeling when the enterprise needs are met and satisfied. It is qualitative by 2 concrete sub-criteria.

a : Requirements. There are numerous requirements from the company when they adopt a certain application, not just in case of cloud computing. It can be different needs ranging from technology such as hardware, software, user interface, etc. to business like business processes, functions or user permission, etc. Depending on the distinctive situation of each enterprise, they will have different requirements. This sub-criterion evaluates the degree of company satisfaction based on how much their requirements are met by every deployment model.

b : QoS (Quality of Service) [5]. It has several specific measurements.

i : Offering range/choice. It represents the range or limitation of service offering and the diversity of providing service through adopting three cloud computing deployment models. "In cloud computing environment, the service content offered by service providers can be defined, adjusted according to the needs of the user. Beside the service items, there are also the time, quality and performance requirements provided with the service. Generally, these agreements are referred to as Service Level Agreements (SLA) [16]" [13].

ii : Availability [2, 8, 22, 37]. This measurement refers to which extent the new system deployed in three models is always in ready state to serve and perform its functions. Along with confidentiality and integrity, availability is evaluated one the three most common IT security objectives [4].

iii : Scalability [2, 33]. It concerns about how much the degree that the system is scalable. One pros of cloud computing is that it is able to scale without depending on geographical locations and hardware

performance “in order to handle rapid increase in service demands (e.g. flash-crowd effect). This model is sometimes called surge computing [1]” [43]. Every organization perhaps will change its needs in every time period, so the ability to scale up or scale down to be fit of applied model is pretty critical.

iv : Performance. This concern is a general measurement and it refers to the common performance of the whole system. There are a lot of standards to judge the performance of one system, for example the productivity, the speed of data transfer, the storage capacity, the response time, etc

④ Effort. The fourth main criterion refers to the gained benefit based on used-in effort. According to this criterion, it cares about personnel and human side rather than monetary side. It is divided into the detailed type effort as follow

a : Implementation. The effort is spent to fully implement the solution, e.g. building the system structure, negotiating.

b : Management. It represents the attempt to manage, control and master the built system.

c : Upgrading. In addition to maintain the system, it needs to be upgraded to keep up and achieve more purposes in the future. To obtain that, it requires not less effort from the organization and it varies from this deployment model to that deployment model.

⑤ Time. The last main criteria shows the benefits got from saving time for applying one specific cloud model. It can be deploy time, delivery time, or provisioning cycle time, etc. … In our high-pace society, the more rapid time we spend, the more advantages we get.

3.2 Cost Hierarchy

Cost hierarchy for selecting the optimal deployment cloud model (see <Appendix B>).

Operational Definition

The hierarchy for cost is more simply than the benefit hierarchy. It just has one level that is for criteria and the left level which is for the alternatives. There are six different types of cost needed considering as below.

① Infrastructure. This is cost to facilitate IT infrastructure and equipment to implement cloud computing, for example servers, storage devices, wire system, etc.

② Deployment/Implementation. It refers to the expense for fulfill cloud computing deployment task. Based on the distinct features of the selected cloud model, the enterprise will spend different amount of money.

③ Maintenance [23]. After completing cloud adoption, the important work is to maintain it for long time use and ensuring that the system works stably. It is also one kind of cost, for instance the energy cost for supplying electricity, renewing the hardware, data transfer costs [2], auditing [37, 2, 22], etc.

④ Switching. There is a situation such like changing the vendor or shifting the cloud model that the organization should think about. It will lead to the switching cost such as integration costs [33, 22] accompanying with some considerable problems that will be pointed out in the risk hierarchy.

⑤ Service. Except the above costs, occasionally the organization use the other services for cloud system such as training or learning new knowledge of cloud computing, consulting cost,

etc. It could be some unexpected services occurring during adopting and using time.

⑥ Human resource. The last cost is to invest for human resource of company to be responsible and to manage those above mentioned tasks. This cost also differently changes for each cloud computing model.

