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Assessment of Green and Smart IT Level: A Case Study on Public Research Institute

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***Abstract*—**As the latest advancement and trend in IT field, Green & Smart IT has attracted more and more attentions from researchers. This study focuses on the development of assessing tools which can be used for evaluating Green & Smart IT level within an organization. In order to achieve meaningful results, a comprehensive review of relevant literature was performed in advance, then, Delphi survey and other processes were also employed to develop the assessment tools for Green & Smart IT level. Two rounds of Delphi questionnaire survey were conducted with 20 IT experts in public sector. The results reveal that the top five weighted KPIs to evaluate maturity of Green & Smart IT were: (1) electronic execution of business process; (2) shutdown of unused IT devices; (3) virtualization of severs; (4) automation of constant temperature and humidity; and (5) introduction of smart-work system. Finally, these tools were applied to case study of a public research institute in Korea. The findings presented in this study provide organizations with useful implications for the introduction and promotion of Green & Smart IT in the future

***Keywords*—**Assessment, Case Study, Delphi, Green & Smart

I. Introduction

AS the green growth strategy is recognized as the future growth engine, so does the importance of IT as a main tool to achieve the green growth. This study aims to find out KPIs for assessing Green & Smart IT (GSIT) level in formulating IT-based green growth and smart communication strategy. The word Green IT here has three meanings as follows: (i) Boost green productivity using IT performance; (ii) Make existing IT resources green; and (iii) Accomplish embedded green IT combining green technology and IT infrastructure. On the other hand, Smart IT is any activities that innovate a working and life style using smart devices and social media.

This study adopts a Delphi method to identify important indicators and categories of GSIT which would be realized in the future for the highest value-added, the lowest energy consumption and an effective communication.

This paper is organized as follows. Firstly, we discuss the method used for identifying KPIs and the way of statistical analysis for refining them. Secondly, we propose a new tool for assessing GSIT level and refine it using a Delphi method. Thirdly, we analyze an actual case using the refined KPIs, and consider what KPIs should be executed first. Finally, the results of this research and the direction for further work are presented.

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II. Methods

The Delphi method involves a panel of experts independently and privately providing their level of agreement with a series of statements [1]. The panel was made up of experts with a minimum of five years' experience in one or more of the following areas: the development and delivery of information system, operation of IS, or the IT consulting (IT experts).

There are many variations on this method. This approach used here involved reviewing sources of factors for a public institution to assess their GSIT level [2]. A systematic search of websites and electronic information brochures, and literatures about GSIT level was carried out to identify the full range of strategies for assessing GSIT level in a public institution. A literature search identified 96 factors to assess importance of GSIT.

III. Statistical Analysis

The panel's responses to the questionnaire were analyzed by calculating group percentages. Indicators from each round that were rated as either important or essential by 90% or more of the panels were endorsed as recommended KPIs. Indicators rated as important or essential by less than 80% of the panel were not included as recommended strategies, and indicators rated as important or essential by between 80 and 89% of the panel were included in the subsequent round for re-rating.

To analyze panel member's comments made in Round 1, one author read through all the comments, grouped them together into common themes, identified new ideas presented within the comments, and drafted new items based on the grouped comments. Comments and newly drafted items were then presented to the working group to ensure all new ideas were represented. The working group edited these new items for Round 2 to ensure clarity and consistency of expression.

In order to finally evaluate KPIs, CVR (Content Validity Ratio) analysis was carried out. CVR analysis was used for verifying the validity of a tool [3], because the ratio between the number of full-panel and the number of panel who gave positive answers to some specific KPI is significant in this research (Table I).

