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IMPACT OF PUBLIC CLOUD COMPUTING SERVICE IN KOREAN GOVERNMENT ORGANIZATIONS

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Abstract. *In tandem to advanced overseas IT markets such as the U.S., U.K., China and Japan, the Korean government has launched the Comprehensive Plan for Facilitating Public Cloud Computing and Cloud Computing Development Act. This study assesses the outcomes related to Korean government policies to foster cloud industry growth in the public sector and efforts to mitigate associated risks related to privacy and security. Based upon a Korean government cloud utilization survey, we identified 74 Korean public institutions using public cloud services. The purpose of our study is to analyze the Korean public institution cloud service usage and create metrics to identify and measure business and system performance including downtime, cyber security infringement, impact on business performance and the reduction of total cost of ownership. We analyzed results from 47 responding institutions that responded to our Likert 7-point scale survey. In conclusion, we found that public cloud utilization improved business performance and imparted financial benefits with a reduction in total cost of ownership ("TCO"), with the system expansion and system stability reported as significant.*
Keywords: Cloud computing, Performance evaluation, e-Government

1. **Background and Research Purpose.** Cloud computing services ("cloud") mark an evolution in the deployment and management of information technology and are recognized as a key underlying technology for information and computing technology ("ICT") change. Such services require a transition from company reliant – internal systems to usage of external Internet services. Cloud computing is premised on the idea that total cost of ownership ("TCO") will be reduced as users share capacity, thus increasing business agility, flexibility and service innovation. Such synergy, however, involves management of security, privacy, compliance, data location and potential vendor lock-in. In recognition of the benefits and need to manage risk, governments of countries with advanced IT infrastructure have recognized the importance of cloud services to organization competitiveness and need to develop proper infrastructure to manage the associated risks. In order to promote the cloud and revitalize the cloud at the government level, the Korean

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government has similarly implemented a diverse set of policies to foster cloud industry growth. In 2009, the Ministry of Interior and Security, the Ministry of Trade, Industry and Energy, and the Korea Communications Commission jointly launched K-ICT known as the "Comprehensive Plan for Facilitating Public Cloud Computing". In 2015, K-ICT was followed by the establishment of the 'Cloud Computing Development Act' and in 2016, 'National K-ICT Cloud Computing Act' [1-3,9,10]. In effort to substantiate the effectiveness of such efforts, this study focuses on the performance and achievements of the Korean government's use of cloud in the public sector. This study presents empirical analysis results about the performance of public cloud usage in both system business performance areas. Given the Korean government's investment cloud usage, our study results have the potential to provide future research insight related to metrics to measure system performance in areas of system stability, information protection and cyber security infringement rate, and business performance related to the reduction of total cost of ownership and the degree of increased efficiencies of government sector cloud computing services.

2. **Cloud Utilization by Country.** In some advanced overseas IT markets, countries such as the United States, United Kingdom, Japan and China have developed and implemented specific policies to foster and promote the cloud industry. In the U.S. and U.K., the governments adopted 'The Cloud First Policy'. In the U.S. the official purpose of the Cloud First Policy is to accelerate the pace at which the Federal Government realizes the value of cloud computing by requiring agencies to evaluate safe, secure, cloud computing options before making any new investments. Launched in 2013, in accordance with the 2018 Federal Cloud Computing Strategy, the Cloud First Policy was updated into Cloud Smart – a long-term, high-level strategy to drive cloud adoption in Federal agencies and offer a path forward for agencies to migrate to a safe and secure cloud infrastructure. This new strategy encourages agencies to achieve additional savings, security, and deliver faster services. In the UK, in addition to the Cloud First Policy, the United Kingdom has established policies to revitalize SMEs' cloud services through the procurement of 'digital marketplace'. The UK is set to update cloud first with a policy that reflects the growing appetite for hybrid IT deployments in the public sector. Australia is strengthening security system policies to ensure cloud safety. Meanwhile China is fostering traditional industries and creating city-sized cloud computing and office complexes that include mega data centers with Alibaba holding a cloud computing conference in 2019, attracting 120,000 people, which surpassed the 50,000 people attending Amazon Web Services.

