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ICT-based Information System Operational Stability Diagnostic Evaluation Model for Quantitative Evaluation

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Abstract
With the development of ICT technology connected to the world, information systems connecting countries and companies have been developed. However, in the event of cyberattacks or disruption of information systems, national infrastructure, disruption, and adverse impacts on corporate businesses are expected. In particular, with the development of the fourth revolutionary technology, improvements and changes in the current ISO/IEC 20000, ITIL, and operational supervision of information systems are needed. In this paper, we analyze the limitations of existing models of ISO/IEC 20000 certification and operational stability of ICT-based information systems and design stability diagnosis and evaluation models of ICT-based information systems. We propose and compare stability diagnosis and evaluation models for the operational supervision of the designed information system. It verifies that the composition of the improved diagnosis and evaluation items can be actually used to secure the stability of ICT-based information system operation. The results of this paper contribute to securing the stability of ICT-based information system operation and will be used as basic data for preventing obstacles and accidents.

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1. Introduction

Governments and major private companies are striving to improve work efficiency and stabilize the operation of information systems through the advancement of informatization projects [1]. However, there is a need for stable operation and systematic and efficient management of the operating systems according to the change of the Information & Communication Technology (ICT) information system. According to IT shipbuilding security news in 2019, the number of financial accidents and failures that occurred from 2015 to July 2019 has reached 141 billion won [2]. Based on the current e-Government Act and the introduction and operation guidelines of the information technology architecture, which was enacted in 2005, the Korean government stipulates to manage the performance and management status of informatization projects through information system audit [3]. In particular, as the fourth industrial technology to develop, audit measures need to be improved along with technological development of rapidly changing Information & Communication Technology (ICT) information systems such as Fifth-Generation

(5G), Internet of Things (IoT), and Cloud. To date, public and private informatization projects utilize operational audit, International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 20000, Information Technology Infrastructure Library (ITIL), quality inspection and operational stability of information systems. It is widely used for diagnosis, evaluation and IT service management system [4]. However, due to the development of the 4th industrial technology and the development of ICT information system, the existing models show limitations depending on the operating environment and IT service management system. As a result, the stability diagnosis evaluation through the existing stability diagnosis model exposes the vulnerability to the threat caused by the development of technology. This paper analyzes the components and limitations of the management model for existing ICT information systems such as ISO/IEC 20000 certification management system and ITIL. Based on the analysis results, we design a stability diagnosis and evaluation model for the improved ICT information system.

In this paper, we propose an operational stability diagnosis and evaluation model for the improved ICT information system to secure the stability of the operation of the ICT information system. We verify that the proposed diagnostic evaluation model ensures the stability of the ICT information system. This paper will provide basic data for the model of diagnosis and evaluation to secure the stability of ICT information system operation.

2. ISO / IEC 20000 and ITIL Management Model Analysis

2.1 ISO/IEC 20000 Certification Management System Analysis

The ISO/IEC 20000 certification is based on BS 15000, a British standard developed by the BSI (British Standards Institution) as the International Standard for IT Service Management (ITSM). It was internationally standardized by ISO/IEC and revised in 2011 as shown in Fig. 1. ISO/IEC 20000 is an integrated framework for providing and managing IT services to users and is based on ITIL, the IT service manager [5]. This is to provide standard of IT service management to meet user requirements, to evaluate methodology for control and management of IT service, to provide IT service, and to evaluate cost effectiveness [6]. The composition of the certification scheme of IS0/IEC 20000 consists of management standards for IT services and implementation guidelines for services and operations [7].

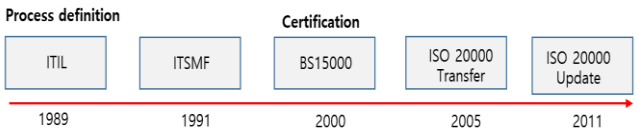

Figure 1. In the development of ITIL with ISO/IEC 20000

2.2 Analysis of Information Technology Infrastructure Library (ITIL) Management Model

ITIL provides an IT service management framework for processes, functions, and roles around IT service planning, delivery, and management [8]. ITIL is divided into “Service Support” and “Service Delivery” areas [9]. The Service Support area is an area [10] that operates and supports Service Delivery processes. The Service Delivery area is an area [11] that defines all processes necessary for service level agreements and service level monitoring with customers for IT services.

