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Study on the Efficiency Evaluation of an Army Supply Support System Using the DEA-ANP Method

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Abstract: The military is devoting efforts toward the development of evaluation information systems for the logistics performance management. Nevertheless, it is difficult to understand the factors affecting the performance management and its improvement. In this study, we suggest that the DEA-ANP provides a supplementary measure for the performance evaluation of a military supply support system. The DEA Model that measure efficiency from the input/output perspective and the ANP Model that complements the discriminant power can facilitate the measurement of the efficiency of the military supply support system as well as the benchmarking of superior teams.

Key words: Management information systems, improvement, military supply support, DEA Model, efficiency, ANP Model

INTRODUCTION

The supply support system of the military refers to a process and an infrastructure system that is for the provision of military supplies from the military support units to the user units. In the present military, taking the example of a private company an attempt is being made to increase the efficiency of the supply support system within the logistical scope. To this end, various measures have been devised for the performance evaluation. As a result, a management instruction for the performance management regarding the supply of munitions has been established and for the carrying out of the performance management, the performance indicators that are related to the supply support systems have been incorporated into the information system. Figure 1 shows the main performance indicators that are related to the supply support system and are included in the directive as well as the relationship between the information system and the performance indicators.

Meanwhile, the military is gradually promoting logistics-innovation pilot projects one step at a time. The details of the pilot projects are also shown in Table 1.

To measure the performance of the supply support system, the construction of an information system called the logistics innovation evaluation system was completed. The logistics innovation evaluation system sets out performance indicators for each of the requisite six tasks and evaluates the efficiency of the supply support system based on the values that are indicated by the performance indicators. Despite these efforts, the evaluation of the supply support system has its limitations in terms of input/output viewpoint. The limitations are as follows. First, since, the performance index is being managed in the information system but only the result value is shown, the feedback and overall evaluation results are insufficient. The logistics innovation evaluation system manages the performance using the overall situational concept (red/green/amber) but the provision of the performance feedback is difficult. In addition, the reliability of the overall results is not sufficient because the weighting basis of each indicator is unclear.

Table 1: Demonstration projects for the military logistics innovation

Step	Period	Project scope
1	July 2014-March 2015	2 corps
2	October 2015-September 2016	1, 2, 3 and 8 corps
3	October 2016-2017	Field army units

Second, it is difficult to compare the performances of military logistics support units within the military support system. Further, it is difficult to compare the current performance-management measures directly due to the infrastructure and scale differences among the units. As can be seen from the table, the differences in the quantities of the human resources, warehouses and equipment among each supply battalion make it difficult

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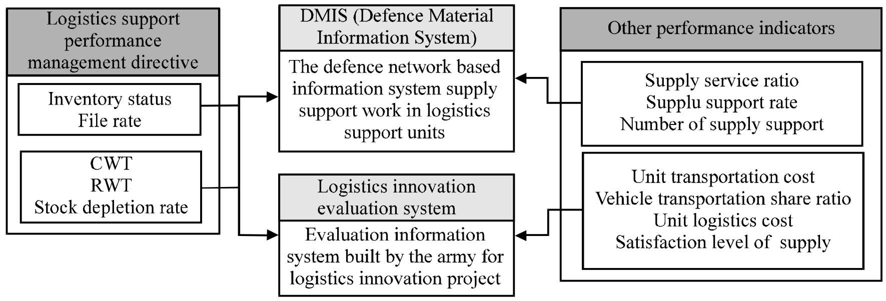

Fig. 1: Relationship between the information system and the performance indicators

to measure the performance of each unit. In addition, it is also, difficult to discern the region or unit that has achieved an excellent performance because the definition of the superior region (unit) is different according to the performance index.

Third, the management system for the calculation of the input/output is insufficient. It is difficult to analyze the input values (human resources, resources) with an output value that affects the performance index. It is also, difficult to derive the analytic results that identify the findings of an analysis such as the analysis of the appropriate input values and the additional investment and cutbacks.

Therefore, this study attempts to devise an overall efficiency-evaluation method to overcome these limitations. In order to introduce an efficiency-evaluation method that covers the calculation of the input/output as a whole, the intention of this study is the exploration of the usage of the Data Envelopment Analysis (DEA) which is widely used as an efficiency measure.