In tandem to other industrialized nations to revitalize the adoption of cloud computing at the government level, in 2009 the Korean government established a comprehensive plan to promote the cloud industry by establishing the 'Comprehensive Plan for Facilitating Public Cloud Computing' jointly by the Ministry of Public Administration and Security, the Ministry of Knowledge Economy and the Korea Communications Commission. While the Korean government announced it would move 750 government services to the cloud by

Table 1. Public cloud usage by Korean government organizations

Division (Number)	Central Government Agencies (47)	Central Administration Affiliated Organizations (378)	Constitution Agency (7)	Local Administrative Bodies and Agencies (245)	Local Public Enterprises (115)	Public Organizations (332)	Schools (12,032)	**Total (13,156)**
Organizations using public cloud	3	5	3	24	14	75	152	276
					89			
Percentage of usage	6.4%	1.3%	42.9%	9.8%	19.9%		1.3%	2.1%

2017. With a target to increase Korea's cloud use by ten times by 2018. According to the 2017 survey on cloud use, as of December 2017, 276 of the 13,156 public organizations were using Korean government public cloud services, excluding schools (12,032), 124 Korean public organizations or 11.0% and 89 out of 447 (19.9%) of public organizations (local public enterprises and public corporations) were using public cloud systems.

3. Cloud Utilization Research Results.

3.1. Results analysis system and survey items.

In order to analyze the outcome of Korean public institution usage of public cloud service, we divided the performance area into system performance and work performance. In the area of system performance, system stability, system security, and cost savings are analyzed in three sub-domains. In order to measure the performance of these sub-domains, the system downtime is defined as a measure of the duration of time for system failure, the cyber security infringement rate is defined as a metric in the system security domain, and the total cost of ownership (TCO) and cloud services TCO were defined as metrics. In the business performance area, we analyzed the performance of the two areas of business productivity and public service. In the area of business productivity, the work processing time and the service build time/release time are defined as the measurement index. In the public service, satisfaction level is defined as the measurement index.

Table 2. Performance analysis scheme

Performance Area	Details	Measurement Index
System Performance	Cost Savings (total cost of information system – total cost of cloud)	Total Cost of Ownership (TCO)
		Total Cloud Cost (TCO)
	System Stability	Downtime
	System Security	Cyber Security Infringement Rate
Business Performance	Business Productivity	Work Processing Time
		Service Build Time/ Release Time
	Public Service	Satisfaction Level

3.2. Cloud utilization survey results.

The cloud computing utilization survey conducted by the Korean government in January 2017 included a total of 1,118 public organizations and 12,032 schools. Among those organizations, 74 organizations reported utilizing cloud services. In this study, we distributed survey questions to those 74 organizations and collected responses from 47 agencies. Since some organizations that responded were utilizing more than one cloud service, we analyzed data from 32 Korean government agencies (27 public agencies, 5 local public entities) using cloud computing services.

In order to analyze the performance of the public cloud, we used data surveyed for 47 services. Of the 47 services, 22 were the introduction of new services and 25 were converted to cloud services. The following are the results of improved administrative work by introducing cloud service. The degree of improvement in business performance through the introduction of the public cloud service was determined by using the Likert 7-point scale (1 point: very low improvement, 7 points: very high improvement). The average improvement in the 10 sectors was 5.3, which was higher than the neutral score of 4 indicating little or no improvement. The following figure summarizes the averages of the performance-based improvements for the 47 agencies. Improved scalability was the highest at 6.1 points and shortened time for collaboration was the lowest at 4.6 points.

