

RESEARCH ON THE PRICING MODEL OF PUBLIC CLOUD SERVICES IN THE PUBLIC SECTOR

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ABSTRACT. *The Korean government is expected to accelerate the adoption of cloud computing in the public sector with the enactment of the Law on the “Development of Cloud Computing and Protection of Users”. However, in order to estimate the cost of introducing cloud computing in the public sector, there does not exist adequate calculation model. In most cases, the IT manager admits the cloud computing cost presented by the cloud service providers. This makes it difficult to judge the appropriateness for cost of public cloud computing. Therefore, this study intends to develop an accurate and easy-to-use model that is suitable for domestic situation and applicable to cloud computing business.*

Keywords: Cloud computing, Public cloud, Pricing model, Public sector

1. **Introduction.** Cloud computing is a new paradigm which has changed traditional business schemes/plans and new economic and financial models of IT service market [1]. The Korean government is also making efforts to improve IT service’s efficiency by adopting cloud services in the public sector. Price is an important factor for government which adopts cloud services. The price is a major impact in the economic aspect, where concepts such as fairness and competitive pricing in multi-provider marketplace affect the actual pricing [2]. The cloud cost model is much more complicated than the previous cost models. Furthermore, in order to estimate the cost of introducing cloud computing in the public sector, there does not exist adequate calculation model.

This study investigates the actual conditions of domestic and foreign cloud computing users and analyzes the implications of the models and system. It also analyzes cloud computing business cost data both domestically and internationally, and cost data by domestic and foreign major cloud service providers. Cost data are collected and analyzed, and the model is set up for the cloud computing service that can be applied in the public sector [3,4,6].

Eventually in this study, we proposed a cost estimation model that can be applied objectively when public cloud computing service is introduced. The results of this study can be applied not only to the basic data for estimation by public institutions that intend to introduce cloud service but also to the budget reviewer who deliberates the budget. In

addition, it is expected that it can be used as a basic data for the private cloud service activation policy based on the analysis result of the private cloud provider cost data in this study.

2. Related Works.

2.1. Cost calculation of government project. The cost calculation at the time of the government procurement contract is generally called the government cost calculation. The government cost calculation is not a cost calculation of a government organization but a cost calculation used when the government decides the planned price to conclude a purchase, manufacture, construction, or contract with the private sector. The government cost calculations are based on the assumption that government agencies, such as the procurement agency, will use the government's accounting rules to set a pre-determined price for contracts, such as construction orders. We will use the cost calculations to determine. In addition, when a government organization purchases its own or issues construction work, cost calculation is necessary. In addition to the determination of the planned price, provisions related to the planned price may be used for the cost calculation of other governments. Therefore, it cannot be the most important criterion.

2.2. Planned price of cloud service project. The purchase method of the core service is classified into the purchase method that requests for procurement through the project participant and the method that the demand organization directly purchases. In the central procurement system, there is a system that utilizes the market synthesis of the country of the project participant (shopping.g2b.go.kr). On the other hand, the original procurement system includes a contract purchase system that can be purchased as a competitive bidding system. The method of purchasing the competitive bidding is to authorize the bidding by the introducing organization and concludes the supply contract after selecting the bidders' evaluation. In addition, in order to purchase a number of contracts, the proposal companies are evaluated based on the proposal request, omitting the announcement of bidding and the supply contract is made after the selection.

2.3. Conventional cloud service cost model [5]. The cost accounting method in the cloud service is generally based on the costs provided by the cloud provider. The only criterion for cloud cost estimates in public sector can be a "public sector cloud service metering systems" cloud computing standardization forums standards. Reasonableness and flexibility should be established when establishing a billing system for public services in a service system in the public sector. These cloud service pricing models are designed