2.3 Limitations of Similar Models Analyzed

As a result of analyzing the operation audit of the ICT information system, the problems and improvements according to the operation status are different according to the auditor's capacity and the operation status check. The evaluation of the areas and items of inspection of the

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operational audit present only conformance and nonconformity. And, after the determination and improvement are revealed, there is a limit to the performance management as shown in Table 1.

Table 1 : Review items focused on operational Information system audit

Division	Critical review items / result	Overall opinion
Operation Management Plan	Do you have a management plan for system operation? / unsuitable	Operational service management system and procedures need to be established, and performance activities shared with the person in charge through daily monitoring records for performance management are needed. In addition, it is necessary to actively carry out security activities by establishing security policies, and strengthen outsourcing management systems for operation management personnel.
Service level management	Has a service level management procedure been established, and is there a service level management? / unsuitable	
Performance management	Do you have a performance management system in place for system and service operation? / unsuitable	
Capacity management	Do you have the capacity and adequate capacity to provide adequate service levels? / Suitable	
Service continuity management	Do you have a preventive check plan and are you conducting a regular preventive check? / Suitable	
Performance / Availability Management	Is a system for performance management established and implemented? / unsuitable	
Security management	Are you establishing a security policy and establishing a management system? / unsuitable	
Outsourcing Management	Is an outsourcing management system established and implemented? / unsuitable	

3. Design of Information System Operation Diagnosis Model Based on ICT

The proposed model is the Operation System-Stability Maturity Model (OS-SMM). The OS-SMM diagnosis and evaluation model is designed with 3 inspection fields and 13 inspection areas. It is designed to be able to evaluate the maturity level of stability of operation audit for ICT information system based on OS-SMM. In particular, the detailed configuration and procedures for the inspection area are organized as shown in Fig. 2. In addition, the evaluation results and improvement items of each item are designed to present quantitative results of the fulfillment rate for each inspection area. The basis for deriving the proposed diagnostic evaluation model is designed with reference to ITIL v3.0, ISO/IEC 20000 and best practices of domestic operational audit as shown in Fig. 3.

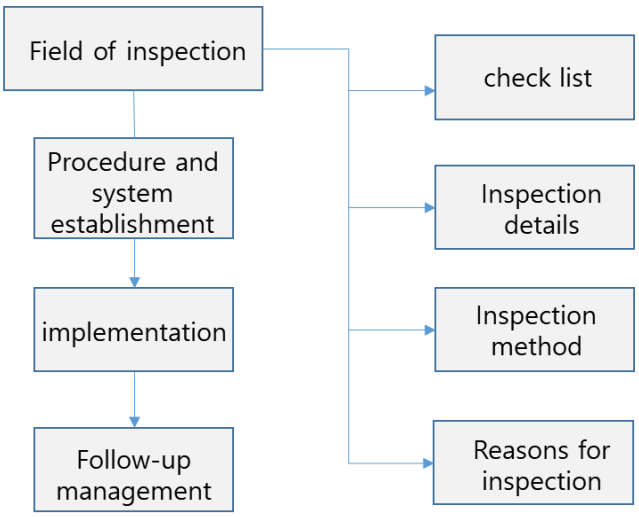

Figure 2. Check configure detailed breakdown by region

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Figure 3. ISO 20000, ITIL v3.0, Operation Information system Audit comparison

The OS-SMM diagnosis and evaluation model proposed in this paper shows the inspection field, inspection area, and purpose of diagnostic evaluation of ICT-based information system operation diagnosis model in Table 2. The purpose of this study is to suggest the purpose of diagnosis and evaluation according to 3 inspection fields and 13 inspection areas by category.

Table 2: Details and Evaluation Goals of the Proposed Diagnostic and Evaluation Model

Field of Inspection	Division	Diagnostic evaluation purpose
1. Established procedures and systems to maintain stability 2. Level of implementation of established procedures and systems 3. Post-management level after implementation	1. Operational Status Management	4. Preventing faults and quickly identifying faults through monitoring operation status
	2. Fault Response Management	5. Respond reinforcement through rapid recovery in case of failure
	3. Fault Prevention Management	6. Strengthen disability prevention through disability prevention activities
	4. Change management	7. Service disruption due to failure caused by change
	5. Availability Management	8. Continuous high availability relationship
	6. Capacity management	9. Timely supply of IT resources when business is needed
	7. Outsourcing Management	10. Blocks stability barriers that may arise due to vendor's service level
	8. Information Security Management	11. Prevent security incidents of IT resources in advance to ensure stability from security accidents
	9. User management	12. Evaluate stable service from users
	10. Disaster Recovery Management	13. Rapid service recovery in case of disaster or accident