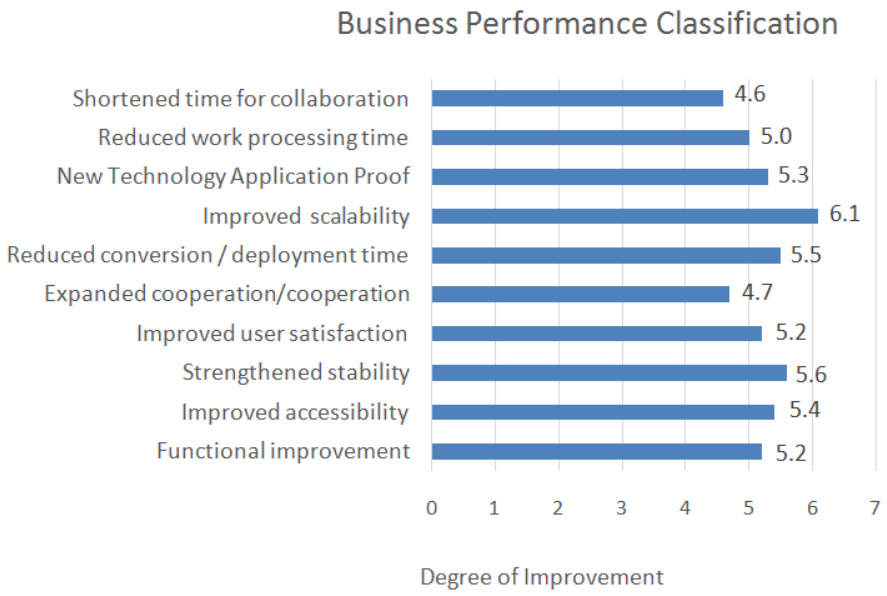

FIGURE 1. Results of the performance analysis

The results show that business performance is divided into new cloud service adoption and service conversion. The service improvement score for conversion service is 5.6 points, higher than the average new service score of 4.9 points. In the new service and conversion areas, improved scalability showed the highest results at 5.9 and 6.2 points respectively. On the other hand, for new services, the expansion of cooperation was the lowest and neutral at 4.0. For service conversion, reduced time for collaboration was the lowest at 5.1.

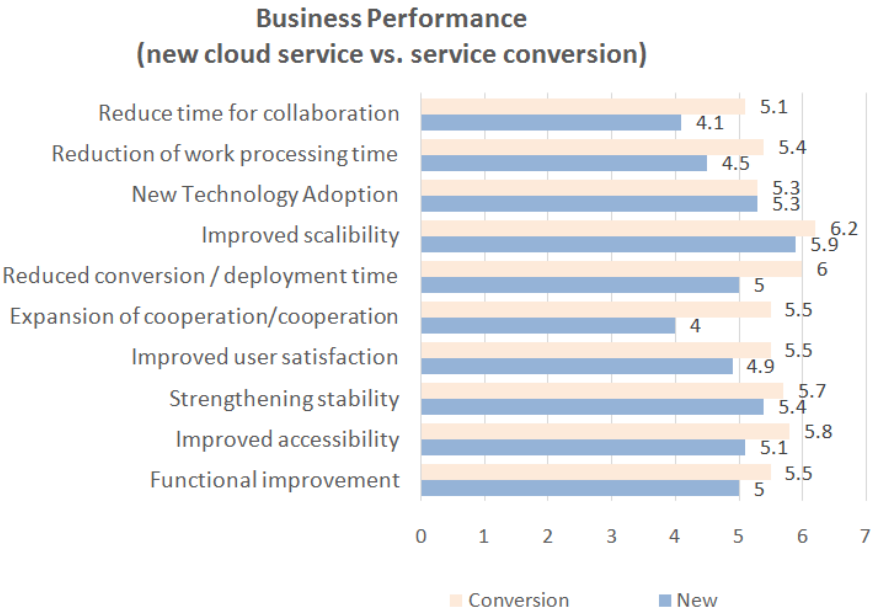

FIGURE 2. Results of work performance analysis (New service vs. conversion)

Apart from the items that examined the degree of improvement in performance in each category, this survey specifically examined the effectiveness of the cloud services used by each organization and the efficiency of collaboration. We specifically included questions related to whether the introduction of cloud services has allowed government agencies to reduce business processing time or time for collaboration and collected and

analyzed related data by measuring improved performance by reduction of staff, increase of processing count, reduction of processing time and reduce time for collaboration. Of the 47 cloud services introduced by public organizations in Korea, 16 out of 47 services (34%) said cloud services had a significant effect on their work processing time; while 11 out of 47 services (23.4%) said cloud services had a significant effect on their collaboration with other workers. 9 services (19.1%) responded that cloud services enabled them to simultaneously reduce work processing time and time for collaboration.