3.3 Opportunity Hierarchy

Opportunity hierarchy for selecting the optimal deployment cloud model (see <Appendix C>).

Operational Definition

The opportunity model is also pretty simple. It contains three primary chances.

① Cost savings. It refers to the opportunity for saving costs in the future while continuously using that cloud computing model. There is this kind of model that may be cost much for implementing, but profitable for long time using while the other is reverse. Several savings can be listed such as lower operating cost [43], extending expenditures, renew or fix IT infrastructure expenses.

② Expansion. It is about the ability that the system is easy reallocation of resources (e.g., networks, servers, storage, applications, services), scale as needed [25]. When the business requirements of company change, the system which is quickly adaptive and responsive will bring the big advantages for the owner, especially the competitive competence.

③ Innovation. Cloud computing is still on its growing progress, thus it is promising to provide valuable benefits for the adapter in the future. Operating organization's business within the cloud computing environment may help the organization not only keep pace with the rapid change but also create and obtain the innovative opportunities.

3.4 Risk Hierarchy

Risk hierarchy for selecting the optimal deployment cloud model (see <Appendix D>).

Operational Definition

The risk hierarchy is little bit complicated comparing to the cost and opportunity hierarchy because "cloud computing service are exposed to a high degree of risks that result from technical issues" [23]. It has three levels; the principal criteria, sub-criteria and the alternatives, respectively. It concerns about these following issues.

① Data. Data is always the paramount care in majority IT application, not just only in cloud computing. Nevertheless, this concern becomes more and more crucial toward cloud computing, by the diversity of implementation form and service provided. The risk related to data could be classified into these issues.

a : Access [9, 33, 15]. This risk comes from the data location. Using the service built on cloud computing, the users have the remote accessibility. It means they can connect and access the service from anywhere, from any computer even without their own computers because everything is on the cloud. So the organizations should be careful in protecting their data access right. Especially in case of public cloud, the adopter often has the worried feelings about the illegal and unauthorized data access by the provider or the third party, like hackers. "Storing the company's data on the service provider's equipment rai-

ses the possibility that important business information may be improperly disclosed to others [12]" [13].

b : Integrity [9]. This concern rising from the sudden troubles or unexpected incidents such as broken hardware, power supply damage leads to the potential loss of data integrity. Therefore, it requires the well-prepared solutions together with the reasonable recovery function to deal with these problems. It is considered one of the three most common IT security objectives [4, 23].

c : Mobility and ownership [15]. How about the data portability and data ownership when the organization will stop its current service to move to another service vendor, or adopt one more cloud service from different provider, or even though changing cloud deployment model e.g. from public cloud to private cloud. The user should know clearly about the data sharing or data integration policy of vendors between clouds, also the data moving rule to ensure the continuous working on the new service and the data possession right. Will the data be removed or still kept after ending service? Moreover, the complexity of the cloud can make the solution become more difficult to execute, then leading more risky.

② Lack of control [21]. It refers to the worry which is about the incomplete control of sensitive data and personal information, especially in large organizations and public cloud adoption. "What are the political implications for organizations that lose control over some aspects of their services?" [19]. Furthermore, in case of using cloud computing as a joint of many providers, how will result in responsibility [17].

③ Security [9, 25, 10, 37]. It is identified as one of five domains that cloud computing is vulnerable by John [14] and the primary consideration as soon as cloud computing has been appeared [15]. Because "the application will be exposed to the Internet, so the security threats will be far higher than the traditional model" [41]. It represents the need of safety and security for a cloud system. The system could be in danger by the hacker's attacks or the poor security capability of that system. It includes two below concerns.

a : Trust. It is how much the degree the organization believes in the service provider and that cloud model to face to safe and secure issues. "For cloud computing to spread, users must have a high level of trust in the methods by which service providers protect their data" [13].

b : Privacy [14, 25, 23]. It refers to which extent the user could be private on the deployment models of cloud computing, in particular the government agency or business requiring high level of confidentiality in data access and transfer like financial transaction, online payment. The important of compliance (loss of confidentiality [43]) in cloud computing is stressed on Informationweek.com (Jun. 23, 2010) as following : "IT must vet service providers in terms of security and compliance in order to assure upper management of their viability and dependability" [23]. "Make sure a cloud service includes data encryption, effective data anonymization, and mobile location privacy" [9].

