

An Evaluation System for a National Defense Informatization Project at the Pre-Project Stage

¹Sangho Lee, ¹Kwang Hyun Baik and ²Byung-Kyu Kim
¹Department of Information Technology Management,
²Department of Computer Engineering,
Sun Moon University, Asan-Si, Republic of Korea

Abstract: Measuring the success of an Information Technology (IT) investment is a difficult task. However, for the selection of an effective IT project within the limited budget the performance of an IT project should be measured. The measurement of the performance of Information Systems (IS) can improve the success of an IT project. This study presents an evaluation system for a National Defense Informatization (NDI) project in the Republic of Korea's Ministry of National Defense (MND) to choose effective IT projects. During the pre-project (especially budgeting) stage evaluation, informatization projects are evaluated on the dimensions of the propriety of project planning, the propriety of performance planning, the propriety of applied technology, budgets and period and economical efficiency.

Key words: Evaluation of national defense informatization project, criteria for selection, IT investment performance, economical efficiency, task

INTRODUCTION

The Korean Ministry of National Defense (MND) has been evaluating National Defense Informatization (NDI) with an established NDI evaluation system (Kwon *et al.*, 2012; Lee *et al.*, 2012) according to the Act on Creation of a Base for National Defense Informatization and Management of National Defense Information Resources in 2013. The MND classified NDI evaluation into three parts: NDI policy, NDI project and NDI maturity level (Kwon *et al.*, 2012). The NDI policy evaluation assesses various policies such as NDI mission, objectives, strategy, plan and budget and analyzes the current state of the MND, Army, Navy and Air Force. The NDI project evaluation assesses the development of the Information Systems (IS) for the national defense, the acquisition of Information Technology (IT) products and services, the operation of developed IS and acquired IT products and services and the management of IT projects in the MND and its armies. The NDI maturity level evaluation assesses the MND and its related organizations' NDI capabilities such as the leaders' view, possessed hardware and communication capacity (Lee *et al.*, 2012).

The objective of this research is to present an evaluation system for NDI projects during the pre-project (especially budgeting) stage.

LITERATURE REVIEW

DeLone and McLean (1992) developed an IS success model, referred to as the D&M by reviewing previous research on IS success factors (Fig. 1). To use and be satisfied by an IS, a user must recognize the qualities of the IS and its information. Then, a satisfied user will use the IS more often. The D&M Model shows that both the use of IS and the user's satisfaction have an individual impact and this impact then has an organizational impact. The D&M Model also shows that the IS quality, quality of information, usage of IS, user satisfaction, individual impact of IS and the outcome of an organization should all be considered during IS evaluation.

The D&M IS success model (DeLone and McLean, 1992) attracted many researchers who conducted empirical studies using the D&M Model. Some empirical studies confirmed the appropriateness of the D&M Model. Others

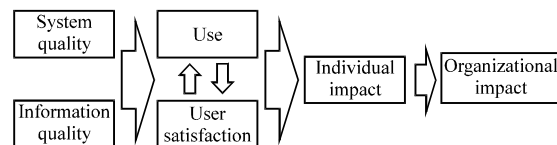


Fig. 1: D&M IS Success Model (DeLone and McLean, 1992), Fig. 2

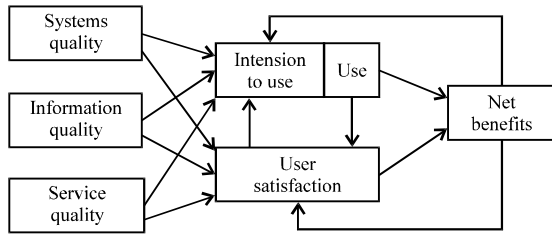


Fig. 2: Updated D&M IS success model (DeLone and McLean, 2003)

presented the limitations of the D&M Model and suggested factors that must be added to the model. DeLone and McLean (2003) published their updated IS Success Model (Fig. 2) after examining the accumulated empirical studies that used their original model.

DeLone and McLean (2003) integrated the individual impact and organizational impact into the net benefits, added a service quality factor and an intention to use factor and added a feedback loop of net benefits into the intention to use and user satisfaction. The relationships are as follows: an increase in the intention to use leads to IS use, an increase in user satisfaction can increase the intention to use and users must use the IS to increase user satisfaction. Further, net benefits also have an effect on the intention to use and user satisfaction. According to the updated D&M IS Success Model, the IS evaluation must be performed on the IS quality, information quality, service quality, intention to use, usage of IS, user satisfaction and net benefits.