Precedent research: Charnes *et al*. (1978) developed the relative-efficiency concept of Farrell and developed a DEA (CCR) Model that measures the relative efficiency using multiple input and output variables (Charnes *et al*., 1978). Banker *et al*. (1984) subsequently proposed the Banker, Charnes and Cooper (BCC) Model by applying the concept of scale to the Charnes, Cooper and Rhodes (CCR) Model. In addition, Thompson *et al*. (1986) proposed a DEA-Assurance Region (AR) Model in order to overcome the problem of poor discrimination regarding the use of the existing DEA Model. Alternatively, Saaty (2004) proposed the Analytic Network Process (ANP) as a decision model to grasp the mutual dependency and feedback between the factors.

A number of cases where the DEA was applied to evaluate military efficiency exist in the literature. Jeong evaluated the operational efficiency of military golf courses and presented benchmarking information that can be referenced regarding low-efficiency courses. Also, it is suggested that the efficiency of the operation could be improved through the unification of the cours operations (Jung and Moon, 2016).

Jeong measured the efficiency of the management department of a navy's resources-management units and it was shown that the DEA-AR Model resulted in a higher level of efficiency than the general DEA Model. Moreover, to improve the efficiency of an inefficient financial-management office where the emphasis was on the strengthening of job training, a recalibration of the staffing power in the financial-management department and a heightening of the efficiency through the use of accurate budget measurements were enacted (Jung, 2013).

Seo and Song (2010) measured the efficiency of a supply-transport battalion and compared the efficiency of each of the four supply classes as follows: 1 (food), 2 (clothing), 3 (gas) and 4 (construction materials). In addition, Seo analyzed the correlation between the input and output variables and the efficiency results Seo and Song (2010). Moon *et al*. (2014) proposed a measure for the evaluation of the efficiency of the maintenance budget for each unit where a DEA measurement of the virtual unit data is conducted to improve the efficiency of the financial-information data of a defense integrated financial-information system .

Although, the studies on the evaluation of efficiency where the CCR or BCC Models have been used have been actively conducted in various military fields, there is an absence of research regarding the application of the DEA-AR Model where the ANP is used for the improvement of the discrimination of the efficiency measurement. Therefore, the intention of this study is the improvement of the discrimination of the efficiency evaluation using a combination of the DEA-AR Model and the ANP.

MATERIALS AND METHODS

Research scope: The research scope for this study was limited as shown in Table 1 in consideration of the study

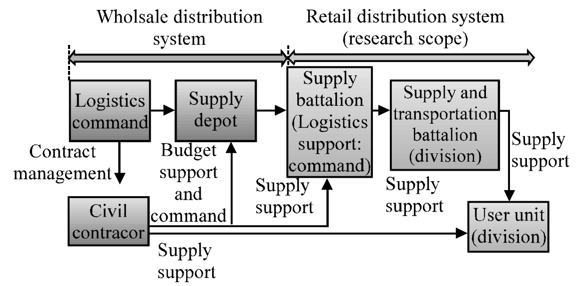

Fig. 2: Military supply support system

Table 2: Research scope

Subject	Research scope
Supply support system	Retail distribution system of army
Types of munitions	Class-2 items (cloth) class-4 items (construction material)
Research subject	Supply battalions in logistics support commands, Supply and transport battalions in divisons

period, data-acquisition conditions and structure of the supply support system. The supply support system of the military can be divided into the wholesale distribution system and the retail distribution system as shown in Fig. 2 and Table 2. A data analysis based on the class-2 and 4 species was conducted in consideration of the similarity of the security and the distribution customers among the munitions classes from 1-9 (repair parts). The target units were divided into two groups. The first group consists of the subordinate units of the logistics support command and the other group consists of the division subordinate units (Berg, 2010).

Data Envelopment Analysis (DEA): DEA is a multifactor productivity-analysis model that measures the relative efficiency of the Decision-Making Units (DMUs) in a cohort. With the assumption of a case with n decision units with m inputs and s products, the relative efficiency of the decision units can be determined using the DEA. Because of this feature, it is useful to measure the efficiency of the multiple outputs versus the multiple inputs of an organization. Therefore, it is widely used as a performance-evaluation method in both private and public institutions and many studies are being actively conducted. Alternatively, the CCR and BCC Models are often used in the DEA Model. For the CCR Model, it is assumed that the efficiency does not change even if the scale changes whereas for the BCC Model, it is assumed that the efficiency changes as the scale changes. In this study, the BCC Model was used because a difference depending on the size of the units was assumed.