④ Recovery. It concerns about the recovery capability to roll back the previous state in case of error, exception, destruction or incident. Besides the data, the system must ensure the cor-

rectness of functions and the consistency in daily operations. “The objective is to recover from most errors and exceptions without human intervention, if possible” [9]. Because cloud computing is a big and complex system, it isn't easy to handle once the problem occurs.

⑤ Internet latency. “It is primarily about the Internet and network performance” [25]. Particularly, the network bandwidth and the data transfer rate are limited to those of Internet Service Provider (ISP). It maybe leads to the data latency and other problems which will influence on the operational activity of system, for example data transfer bottlenecks [2].

⑥ Permanence. Toward the public cloud model, the concern is how long the system survives. Is it long term or short term? And there is a sustainable survival? Moreover, there is a worry about the uncertainty particular in rental software contracts [30] and general in the agreements, SLA like missing or lacking of important terms due to unpredictability, etc.

⑦ Vendor lock-in. The dependency and the tie of provider regulations is one of user attention worthy.

3.5 Alternative

From the aspect of deployment, specializing in the viewpoint of publicity of usage of cloud computing, there are three types of cloud [25].

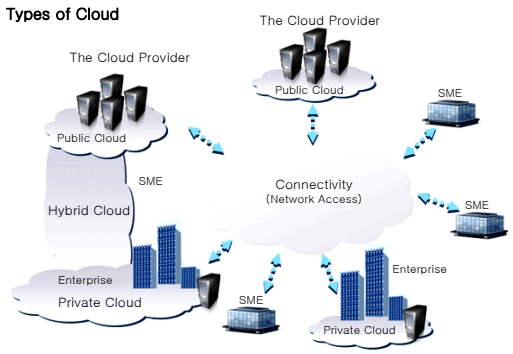
① Public cloud. The cloud infrastructure is made available to the general public and is owned by an organization selling cloud services. The vendors of this cloud offer their services to any customers through the public Internet, for example Salesforce.com, Google App Engine, Microsoft Azure, and Amazon EC2 [25]. The customer has no visibility and control over where the infrastructure is hosted. And the computing infrastructure is shared between any organizations using that service. The service based on this type of cloud computing can deliver the best economies of scale, in contrast, it can limit the configuration, SLA specificity and security due to the shared infrastructure

② Private cloud. The cloud infrastructure is owned or leased by a single organization and is operated solely for that organization e.g. large companies, universities, hospitals or government units [25]. Thus, the service built on this cloud is inside (resides within) the firewall system of the organization and works on the private network. Private clouds are of two types : On-premise private cloud and externally hosted private cloud (or off premise). Externally hosted private cloud is also exclusively used by one organization, but is hosted by a third party specializing in cloud infrastructure while on-premise private cloud is reverse. Externally hosted private cloud is cheaper than on-premise private cloud. These clouds offer the greatest level of security and control [43], but they require the company to still purchase and maintain all the infrastructure and software directly or indirectly, which reduces the cost savings that is one of the advantages of cloud computing.

③ Hybrid cloud. It is realized by the mix or combination of private cloud and public cloud [25] to supply the services but still remain as a unique entity. A hybrid cloud includes the services from both the private and public space with multiple options for provider. This kind of cloud is more complicated than the others and requires the customer to have to keep track the system and also ensure that all aspects of the business

can communicate with each other. But it offers more flexibility than both public and private cloud, specifically the tighter control and security while still facilitating service expansion and contraction [43].