	11. Quality Management	14. Provide the target quality of service agreed with the user
	12. Configuration management	15. Configuration items necessary to provide stable service
	13. Improvement implementation management	16. Enhance stability maturity level by tracking and implementing improvement

4. Validation of ICT-based Information System Operational Diagnosis Model

The results of comparing the OS-SMM diagnostic evaluation model proposed in this paper with the operational audit, ISO/IEC 20000, which are similar evaluation models, are presented in Table 3. Compared with the OS-SMM diagnostic evaluation model, ISO/IEC 20000, and operational audit proposed in this paper, it has six characteristics and advantages. From the practical point of view, the inspection items were checked based on the requirements of the operating viewpoint for the ICT information system. In addition, the proposed OS-SMM diagnostic evaluation model examines the improvement that confirms the quantitative stability maturity level.

Table 3: Comparison of Operational Diagnosis Evaluation Models with Operational Audit, ISO/IEC20000, OS-SMM Proposal Models

Operation Audit	ISO/IEC 20000	OS-SMM (Proposal Model)
The inspection area (process) was qualitatively evaluated by the expert judgment of the auditor	In the certification inspection area (process), satisfaction is evaluated quantitatively	Satisfaction level of fulfillment by inspection area (process) was evaluated quantitatively
The performance level assessment results for each test item are qualitative	The performance level evaluation result of the check item is evaluated quantitatively	The results of the implementation level assessment by inspection item are Step 4 (FA: Full Archived, LA: Large Archived, PA: Partial Archived), NA: Not Archived)
Management and control / planning and implementation of information systems subject to evaluation, daily operation activities, and disability prevention maturity are evaluated separately	Management and control / planning and implementation of the evaluation targets, operation activities, and prevention of disability are evaluated so that they are not distinguished	Management and control / planning and implementation of information systems subject to evaluation, daily operation activities, and disability prevention maturity are evaluated separately
The management, control / planning and implementation of information systems to be assessed, operational activities and failure maturity are evaluated indistinguishable	Based on the certification standard, only the operational status of the target system is compared / analyzed and the improvement is derived	Assessed from the perspective of information system stability management system linked to technology and operation
The inspection method for each inspection item is	The inspection model for certification consists only of	The inspection method for each inspection item is practically

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practically suggested, which can minimize the subjectivity of the evaluator	technical and operational points of view	suggested, which can minimize the subjectivity of the evaluator
It is not linked to other inspection models	It is not linked with other inspection models	Linked to other inspection systems

The stability evaluation method for the operating point of ICT information system through the OS-SMM diagnosis and evaluation model proposed in this paper is carried out through the following process.

Step 1: The maturity level of each inspection item is defined according to the inspection contents of 13 inspection areas. It is defined as Level 3 if the inspection area, inspection contents, and inspection items are "Standard and Consistent Process Definition", Level 4 if "Internal Process Rating", and Level 5 if "Continuous Process Improvement".

Step 2: Evaluation of the performance level is carried out by interviewing the person in charge of evaluation, evidence of operation status, and related results, and then evaluating the performance level by inspection field and items. The results of the assessment grade are assessed according to NA (Not Archived), PA (Partially Archived), 51% to 85% LA (Largely Archived), and 86% to 100% FA (Fully Archived) when the results of the assessment are achieved by comparing the inspection methods and contents of the inspection items.

Step 3: The performance satisfaction for each of the 13 inspection areas measures the performance fulfillment rate for the performance activities required for each maturity level. In addition, the evaluation assigns scores to the inspection areas by each stability level, weights by inspection items, and performance grades.

Step 4: After counting the implementation results by inspection area, the final results of the evaluation target system are scored by calculating the fulfillment rate and average fulfillment rate by maturity level by inspection area. At this time, the fulfillment rate for each final evaluation grade is FA (Fully Achieved): 81% ~ 100%, LA (Largely Achieved): 61% ~ 80%, NA (Not Achieved): 0% ~ 60%.

Step 5: Based on the quantitatively diagnosed and evaluated results, in order to improve the actual stability maturity level, comprehensive opinions are presented for each inspection field, and a final result report including the evidence corresponding to the opinions is prepared.