The Korean government evaluates government services based on the Basic Act for the Evaluation of Government Service in 2014. This act's objective is to increase the efficiency, effectiveness and responsibility of the national administration by strengthening its autonomous evaluation capability and developing integrated performance management systems for national administrative organizations and their agencies, local autonomies and public institutions.

The evaluation of government services is divided to a "self-evaluation" and a "specific evaluation". The self-evaluation is the evaluation of the essential policies of national administrative organizations or local autonomies by themselves. The specific evaluation is the evaluation of the policies to manage the government services of national administration organizations by the Prime Minister in an integrated way.

Meanwhile, the Korean Ministry of Strategy and Finance (KMSF, 2012) operates the performance management system for financial projects based on the 8th article of the Act on National Finance in 2014. This is an autonomous performance monitoring system for

national administration organizations, province administration organizations and public agencies or institutions to deduce the strategic goals, performance objectives and performance metrics in the performance plan. After projects, they present the completed performance objectives in a performance report for verification. The Ministry of Strategy and Finance (KMSF, 2012) then checks the evaluation results in the performance report and uses them for financial operations such as national budgeting, evaluation of organizations and determining incentives. In addition, there is also a "program evaluation" to analyze the effectiveness of the project or program in depth by external experts with statistical techniques.

EVALUATION SYSTEM FOR NDI PROJECT (AT THE PRE-PROJECT STAGE)

Types of NDI project: A NDI project can be classified as either a development project, a maintenance project or a purchase project (Table 1). A development project can be further divided into IS or infrastructure development. IS development is the development of new IS such as the Defense Integrated Logistics Information System, C4ISR (Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance) systems, Defense Medical Information System or an upgrade to IS that is beyond the maintenance budget. Infrastructure development is the construction of infrastructure such as a data network or an integrated database. A maintenance project is related to the operation of and minor correction (or update) to existing IS. Finally, a purchase project is the buying of computer hardware, equipment and commercial software.

Types of the evaluation for NDI project by time: NDI project evaluation is divided into the evaluation at the pre-project stage, the evaluation at the in-project stage and the evaluation at the post-project stage. The objective of the evaluation at the pre-project stage is to select effective IT projects and check their readiness (Table 2). The objective of the evaluation at the in-project stage is to review the management of the NDI project. The objective of the evaluation at the post-project stage is to determine if achieved project results meet the expected outcomes and performance in the project plan and performance plan.

Evaluation of defense IS project: This research covers the updated evaluation system for an NDI project at the pre-project stage by revising the methods (Kwon *et al.*, 2012) of the existing evaluation system. This updated evaluation system for NDI projects at the pre-project

Table 1: Types of National Defense Informatization (NDI) project

Types	Sub-type	Example
Development	IS development	Development of new IS (e.g., Defense Medical Information System (DEMIS), Defense Modeling and Simulation (M&S) systems) Upgrade project of old IS (e.g., upgrading defense material information systems)
	Infrastructure development	Installation of data network Construction of integrated database
Maintenance		Operation and maintenance of IS (e.g., operation and maintenance of defense ammunition information systems)
Purchase		Installation (e.g., installation project of military internet cafe)
		Purchase of commercial software (e.g., acquisition of commercial software for defense logistics integrated information systems)

Table 2: The type of evaluation for NDI project by time

Stages	Evaluation at the pre-project stage		Evaluation at the in-project stage	Evaluation at the post-project stage
	Planning	Budgeting		
Objective	To decide new project needs by examination of project validity and appropriateness	To review performance objectives and validity of the project plan	To manage the project effectively	To evaluate project performance/outcome in operation after acceptance
Target	Major projects among proposed projects	Major projects among decided projects	Major projects	IS in operation and maintenance phase
Time	Need review phase	Pre-contract phase after need decision	During the project	1 year after acceptance
Method	Review of appropriateness to NDI policy and environment	Use of evaluation metrics in the evaluation system	Using the result of IS audit or project management	Use of evaluation metrics in the evaluation system

Table 3: An evaluation framework for NDI project at the pre-project (budgeting) stage