[Figure 2] depicts the whole picture of cloud computing, including three deployment models and the interaction between them in the macro context.



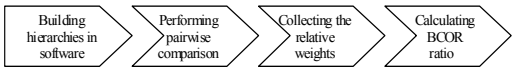
[Figure 2] Three Types of Deployment Model in an Overview of Cloud Computing

4. Numerical Example

This case is shown to illustrate the real using process of BCOR and how to apply the built models to solve the problem intuitively.

XYZ is a medium size company working on public relation. Because of the large demand on managing customer information and leveraging it most productively, the company wants to adopt customer relationship management (CRM) system. Between the traditional model client-server and new emerging paradigm-cloud computing, XYZ tends to choose cloud computing due to its promising vista, thus the company can be able to broaden its CRM system with new functions like social CRM, and catch new trends in business environment, e.g. social commerce, online user's community in the future. Since the crucial role of CRM system, the company carefully considers which approach of cloud computing service which it should implement to ensure the performance and the stable development of system in long term. Hence, organization XYZ applies the BCOR framework to support the decision-making of opting for 3 models of cloud computing.

The company use *ExpertChoice* software (or *SuperDecision* software is also a good replacement). The detail procedure is modeled as follow.



[Figure 3] Detail Steps of BCOR Analysis

Because the whole process is almost executed by the software, except some important parts that need the intervention of human like building and evaluating the hierarchy, the company maybe won't have any obstacles to perform it.

① Realizing the available hierarchies : benefit, cost, opportunity, risk into the software.

② Making the pairwise comparison for all the hierarchies and alternatives.

③ Getting the relative weight of each alternative in every hierarchy through the automatic synthesizing function of software. <Table 1> shows the priority of criteria and the relative weights of 3 alternatives according to the criteria in each model.

④ Deriving the BCOR ratio of each alternative then selecting the best alternative. The company can consider among three different ratios and choose which one is the best match to their aim, then, calculating the corresponding ra-

〈Table 1〉 The Relative Weights of 3 Alternatives with Respect to Criteria

Benefit	Priorities	Public Cloud	Private Cloud	Hybrid Cloud
TOC/Investment	0.088	0.731	0.188	0.081
Energy/Power	0.022	0.667	0.111	0.222
Data Control	0.137	0.072	0.649	0.279
Corporate Policies	0.046	0.085	0.644	0.271
Requirements	0.092	0.072	0.649	0.279
Offering Choices/Range	0.044	0.691	0.149	0.160
Availability	0.047	0.122	0.558	0.320
Scalability	0.022	0.625	0.136	0.238
Performance	0.164	0.100	0.466	0.433
Implementation	0.016	0.731	0.188	0.081
Management	0.059	0.731	0.081	0.188
Upgrading	0.053	0.683	0.117	0.200
Time	0.208	0.769	0.147	0.084
Final weight		0.377	0.375	0.248
Cost	Priorities	Public Cloud	Private Cloud	Hybrid Cloud
Infrastructure	0.051	0.067	0.661	0.272
Implementation	0.185	0.061	0..353	0.586
Maintenance	0.279	0.105	0.637	0.258
Switching	0.257	0.558	0.122	0.320
Service	0.094	0.333	0.333	0.333
Human Resource	0.134	0.085	0.644	0.271
Final weight		0.246	0.407	0.346
Opportunity	Priorities	Public Cloud	Private Cloud	Hybrid Cloud
Cost Savings	0.088	0.600	0.200	0.200
Expansion	0.243	0.140	0.528	0.333
Innovation	0.669	0.097	0.570	0.333
Final weight		0.150	0.528	0.322
Risk	Priorities	Public Cloud	Private Cloud	Hybrid Cloud
Access	0.189	0.691	0.091	0.218
Integrity	0.031	0.683	0.117	0.200
Mobility and Ownership	0.077	0.731	0.081	0.188
Lack of Control	0.077	0.683	0.117	0.200
Trust	0.058	0.691	0.091	0.218
Privacy	0.232	0.691	0.091	0.218
Recovery	0.112	0.250	0.095	0.655
Internet Latency	0.039	0.691	0.091	0.218
Permanence	0.131	0.691	0.091	0.218
Vendor Lock-in	0.055	0.243	0.088	0.669
Final weight		0.616	0.094	0.290

tio for each alternative. <Table 2> is the final weights of 3 alternatives for each hierarchy and the ratios. The formulations of these ratios are as below.