DEA-AR: The general DEA Model is problematic in terms of the efficiency evaluation as the weight of a relatively

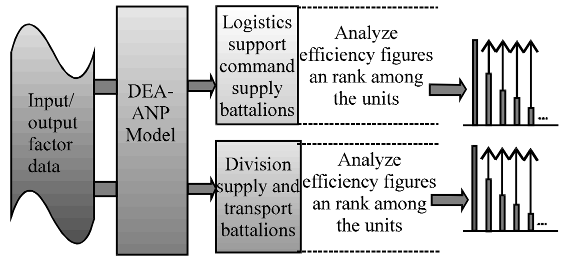

Fig. 3: Efficiency-evaluation process

important element is 0 or the weight of a relatively insignificant element is biased to an excessively large value. To solve these problems, the DEA-AR Model is frequently used. As shown in Table 3, the upper and lower limits of the input and output factors are fixed to solve this problem:

$$\begin{aligned} OL_r\mu_1 \le \mu_r \le OU_r\mu_1,\ \mu_1 \ge 0, r = 2,3,...,s \\ IL_r v_1 \le v_r \le IU_r v_1,\ v_1 \ge 0, i = 2,3,...,m \end{aligned} \quad (1)$$

Where:

OL_r = Lower limit of the weight of output variables
OU_r = Upper limit of the weight of output variables
IL_r = Lower limit of the weight of input variables
IU_r = Upper limit of the weight of input variables

ANP (network analysis, Analytic Network Process): In order to utilize the DEA-AR Model, the upper and lower limits of the input and output-factor weights should be fixed. To do this, the upper and lower bounds of the weighted ratios of the input and output-factor data of each efficiency-evaluation object are calculated using the ANP.

Generally, the Analytic Hierarchy Process (AHP), a layer analysis is used for the weight measurement but AHP-based difficulties exist regarding the structure and the layer of the input and output elements of this study. Due to the assumption that each AHP element is independent, it is difficult to reflect the dependencies between the elements.

Therefore, it is possible to strengthen the discriminative power of the efficiency evaluation by applying the ANP that overcomes these problems.

Efficiency-assessment process: This study evaluates the efficiency of the logistical support units that are in charge of the supply process using the DEA-ANP Model which is a combination of the DEA and ANP Models. A brief summary of the evaluation process as shown in Fig. 3 is as follows: attainment of the input and output-element data by acquiring and organizing the related data pools. Measurement of the weights of the input and

Table 3: Input- and output-element candidates

	Indicator (element)	Indicator description	Source
Input	Number of human	Number of personnel of military support units resources related to supply support work (Officer+civil servant+NCO+soldier)	D-MAPSS
	Number of warehouses	Number of warehouses utilized by munitions support units	DMIS
	Warehouse size (area)	Area of warehouse utilized by military support units	DELIIS
	Number of cars	Number of commercial vehicles and military standard vehicles used for supply support work	
	Number of forklifts	Number of forklifts used for cargo loading and shipping	
Output	CWT (Customer Waiting Time)	The time elapsed from the logistics items request to the receipt of the user (customer) unit	DMIS
	RWT (Requisition Waiting Time)	Time elapsed from logistics claim to receipt of the logistics support unit	
	CWT variance (dispersion)	The degree to which each CWT value deviates from the average CWT	CWT-based
	RWT variance (dispersion)	The degree to which each RWT value deviates from the average RWT	RWT-based
	Stock-depletion rate (%)	Percentage of items with zero inventory versus authorized items	Logistics innovation evaluation information system, DMIS
	Supply-support ratio (%)	The ratio of the total number of effective claims to the number of releases within the period	DMIS
	Supply-service ratio (%)	Percentage of total effective claims to immediate actions	
	Supply amounts	Amounts of requests/releases related to the supply support	
	Cost of supply	Total cost of requests/releases related to the supply support	
	Weight of supply (g)	Gross weight of requests/releases related to the supply support	

output-element data using the ANP. Measurement of the efficiency using the DEA. Derivation and analysis of the efficiency figures and rankings among the units of the same level. The improvement requirements for the input element are derived based on the highly efficient benchmark units.