For 11 of the 16 services (68.8%) responded that they had the effect of reducing work processing time and indicated that cloud services also had concrete results of personnel reduction and processing time reduction. We presented concrete results of shortening the collaboration work process time for nine services corresponding to 81.8% of the eleven services that were effective in the efficiency of the collaboration process. Five organizations specifically responded that there was a reduction in the number of people who have gone through the program. The number of existing personnel is reduced to one or two in two or three, with an average of 40% of the total number of employees.

4. **Financial Benefits.** The analysis of public institutional cloud adoption performance analysis is based on TCO (total cost of ownership). TCO is a method of determining the actual cost of an enterprise having a specific information system, including both direct and indirect costs for the information system. In this economic performance analysis, the economic performance was measured by comparing the TCO of the public cloud with the TCO of the information system. In this study, TCO data of 46 systems were analyzed through the questionnaire survey on economic performance of public organizations that have been using or using public cloud services. After excluding eight cases due to lack of questionnaire responses to evaluate economic performance we analyzed 38 systems. Of these 38 responses, 33 (86.8%) indicated that the public cloud systems were more cost effective than their own cloud.

Table 3. Analysis of financial results of public cloud usage (No. of systems)

No. of responses: public cloud systems are more cost effective	No. of responses: to build their own cloud is more cost effective	Total systems surveyed	Logical basis
33	5	38	Comparison of present value of total cost (TCO)

Of the 38 systems, 27 systems use IaaS, 10 systems use SaaS, and 1 system use PaaS. The following table shows the number and percentage of systems that have been evaluated as financially cost effective: 81.48% of IaaS users evaluated their systems were financially cost effective, and in case of SaaS, all 10 systems indicated public cloud systems as financially cost effective. In conclusion, survey results indicated that utilizing a public cloud was more economical than building on their own.

Table 4. Analysis of financial effectiveness of public cloud usage (No. of systems)

Division	Public cloud more economical (No. of systems)	More economical to build on their own (No. of systems)	Total number of systems surveyed	Percentage of public cloud
IaaS	22	5	27	81.48%
SaaS	10	0	10	100%
PaaS	1	0	1	100%
Total	33	5	38	86.84%

5. **Conclusion.** Given the quintessential role of cloud computing in ICT technology change, it is important to understand both the Korean government's role in securing an IT infrastructure and the effectiveness of the plans such as the Comprehensive Plan for Facilitating Public Cloud Computing. The purpose of this study is to assess the effectiveness of Korean government policies and to understand the level of cloud utilization in public sector, system performance and related business performance and economic benefits.

Our study concluded that the introduction of cloud services has allowed government agencies to reduce business processing time and collaboration time with 16 of 47 (34%) reporting cloud services had a significant effect on their work. In terms of financial benefit to the organization we assessed total cost of ownership (TCO), which included both indirect and direct costs for the information system with 33 of 38 (86.8%) indicating that the public cloud systems are more cost effective than their own cloud. The survey found that 19.9% of the 447 public organizations were using public cloud systems. While such indicates a tangible progress and is beyond an early adoption stage, more efforts are needed to achieve the 40% target set by the Korean government.

In conclusion, our study found that public cloud utilization improved business performance and imparted financial benefits with a reduction in TCO, with the system expansion and system stability reported as significant. Understanding the specific impacts on business performance and overall reported decreases in TCO provides underlying data supporting investments IT infrastructure in Korea and also creates a strategic business case for private enterprise adoption of cloud and relative efficiencies in terms financial benefits from total cost of ownership and potential gains in business performance. According to this study, it is confirmed that the active use of the government has tangible results of cloud use. The results of this study can be used to check on the policy achievements and effectiveness of policy implementation efforts. Future study can be conducted based on our study results to analyze system performance related to the degree of total cost savings between public cloud usage and building own system; specifics related to severity of any data breaches or security infringement and; the degree of work processing improvement. More detailed performance study based on qualitative interviews with system engineers and managers may render insights related to implementation challenges that the government should consider in rolling out cloud services in the future.

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