① B/C = Benefit/Cost
② B/(C×R) = Benefit/(Cost×Risk)
③ (B×O)/(C×R)
= (Benefit×Opportunity)/(Cost×Risk)

For every ratio, the alternative that has the highest value is the recommended solution. In case of <Table 2>, if company XYZ uses BCOR ratio, the optimal choice will be private cloud.

5. Conclusions

By combining BCOR technique of the AHP and cloud computing, the paper suggests a selection framework to support the decision makers in the issue what type of deployment models should be applied as adopting cloud computing. This framework has four hierarchies representing for four primary aspects including benefit, cost, opportunity, and risk together with various criteria. The approach to develop these selection models is from the practical view point rather than the theoretical perspective. And it hopes to provide a useful, significant and also comprehensive tool for the managers, CIO to solve the problem such like this. Furthermore, it is also a contribution to the research field of cloud computing which doesn't have many practical and deep studies for the similar issue. The other researchers could refer this paper to serve for their deeply and widely further studying or to develop the more holistic framework, etc. In addition, the results of this research also partic-

〈Table 2〉 Summary the Final Weights and the Calculation of Ratios

Alternative	Benefit	Cost	Opportunity	Risk	Standard B/C	Pessimistic B/(C×R)	Realistic (B×O)/(C×R)
Public cloud	0.377	0.246	0.150	0.616	1.533	2.488	0.373
Private cloud	0.375	0.407	0.528	0.094	0.921	9.802	5.175
Hybrid cloud	0.248	0.346	0.322	0.290	0.717	2.472	0.796

ipate in the growing and evolution period of cloud computing.

The given challenges, obstacles and chances could be worthy to consider for better improvement and utilizing cloud computing from the vendor and user aspect.

For the purpose to be more valuable, empirical and persuasive, this study will be going to conduct a case study to apply the got result from this time. By using the developed models to specific organization who has the need to adopt certain service of cloud computing, it is promising not only to gain helpful lessons for research but also to obtain real experiences for readers reference and utilization.

Through the right and overall assessing about cloud computing based on well-equipped knowledge, clearly understanding the needs and situation of the organization, the users can maximize the benefits, meanwhile minimize the disadvantages, and prevent the risks at the same time by choosing the best deployment model for their organization to use up the value of cloud computing, the next bright era of IT.