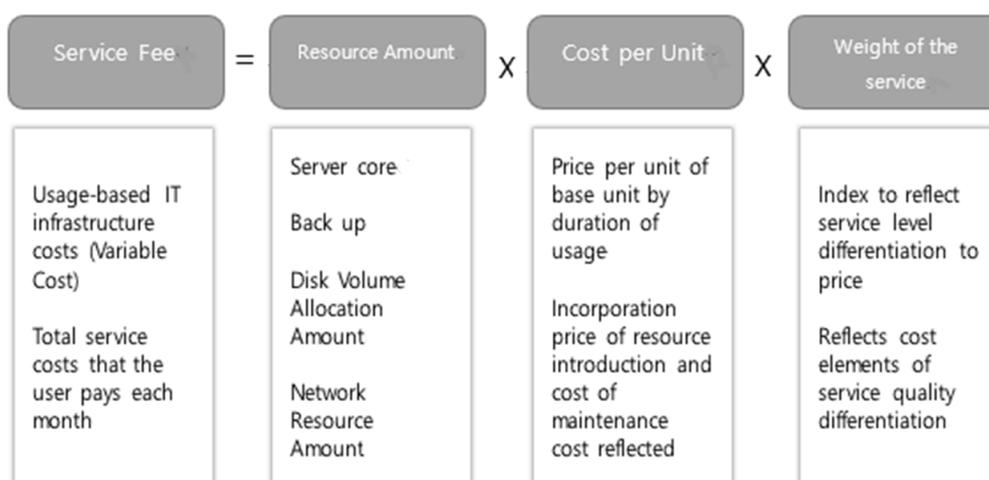


FIGURE 1. Conventional price model

around infrastructure as a service. The price of the infrastructure service, that is, the service fee is calculated as the product of the resource quantity, the resource unit price and the service class weight.

The price of a cloud service is the service fee that is notified to the user every month as the use based IaaS service fee or when the use of individual services ends. The amount of resources is the amount of in-flight transaction resources allocated to the user or used. The server service is the number of CPU cores of the allocated server, the storage service is the allocated disk capacity, and the backup service is the backup amount.

3. Proposed Pricing Model for a Cloud Service.

3.1. **Cloud computing pricing model.** Consumers can evaluate potential service providers based on three key parameters: price approach, quality of service (QoS), and duration of use. Figure 2 illustrates the main aspects of the pricing model.

The pricing method refers to the pricing process. The pricing method can be divided into fixed price without consideration of volume, fixed price + cost per unit (Billing the customer a unit charge based on fixed price and rate), contract purchase quantity + unit price (the customer pays a fixed price for the contracted usage amount, and the customer has to pay a fixed fee per unit when the usage amount is exceeded), ceiling unit price (the supplier does not charge the customer for exceeding the limit and the customer also pays the up to the certain limit), unit price (independently priced by contract), and the like.



FIGURE 2. Proposed pricing model

TABLE 1. Pricing method

Pricing method	Contents
Fixed price without consideration of volume	A fixed price on a customer regardless of the volume of the service or product
Fixed price + cost per unit	Based on fixed prices and unit rates
Contract purchase quantity + unit price	A fixed price for contracted usage and impose by a flat fee per unit for exceeded usage
Ceiling unit price	Per unit up to a certain limit and no additional charge in exceeded usage
Unit price	Different prices per unit per customer

Quality of Service (QoS) is a requirement that a CSP (Cloud Service Provider) must provide to a consumer. QoS requirements can include service availability, security, privacy, scalability and integrity of the CSP. Ensuring CSP keeps these requirements at a high level improves the quality of the cloud services provided. The period of use can be defined as the period during which the customer can use the supplier service based on the SLA (Service Level Agreement) between the parties. It can last forever based on subscription term or Pay-Per-Use (PPU) model.

3.2. Definition of cloud computing price model by categories & characters.

When using cloud computing services, the factors for price calculation may be different according to service type such as IaaS, SaaS, PaaS, and service provider’s pricing policy. Moreover, the method of calculating the price of a complex service becomes more complicated. Cloud computing service fee can be determined by the amount of resources invested, the unit cost of each resource, the class weight of the service provided according to SLA, and the discount rate by period or billing method.

$$\text{Service Fee} = \text{Resource} \times \text{Unit Cost of Resource} \times \text{Class Weight of the Service} \times \text{Discount Rate} \tag{1}$$

In particular, discount rate may be applied according to the cloud billing method, which can affect the usage rate. The billing method of the private cloud differs depending on the negotiation with the service provider and usually categorized by these six types.