Evaluation items	Evaluation Metric (EM)	Explanation	Weight
Propriety of project planning	<EM 1-1> clarity of project goals	Project goals should be clarified and appropriate to achieve the performance objectives	
	<EM 1-2> conformance to the procedure for project planning	Project planning should conform to related laws, regulations, guidelines and processes	
	<EM 1-3> completeness of preliminary study in project planning	In-depth and wide case studies related to the project are needed	
	<EM 1-4> completeness of a public hearing in project planning	Were there substantial and rich public hearings from users and stakeholders related to the expected result of project?	
Propriety of performance planning	<EM 2-1> propriety of performance objective	Are performance objectives appropriate?	
	<EM 2-2> propriety of performance metric	Are performance metrics appropriate?	
	<EM 2-3> propriety of performance metric target value	The target value of performance metrics should be reasonable to achieve the performance objective in the project or on the trend	
Propriety of applied technology	<EM 3-1> case analysis of applied technology	Were the use cases of considered technologies in other areas investigated?	
	<EM 3-2> comparison analysis of applied technology	Was it compared applied technologies with other alternate technologies?	
Budget and period	<EM 4-1> completeness of budgeting	The cost estimation should be performed in the view of the total cost of ownership	
	<EM 4-2> appropriateness of budgeting	Is project budgeting appropriate to the standard?	
	<EM 4-3> appropriateness of project period	The project period should be appropriate to the standard considering the performance objectives in the project	
Economical efficiency	<EM 5> benefit-cost ratio	The ratio of benefit-cost should be larger than the specific benefit-cost ratio standard	

Lee *et al.* (2012)

stage, as shown in Table 3, evaluates the propriety of various factors such as project planning, performance planning, applied technology, budget and period and economical efficiency.

The propriety of project planning is evaluated on multiple Evaluation Metrics (EM) such as the clarity of project goals, conformance to the procedure for project planning, completeness of the preliminary study in project planning and completeness of a public hearing in project planning (Lee *et al.*, 2012). The propriety of performance planning is evaluated on the correctness of the performance objective, performance metric and performance metric target value. The propriety of applied technology is examined on whether there is an example in other fields and if it was cross-examined with other

technologies. The propriety of the budget and period is measured by the completeness of budgeting concerning the total cost of ownership (e.g., development, operation and maintenance, user education, building, equipment, energy, management and disposal cost), the rationality of budgeting and the appropriateness of the project period needed to achieve the targeted outcome. Finally, the propriety of economic efficiency analyzes the ratio of benefit to cost. The ratio should be larger than the MND's specific benefit-cost ratio standard. The weight of these evaluation metrics can then be calculated by the Analytic Hierarchy Process (AHP) (Saaty, 1990).

This evaluation system presents the measurement methods for each evaluation metric as shown in Table 4-7. The clarity of project goals metric (EM #1-1)

Table 4: Clarity of project goals metric (EM #1-1)

Evaluation items	Propriety of project planning
Definition	Check that project goal is clear and concrete and that whether project owners develop the project plan to appropriate the achievement of performance objectives in the performance plan
Measurement method	Is the project goal clear and appropriate to achieve the performance objectives No, Yes Decision rule to 'Yes' (below all items should be satisfied) Specific situation or problems to be solved by IT project should be clear and concrete Project owners have to concretely present specific situation or problems to be solved by IT project and logically demonstrate that the contents or outcomes of IT project can contribute to solve the situation or problems A connection between the project goal and the achievement of performance objectives (or logical relationship between cause and effect) should be clear and concrete Decision rule to 'No' (when it is applicable to any case below) The project goal is general or abstract compared to the contents and scope of IT project Specific situation or problems to be solved by IT project are not clear The connection between project goal and performance objectives is not clear
Gathering method	System, data, questionnaire and interview
Data sources	Document that can see the project-related data such as project goal, project contents, project target (e.g., performance plan, demonstration material of project)
Lee <i>et al.</i> (2012)	

Table 5: Conformance to the procedure for project planning metric (#EM 1-2)