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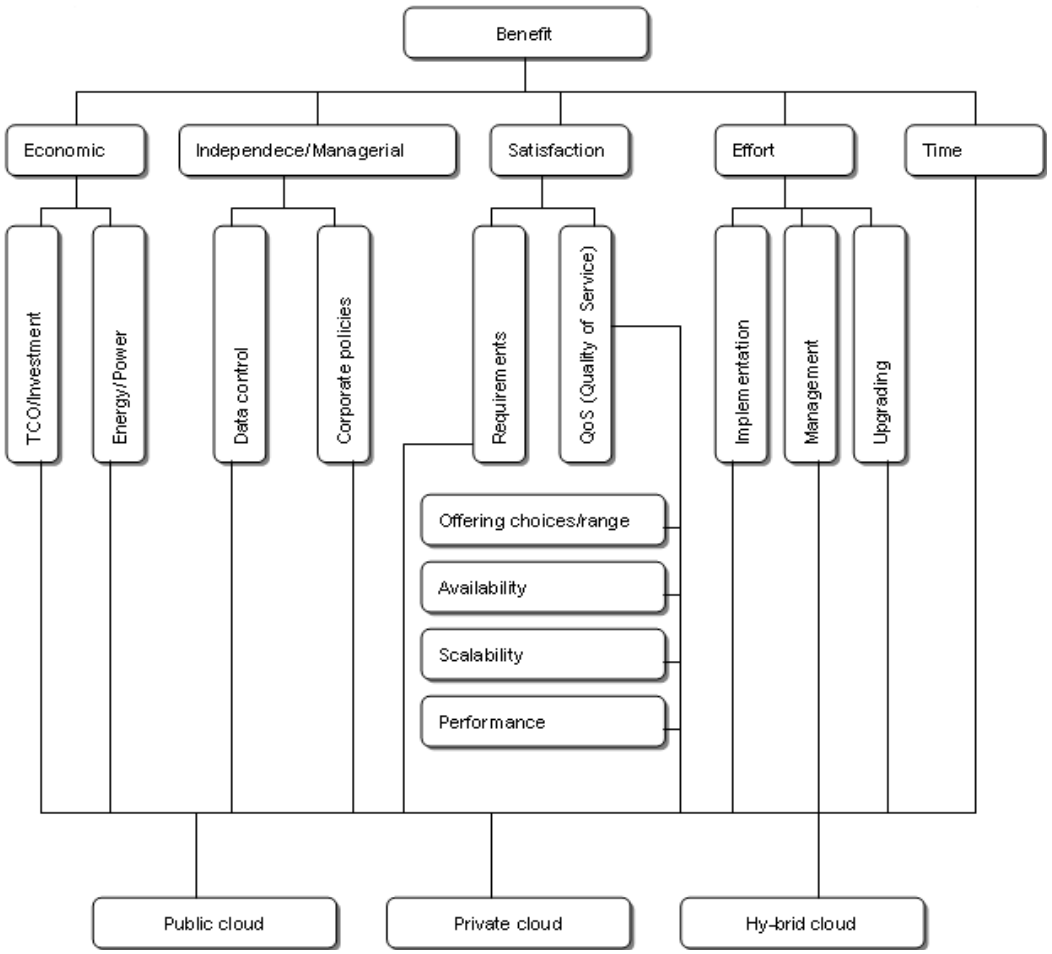
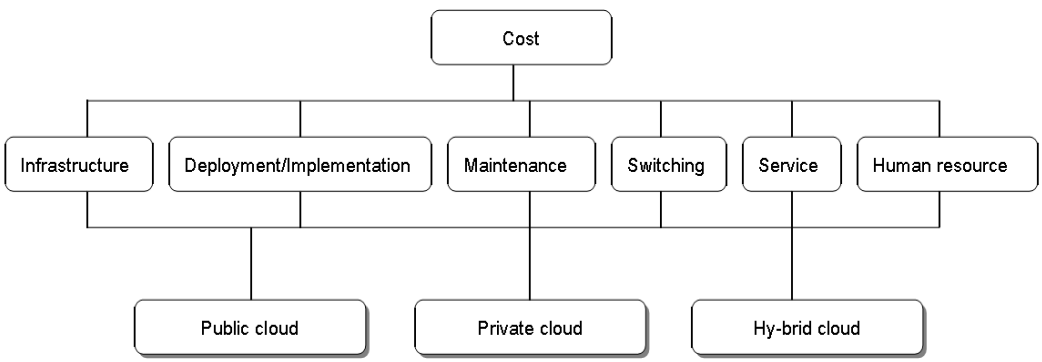
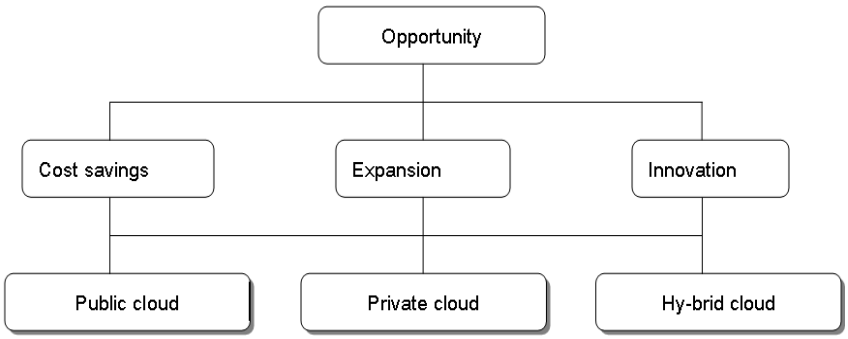
〈Appendix A〉 Benefit Hierarchy