TABLE I
Minimum CVR According To Number Of Sample

No. of sample	10	11	12	13	14	15	20	25
Min.CVR	.62	.59	.56	.54	.51	.49	.42	.37

TABLE II
REFINED INDICATORS OF GREEN & SMART IT LEVEL

1st category	2nd category	Indicators	Average(5-scale)
Working practices	Application	Electric execution of Business Process	4.50
		E-payment with customers	3.92
		Solution for rationalization of application	4.08
		Improvement of Business Process	4.08
		Unified communication tool	4.33
	IT operational management	Practice of Green & Smart IT for employee	3.92
		Utilization of smart video-conferencing	4.00
		Support remote/mobile working environment	4.17
		Encouraging remote/mobile working	4.08
		Leadership/policy/system of green & smart IT	4.17
Office environment	PC/monitor/ printer	Removing the display screen saver	3.50
		Introducing desktop virtualization	4.08
		Power off unused IT equipment	4.25
		Integrated all-in-one(fax, copier, scanner, etc.)	3.33
	Office equipment	Using wireless network replaced by a wired one	3.58
		Applying an intelligent lighting system	3.67
		Introducing building control system	4.17
		Power off display screen on weekend and at night	4.00
Data Center	Server	Introducing server virtualization	4.00
		Optimizing use of the server instance	3.83
		Rationalizing a scale of IT facility	4.00
		Server performance and power efficiency	3.75
	Infrastructure	Storage consolidation	3.42
		Managing utilization indicators of storage equipment	3.92
		Enforcing network convergence	3.18
		Intelligent management unit for power distribution	3.58
		Back-up SW single-platform integration	3.42
	Building facility	Real-time monitoring use of power	4.00
		Energy-efficient data center	3.92
		Automation of constant temperature/humidity	4.25
IT resource Life-cycle	Purchasing management	Efficiency of IT asset replacement life-cycle	3.92
		IT asset management based on CMDB	3.92
		IT equipment for energy efficiency certification	3.83
		Consideration of carbon emissions at IT asset purchase	3.42
	Disposal Recycling	Waste audit and minimization of environmental impact	4.00
		Introduction of IT asset recycling regulations	4.08
		Recycling IT supplies	3.83
Communication	Inner communication	Communication between members using SNS	3.67
		Construction of FMC	3.75
		Development of system infrastructure for remote working	4.33
		Security training and operational policy for SNS manager	3.83
		Establishing Security compliance and information security system	3.92
	Outer communication	Development and utilization of Publicity SNS	3.83
		Providing knowledge/information through social media	3.75
		Inter-departmental information cooperating system	3.75
		Developing and providing applications for smart devices	3.58
		Dedicated employee for SNS	3.83

Table II shows a tool of assessing GSIT level which is composed of five 1st categories, eleven 2nd categories, and forty six KPIs.

IV. APPLICATION

We apply here the refined KPIs to actual case study of KISTI (Korea Institute of Science and Technology Information) that is a public research institution in Korea.

KISTI is a government-funded research institute designed to maximize the efficiency of science and technology R&D and support high-tech R&D for researchers. KISTI has laid the foundation for sophisticated R&D by collecting science and technology information from countries around the world and providing the information to companies and research institutions. Also, KISTI has supplied customized information analysis service to enable researchers and small & medium sized companies to make a right decision on time and has contributed to maximizing research efficiency through building the super computing and research network [4].

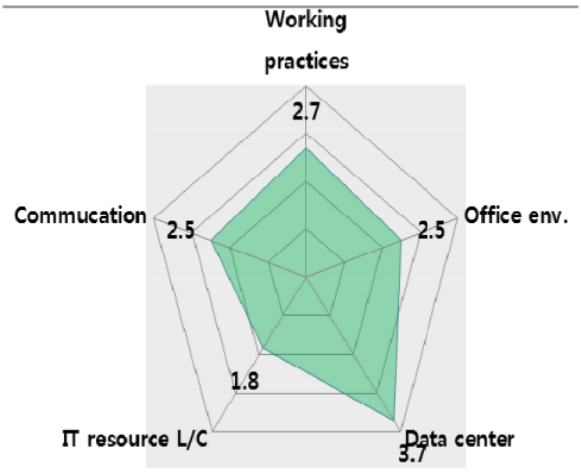
In this study, a five point scale consisting of five sections as a measure for detecting the level of GSIT was used. If the effort for performing GSIT is very low, the level is one.

On the other hand, if establishment of improvement targets and continuous improvement is underway systematically, the level is five as showed in Fig 1.