Input and output-factor data acquisition, summarization

Construction of input and output-element candidates: For the efficiency evaluation, it is important to select the input and output-factor data that can represent the supply support system. Therefore, a pool is constructed based on the data that can be secured within each information system as shown in Table 2. The information systems that are used for the pool construction are the Defense Materials Information System (DMIS), the Equipment Maintenance Information System (DELIIS), the logistics innovation evaluation information system and the Defense Workforce Planning Support System (D-MAPSS).

Selection of the input and output-element data: The data to be used for the actual efficiency measurement should be selected for the data candidates that are constructed in the previous section. The selection criteria are important for the selection and the following three criteria were selected based on discussions with militar experts.

First, the data need to be representative. It is important that it is representative of the performance measurement against the other factors and it is important to be able to manage the target unit. The second criterion is reliability. The reliability of the collected and secured data is important, so that, the data are measurable. Third, the selection history of the data in terms of previous studies is important. In this study, the input/output data in the defense-related DEA precedent research are considered. As a result of the data selection that is based on the three recommended considerations, the numbers of the inputs, human resources, warehouses and vehicles (including the forklifts) were selected and the selected output factors are the Customer Waiting Time (CWT), Request Waiting Time (RWT), RWT variation (standard deviation) and supply-service ratio. Table 4 shows the results of this screening.

However, the output-element data are used differently depending on the unit group (supply battalions, supply and transport battalions) and the lead time that is used in the supply support system is somewhat different. The supply battalions utilize the RWT and the supply-and-transport battalions use the CWT. The data that are used for the measurement of the efficiency of the supply support system are shown in Fig. 4.

Summary of the input and output-element data: In the case of the number of the human resources, only those people who are directly related to the supply support system were selected and counted. For example in the case of a supply battalion, the personnel in charge of the class-3 items or other work were excluded. The removed output factors are the data that are excessively high compared with the average or that are likely to be distorted.

Weight measurement of the input/output factors using the ANP

ANP-Model construction and survey: In order to calculate the weights of the input and output factors, the ANP

Table 4: Input/output-element data-selection results

Indicator (element)	Represen tative	Respons ibility	Selection history of previous studies	Indicator selection
Number of human resources	Δ	○	○	√
Number of warehouses	○	○	○	√
Warehouse size (area)	×	×	Δ	
Number of cars	○	○	○	√
Number of forklifts	○	○	○	√
CWT (Customer Waiting Time)	○	○	×	√
RWT (Requisition Waiting Time)	○	○	×	√
CWT variance (dispersion)	○	○	×	√
RWT variance (dispersion)	○	○	×	√
Tock-depletion rate (%)	○	Δ	×	
Supply-support rate (%)	○	Δ	×	
Supply service ratio (%)	○	Δ	×	
Supply amounts (Number of cases)	×	Δ	×	
Cost of supply (won)	×	×	○	
Weight of supply (g)	×	×	×	

Table 5: Examples of the input/output-factor weightings

Input/output factors	A	B	C	D	E	...	J
Number of human resources	0.11061	0.15468	0.22000	0.09110	0.19705	...	0.17260
Number of equipment	0.07962	0.26071	0.14000	0.22947	0.17619	...	0.26396
Number of warehouses	0.03200	0.08460	0.14000	0.17943	0.12676	...	0.06344
RWT	0.27656	0.15977	0.10812	0.25000	0.15125	...	0.05265
RWT variation	0.25455	0.15236	0.20026	0.10714	0.17462	...	0.19910
Supply-service ratio	0.24667	0.18787	0.16163	0.14286	0.17413	...	0.24825

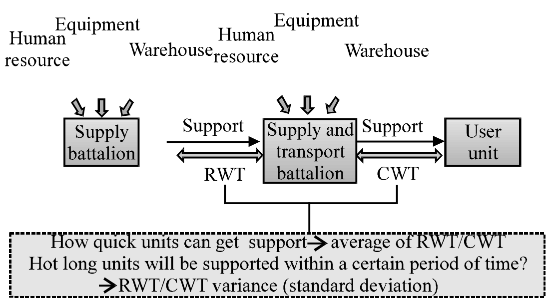

Fig. 4: Input and outputs of the supply-support-system data description

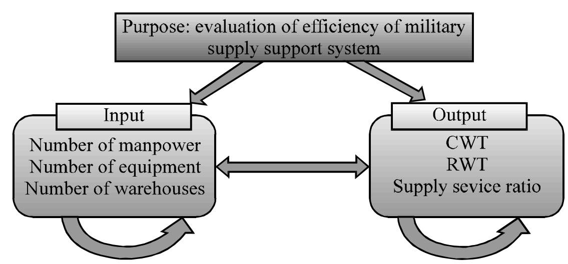

Fig. 5: ANP Model

Model that is shown in Fig. 5 was constructed based on the purpose including the input and output factors. This model consists of the purpose and input/output factors and clusters. Further an association between the elements was assumed and the nodes are connected and it was expected that the mutual influences are between the elements of the cluster for the construction of the feedback node. Based on the constructed ANP Model, the weights were examined through a comparison of the influences between the elements based on aquestionnaire. The subjects of the survey are 10 workers in the field of military-related research.