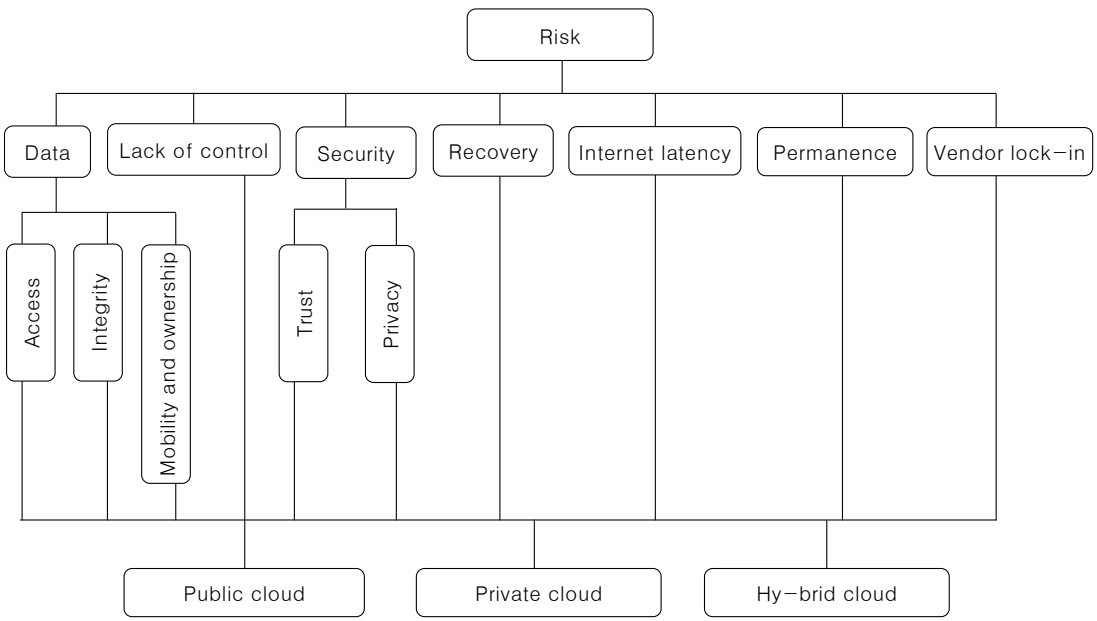
〈Appendix B〉 Cost Hierarchy



〈Appendix C〉 Opportunity Hierarchy



〈Appendix D〉 Risk Hierarchy



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서강대학교 경영학과, 동 대학원에서 경영학 석사 및 박사학위를 취득하였다. 동국대학교 경상학부 부교수로 재직하고 있으며, Annals of Management Science, The Open Operational Research Journal의 편집위원으로 활동 중이다. 주요 관심 분야는 지식경영, 기업성과측정, 데이터마이닝, 복잡계 이론, 다기준의사결정 등이며, Human Factors and Ergonomics in Manufacturing, Expert Systems with Applications 등의 국외 학술지와 경영학연구, 경영과학회지 등의 국내 학술지에 다수의 논문을 게재한 바 있다.

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동국대학교 테크노경영협동과정 석사과정에 재학 중이며, 관심분야는 서비스사이언스, 데이터마이닝, 공급사슬관리 등이다.