Fig. 1 Measure of GSIT assessing tool

In order to diagnose GSIT level and maturities in KISTI, we applied GSIT assessing tool to KISTI's case. As showed in Fig 2, KISTI took 2.6 point of 5-point scale. Specifically, 'Data center' won 3.7 point while 'IT resource life cycle' gained 1.8 point.

Based on the result of these diagnostic views, GSIT activities in 'Data center' sector were well promoted and managed, while the readiness in 'IT resource life cycle' sectors were relatively low.



Overall score: 2.6(average)

Fig. 2 Measure of GSIT assessing tool

A. Working practices

The GSIT level was normal in 'Working practices' sector. Specifically, 'Application' part was 3.4 out of 5 that was relatively high level whereas 'IT operational management' got low value.

In order to reinforce the level of GSIT in this part, the major challenges would be: 1) Continuing education and training related to GSIT, 2) Smart Video-conferencing System, 3) supporting employees' remote / mobile tools and providing remote-work space, 4) Establishing GSIT leadership, regulation and management system, and 5) an integrated management program of applications.

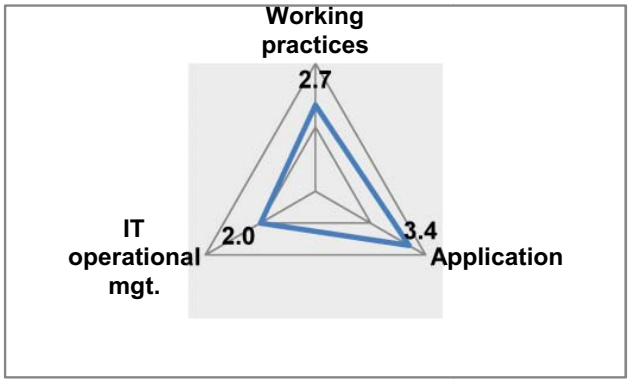


Fig. 3 Working practices sector

B. Office environment

The GSIT level was normal in 'Office environment' sector. 'PC/monitor/printer' and 'Office equipment' part was 2.5 out of 5 on the same level.

In order to reinforce the level of GSIT in this part, the major challenges would be: 1) Power savings, such as replacing a thin client including desktop virtualization, 2) Intelligent lighting and building energy management system to improve energy efficiency, and 3) turning off automatically the display screen on the weekend and at night.

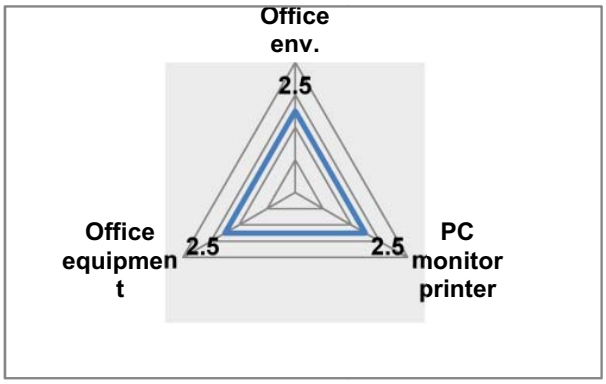


Fig. 4 Office environment sector

C. Data center

The GSIT level in 'Data center' sector was higher than other sectors. Especially, 'Infrastructure' was 4.0 out of 5 that was the highest level.

These results for KISTI comes from well-managed functions as central organization related to super-computing, national science and technology information analysis and distribution.

In order to reinforce the level of GSIT in this part, the major strategies would be: 1) installing intelligent power distribution and monitoring the equipment, 2) complementing the data center facilities for energy efficiency, 3) server optimization and power supplying based on performance efficiency.