- ① Fixed monthly billing method: The service usage fee is calculated at fixed cost per month.
- ② Fixed annuity billing method: Calculate service usage fee as annual fixed cost.
- ③ Prepayment method: Pay for the first year, such as a lump sum, and use it during the contract period.
- ④ Partial monetization method: Calculate in the form of basic charge for certain limit + additional charge in additional usage.
- ⑤ Multi-year contract method: Multi-year contract can be made through negotiation with service provider, and the fee can be reduced by negotiating with contract.
- ⑥ Charging method per specific unit: The usage fee is in/decreased according to the amount of usage, and the form varies according to how the contract is used (Per Storage GB, Per transaction charge) regardless of the usage period.

Therefore, it is possible to define the model by types/characteristics on the basis of analysis and factors affecting such usage.

TABLE 2. Calculation items for each H/W component

Object			Calculation items			
			Resource amount	Resource unit cost	Class weight of the service	Discount rates
IaaS	Server	CPU	○	○	○	○
		Memories	○	○		
		Disks	○	○		
	Storages		○	○		
	Backup		○	○		
	Networks		○	○		
PaaS	OS		○	○	X	
	DB(MW)		○	○	X	
SaaS	Application		○	○	X	

Based on the cloud service model, the service types are classified into three categories: IaaS, PaaS, and SaaS. Costs for IaaS are divided into four categories: server, storage, backup, and network. The server is subdivided into CPU, memory, and disk, and the server usage cost is finally calculated. PaaS generally provides runtime, middle, and OS as services, and it is targeted to calculate OS and DB(MW) that most CSPs in Korea and overseas provide. Finally, although SaaS can be applied to applications and data, only the application is limited to this study. The calculation items for cost estimation are composed of four factors, that is, resource amount, resource unit price, service class weight, and discount rate. Depending on the applicable model (target), service class weights can be applied differently between IaaS (Infrastructure as a Service), PaaS (Platform as a Service), SaaS (Software as a Service).

4. Conclusions. It is expected that the introduction of cloud computing in the public sector will accelerate in accordance with the enactment of the “Law on Development of Cloud Computing and Protection of Users” in Korea. However, in order to estimate the introduction cost of public cloud computing in the public sector, there is no adequate calculation model. In most cases, the information business manager admits the cloud computing cost proposed by the developer. As a result, it is difficult to judge the appropriateness or cost of public cloud computing.

The purpose of this study is to develop a cloud service model that is suitable for domestic situation and applicable to cloud computing business and can be used easily and accurately. The proposed model is designed in detail considering the most important factors affecting the pricing of cloud computing. Finally, it is designed to apply different equations according to the type of cloud considering the characteristics of cloud.

This study has limitations in that the criterion applied by the calculation items which is the core of the model is analyzed and applied only to the data of domestic companies. In particular, in case of the service class weights, it is intuitively selected according to judgment through FGI of group. Therefore, in future research, there should be an attempt to obtain an objective basis for the application criteria of these estimation items through questionnaire survey and in-depth analysis of international data.

REFERENCES

- [1] A. Ibrahim, Price schemes in cloud computing: An overview, *International Journal of Advanced Computer Science and Applications*, vol.7, no.2, 2016.
- [2] A. Ibrahim, Cloud computing: Pricing model, *International Journal of Advanced Computer Science and Applications*, vol.8, no.6, 2017.
- [3] M. Al-Roomi, S. Al-Ebrahim, S. Buqrais and I. Ahmad, Cloud computing pricing models: A survey, *International Journal of Grid and Distributed Computing*, vol.6, no.5, pp.93-106, 2013.
- [4] I. A. Kash and P. B. key, Pricing the cloud, *IEEE Internet Computing*, vol.20, pp.36-43, 2016.
- [5] S.-H. Chun et al., Service models and pricing schemes for cloud computing, *Cluster Computing*, vol.17, no.2, pp.529-535, 2013.
- [6] P. Samimi and A. Patel, Review of pricing models for grid & cloud computing, *Proc. of IEEE Symposium on Computers & Informatics*, 2011.