Definitions	Check whether all required laws, regulations, guides, and processes in IT project are fulfilled
Measurement method	Were the laws, regulations, guides and processes that is related to IT project substantially carried out? (No-Some-Fairly-Yes) Decision rule to 'Yes' (below all items should be satisfied) All laws, regulations, guides and processes which are required in IT project progress should be carried out There should be all evidence related to the fulfillment of all required laws, regulations, guides and processes Decision rule to 'Fairly' In case of most fulfillment of laws, required regulations, guides and processes in IT project and there is most evidence related to the fulfillment of required laws, regulations, guides and processes in IT project Decision rule to 'Some' In case of some fulfillment of required laws, regulations, guides and processes in IT project and there is some evidence related to the fulfillment of required laws, regulations, guides and processes in IT project Decision rule to 'No' (when it is applicable to any case below) In case of non-fulfillment of all required laws, regulations, guides and processes In case that there is no evidence related to the fulfillment of required laws, regulations, guides and processes in IT project No in the clarity of project goals metric (EM #1-1)
Gathering method	System, data, questionnaire and interview
Data sources	Evidence data that can show the fulfillment of all required laws, regulations, guides and processes
Lee <i>et al.</i> (2012)	

Table 6: Propriety of performance objective (#EM 2-1)

Definitions	Check whether the performance objectives are established appropriately
Measurement method	Were the performance objectives established appropriately? (No-Some-Fairly-Yes) Decision rule to 'Yes' (below all items should be satisfied) The performance objectives in the IT project are sufficiently associated to the mission and goals of the NDI The project owner presents clearly the outcomes of the IT project The performance objectives can be measured with appropriate performance metrics Decision rule to 'No' (when it is applicable to any case below) In case of the performance objectives in the IT project are not sufficiently associated to the mission and goal of NDI The project owner did not present clearly the outcome of the IT project The performance objectives cannot be measured with appropriate performance metrics If multiple performance objectives in the IT project were used, a proper weight should be considered (e.g., weight with logical explanation in the project plan) and 'Some' and 'Fairly' are used in the evaluation
Data sources	Document that can see the project-related data such as project goal, project contents, project target (e.g., performance plan, demonstration material of project)
Lee <i>et al.</i> (2012)	

checks whether the project goal is clear and concrete and achieves the performance objective of the performance plan as shown in Table 4. This metric is measured as "yes" or "No". To be judged "yes", the specific situation or problems to be solved by an IT project and a connection between the project goal and the achievement of the performance objectives (or a logical relationship

between cause and effect) should be clear and concrete. The conformance to the procedure for project planning (EM #1-2) examines whether laws, regulations, guides and processes are fulfilled as shown in Table 5. It is evaluated on four points, "Yes", "Fairly", "Some", "No". To be judged "yes", all required laws, regulations, guides and processes should be fulfilled and all evidence related to

Table 7: Propriety of performance metric (#EM 2-2)

Definitions	Check whether or not the performance metrics can be used as an instrument to confirm the achievement of the project goal
Measurement method	<p>Were the performance metrics established appropriately? (No-Some-Fairly-Yes)</p> <p>Decision rule to 'Yes' (when the following items are all satisfied)</p> <p>The performance metrics of the IT project cover the project content</p> <p>The performance metrics of the IT project are the outcome measure to decide if the project goal has been achieved</p> <p>The definitions and equations of the performance metrics are clear and rational</p> <p>Decision rule to 'No' (when it is applicable to any case below)</p> <p>In case of the performance metrics of IT project partially covered some contents of the project</p> <p>In case that the performance metrics do not or partially connect to the project goals</p> <p>In case of all performance metrics are composed of the input or output quantity</p> <p>The definitions and equations of the performance metrics are not clear or appropriate or irrational</p> <p>All performance metrics are qualitative measures such as the level of user satisfaction</p> <p>In case of the achieved performance cannot compare to the past performance or the performance of other projects</p> <p>In case of the evaluators cannot verify the measurement of the performance metrics through appropriate process with presented evidence data</p> <p>If multiple performance metrics in the IT project were used, a proper weight should be considered (e.g., weight logically explained in the project plan) and 'Some' and 'Fairly' are used in the evaluation</p>
Data sources	<p>Evidence data that can show the linkage between the project goals and the performance metrics</p> <p>Document that can see the project-related data such as the project goal, project contents, project target (e.g., project plan, performance plan with the performance metrics and their target value, demonstration material of project)</p>

Lee *et al.* (2012)

this fulfillment was presented. A project is marked as “No” when it does not follow any laws, regulations, guides and processes, does not have proof data, does not have a clear project goals (evaluating with EM #1-1) or does not follow the procedures of planning.