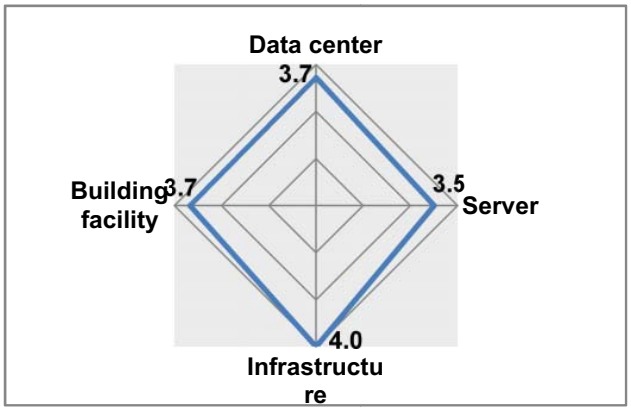


Fig. 5 Data center sector

D. IT resource life-cycle

The GSIT level was significantly low in 'IT resource life-cycle' sector. Specifically, 'Purchasing management' was 2.0 and 'disposal/recycling' part was 1.7 out of 5 respectively.

In order to reinforce the level of GSIT in this part, the major challenges would be: 1) Reviewing and improving carbon emissions in procurement process, 2) Examining asset disposal and minimizing environmental impacts, 3) Considering energy efficiency when purchasing assets, 4) Encouraging recycling of consumables for example paper, batteries, and printer cartridges.

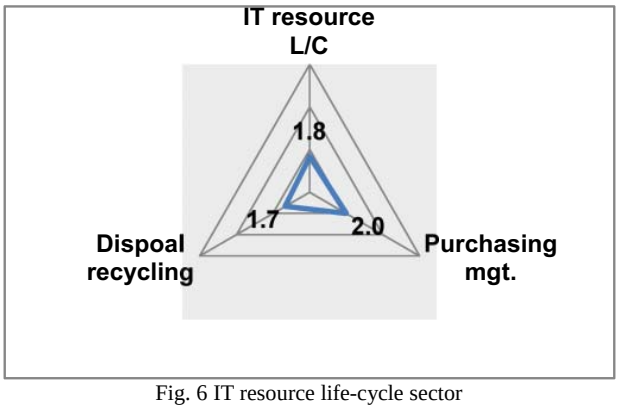


Fig. 6 IT resource life-cycle sector

E. Communication

The GSIT level was normal in 'Communication' sector. Specifically, 'Outer communication' part was 2.8 out of 5 that was relatively high level whereas 'Inner communication' got slightly low value (2.2).

In order to reinforce the level of GSIT in this part, the major challenges would be: 1) Consolidating communication system with external stakeholders like SNS or mobile service for outer communication, 2) Developing mobile convergence services (FMC) for improving business efficiency, 3) Practicing security trainings for SNS managers and establishing the operating policies.

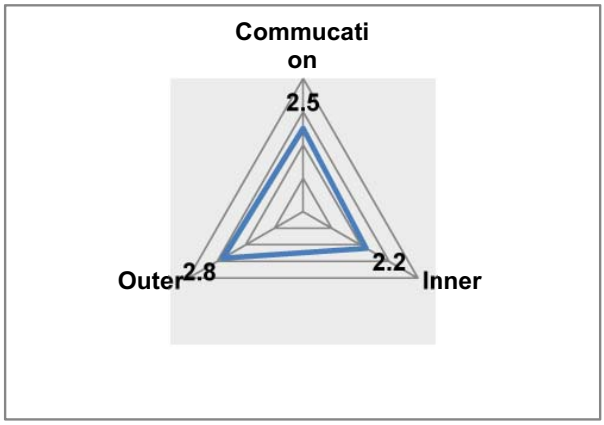


Fig. 7 Communication sector

V. Conclusion

The outcomes of the Delphi survey demonstrate five categories and five KPIs with high priorities. Five categories include: Working practices, Office environment, Data center, IT resource life-cycle, and (inner/outer) Communication. And five KPIs include: Electronic execution of business process, Shutdown of unused IT devices, Virtualization of severs, Automation of constant temperature and humidity, and Introduction of smart-work system. We carried out CVR analysis so as to determine the adequateness of KPIs for GSIT.

The result of case study applying the assessing tool to KISTI was 2.6 point. 2.6 point belongs to the third level ("Defined") of GSIT maturity model. It seems that KISTI should focus on the life cycle of IT resources in order to raise GSIT level.

In the future, this assessing tool will be applied to several cases, and will be evaluated to ensure that the result of its application appropriately indicates the level of GSIT.

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