An example of the results assessed in the field through the OS-SMM diagnosis and evaluation model proposed in this paper is shown in Table 4. In this regard, the verification of the proposed OS-SMM diagnosis and evaluation in consideration of the characteristics of the system to be evaluated was estimated at 100% score, and evaluated at the site. The results of categories 1 and 3, which were derived from the final evaluation results, were Level 3: 33.3% and Level 3: 40.0%.

1. Level 3: 33.3%(NA), Level 4: 33.3%(NA), Level 5: 22.2%(NA).

2. Level 3: 86.6%(FA), Level 4: 80.0%(LA), Level 5: 60.6%(NA).

3. Level 3: 40.0%(NA), Level 4: 62.2%(LA), Level 5: 40.0%(NA).

Average results in 13 categories in the field evaluation are equivalent to Level 3: 89.9% (FA), Level 4: 69.1% (LA), and Level 5: 43.0% (NA).

When the OS-SMM diagnosis and evaluation proposed in this paper was applied at the site of

operational monitoring of the ICT information system, it was judged that Level 3:86.6% (FA), Level 4: 69.1% was acceptable based on the average result value, but Level 5:43.0% was difficult to adopt, as shown in Table 4. Therefore, Level 3: 86.6% (FA) and Level 4: 69.1% through the OS-SMM diagnosis and evaluation system proposed in this paper can be adopted and verified. However, Level 5: 43.0% was not adopted, and it was determined that improvement was needed once again.

Table 4 : Example of evaluating the stability implementation maturity level of an information system

Operation Audit Inspection area	Performance Satisfaction Levels by Maturity Level
Operational Status Management	Level 3: 33.3%(NA), Level 4: 33.3%(NA), Level 5: 22.2%(NA)
Fault Response Management.	Level 3: 86.6%(FA), Level 4: 80.0%(LA), Level 5: 60.6%(NA)
Fault Prevention Management.	Level 3: 40.0%(NA), Level 4: 62.2%(LA), Level 5: 40.0%(NA)
Change management.	Level 3: 100%(FA), Level 4: 66.6%(LA), Level 5: 42.8%(NA)
Availability Management.	Level 3: 100%(FA), Level 4: 77.7%(LA), Level 5: 47.6%(NA)
Capacity management	Level 3: 100%(FA), Level 4: 77.7%(LA), Level 5: 50.0%(NA)
Outsourcing Management.	Level 3: 100%(FA), Level 4: 80.0%(LA), Level 5: 77.7%(NA)
Information Security Management	Level 3: 100%(FA), Level 4: 95.5%(FA), Level 5: 50.0%(NA)
~	~
Improvement implementation management.	Level 3: 40.0%(NA), Level 4: 33.3%(NA), Level 5: 33.3%(NA)
Average Stability Maturity Satisfaction Rate	**Level 3: 89.9%(FA), Level 4: 69.1%(LA), Level 5: 43.0%(NA).**
A Comprehensive opinion	**Average stability performance maturity level of the information system to be evaluated is Level 3+**

In this paper, we propose OS-SMM diagnosis and evaluation model for the operation audit of ICT information system reflecting the 4th industrial technologies. It was verified that the proposed OS-SMM diagnosis and evaluation model would be applied at Level 3 and Level 4. The proposed OS-SMM diagnosis and evaluation model is verified to be able to diagnose and evaluate the stability of the operation area of ICT operation service and information system. In addition, the proposed OS-SMM diagnosis and evaluation system is expected to improve the stability maturity rate as the activities to be performed to increase the fulfillment rate of each inspection area are clearly presented.

5. Conclusion

Stability needs to be strengthened by improving the stability diagnosis and evaluation of the operation management status of ICT information system due to the recent development of the 4th industrial technology and ICT technology. In addition, the stability aspect needs to be clearly evaluated by dividing the management items into categories. In this paper, we analyze the existing operation audit part which diagnoses the level and quality status of ICT information system operation and performs the objective evaluation, and designs and proposes an improved model. For the operational audit of the ICT information system proposed in this paper, OS-SMM, which is an evaluation model, was applied in the field, and it

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was judged that it can be applied in Level 3 and Level 4. Thus, the OS-SMM proposed in this paper has been shown to be effective in assessing the maturity rate of stability performance, including system management and operation control, planning, implementation, and prevention of obstacles, for ICT services by ensuring operational stability of the information system applied with quantitative assessment. Future research is needed to secure improved stability at Level 5, which OS-SMM has not adopted.

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