The propriety of performance objective metric (EM #2-1) is shown in Table 6. This checks whether the performance objectives are established appropriately. “yes” is marked when the following items are all satisfied:

- The performance objectives in the IT project are sufficiently associated to the mission and goals of the NDI
- The project owner presents clearly the outcomes of the IT project
- The performance objectives can be measured with appropriate performance metrics

The propriety of performance metric (EM #2-2) is shown in Table 7. This metric checks whether the performance metrics can be used to confirm the achievement of the project goal. “Yes” is marked when the following items are all satisfied:

- The performance metrics of the IT project cover the project content
- The performance metrics of the IT project are the outcome measure to decide if the project goal has been achieved
- The definitions and equations of the performance metrics are clear and rational (the explanation, definition of metrics and measurement method of other than evaluation metrics can be found in the research report (Lee *et al.*, 2012) in the references)

The evaluation system also includes a pool of performance metrics (Lee *et al.*, 2012) from which project owners can select the performance metrics for their project. One group of performance metrics is related to the national defense business process and the other is related to technology. Two examples of the performance metrics are in Table 8 and 9. The customer waiting time is the required time from ordering munitions for end users (ordering units) to receiving them (Table 8). This metric is related to the business process and is calculated by the sum of the waiting time for each customer multiplied by the number of receipt items divided by the total quantity of receipt items for defense logistics in the predefined specific period.

The achievement ratio of the target Mean Time Between Failures (MTBF) is the ratio of the realized MTBF to the target MTBF in the predefined specific period (Table 9). This metric is related to technology and is calculated by dividing the realized MTBF by the target MTBF and multiplying by 100 to get a percentage. Meanwhile, the MTBF is calculated by dividing the operation time by the number of failures in the predefined specific period.

There are two methods of applying the presented evaluation system to a NDI project. The first is that the organizations or departments which can be the project owner, supervising the IT projects can evaluate themselves with the evaluation system and then the evaluation organization or evaluators check these evaluation reports. The second is that the evaluation organizations or evaluators can perform the evaluation of IT projects by following the evaluation system. As the two methods have their own merits and limitations, the circumstances and contexts of the evaluation must be considered.

Table 8: An example of performance metric: customer waiting time

Performance areas	Business process
Performance item	Efficiency
Metric name	Customer waiting time
Definition	The required time from ordering munitions for end users (or ordering unit) to receiving them in the predefined specific period
Measurement equation	$x = (\sum(CWT_i \times n_i)) / N$, where CWT = Customer Waiting Time from order to receipt, n = the number of receipt items for the specific user, I = user (or unit), N = total quantity of receipt items for defense logistics in the predefined specific period
Gathering method	System, data, questionnaire and interview

Lee *et al.* (2012)

Table 9: An example of performance metric: achievement ratio of target Mean Time Between Failures (MTBF)

Performance areas	Technology
Performance item	Service availability
Metric name	Achievement ratio of the target Mean Time Between Failures (MTBF)
Definition	The percent ratio of realized MTBF to target MTBF in the predefined specific period
Measurement equation	$X = (\text{Realized MTBF} / \text{Target MTBF}) \times 100$, where $\text{MTBF} = (\sum(t_d - t_a)) / n$, t_d = start of downtime, n = number of failures in the predefined specific period
Gathering method	System, data, questionnaire and interview

Lee *et al.* (2012)

CONCLUSION

This study presents the updated evaluation system at the pre-project stage by revising the existing evaluation system (Kwon *et al.*, 2012) for NDI projects. The updated evaluation system uses the five dimensions of the propriety of project planning, the propriety of performance planning, the propriety of applied technology, budget and period and economical efficiency (Lee *et al.*, 2012). The evaluation of IT projects requires significant resources and effort. The updated system benchmarked and tried to accept the evaluation metrics from the existing evaluation system of Korean government to reduce repetitive evaluations.

Like most studies or methodologies, the updated evaluation system is not without limitations. It is important to develop a rational and theoretically perfect system but the development of an evaluation system that users can easily understand and use is more important. Use of the evaluation system can provide lessons learned and cause demand for its revision with the accumulation of user experience. Lessons learned and requirements for revision can make the evaluation system more rigorous. With such a feedback mechanism, it is possible to develop an evaluation system that many users and evaluators can accept and use.

ACKNOWLEDGEMENT

This research was supported by the Sun Moon University Research Grant of 2010.

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