Weight results: The ANP survey results were used to calculate the input and output factors of each unit (numbers of the human resources, equipment and warehouses; The CWT, the RWT, the CWT variations, the RWT variations and the supply-service ratio). Based on the derived results, the upper and lower bounds of the data-weighting ratio were calculated and compared with that of the DEA-AR Model. Table 5 shows the weights of each unit of the input and output elements of the supply battalion and the Consistency Ratio (CR) is <0.1.

Results of the efficiency evaluation

Comparison of the data of the efficiency-evaluation subject units: Prior to the measurement of the unit efficiency values an examination of the characteristics of the input and output factors among the unit groups was performed. It was confirmed that the average number of human resources in the supply battalion group is larger than that of the supply-and-transport battalion group, this is attributed to the fact that the supply battalion group is higher than the supply-and-transport battalion group in terms of the overall hierarchy. A significant difference in the supply-service ratios is not evident. For a reference, it was confirmed that the supply and demand amounts of the items of classes 2 and 4 are approximately 2.3 times

Table 6: Descriptive statistics of the input/output factors between the unit groups

Variables	Supply battalion group	Supply and transport battalion group
Number of units	7	15
Average number of human resources	148	98
Average number of equipment	33	34
Average number of warehouses	28	12
Average CWT	-	8.0 days
Average RWT	7.2 days	-
Average supply-service ratio	85.4 %	84 %

more than those of the supply-and-transport battalion group. Table 6 is a summary of the comparison contents.

Result of the efficiency evaluation of the supplybattalions: First, the DEA-ANP Model was used to measure the relative efficiency values of the supply battalions. As a result of this measurement, it was confirmed that the efficiency of the three units is as high as 100%. It should be noted, however, that this efficiency measure is a measurement of the relative interunit efficiency, so, 100% is not a perfect state. The results of the detailed investigation of the causes of the three highly efficient units are as follows.

The reported supply-service ratio of the A unit is 92.4% and this exceeds the overall average of 85.4%. In addition, the RWT variation of 3.671 is better than the average of 5.24. The human-resource and warehouse numbers of the B battalion are relatively low. The human-resource number of 125 is less than the total average of 148 and the 13 warehouses represent less than half of the average number of 28. Finally, it was confirmed that the numbers of the human resources, warehouses and equipment are lower than those of the G battalion which are 136.23 and 26, respectively.

The efficiency values of the remaining units except for the A, B and G units are from 77.7-97.1 % and this can be interpreted as there is room for improvement of the input. Therefore, it is desirable to derive the improvement requirements of the input factors based on the benchmarked units (the top three units) and to use them as reference models for the performance evaluation. Table 7 shows the results of the efficiency measurement of the supply battalions.

Efficiency-measurement results of the supply-transport battalions: A review of the results of the efficiency measurement of the supply-transport battalions which was conducted for a relatively large number of units is performed next. The measurement details are shown in Table 8 where in it can be seen that only three units

Table 7: Efficiency-measurement results of the supply battalions

Units	Efficiency (%)	Ranking
A supply battalion	100.00	No. 1
B supply battalion	100.00	No. 1
C supply battalion	97.050	No. 4
D supply battalion	81.460	No. 6
E supply battalion	77.700	No. 7
F supply battalion	81.640	No. 5
G supply battalion	100.00	No. 1

Table 8: Efficieny-measurement result of the supply and transport battalions

Units	Efficiency (%)	Ranking
Supply and transport battalion in M division	94.55	No. 80
Supply and transport battalion in N division	93.10	No. 10
Supply and transport battalion in O division	96.86	No. 40
Supply and transport battalion in P division	100.00	No. 10
Supply and transport battalion in Q division	95.04	No. 60
Supply and transport battalion in R division	92.82	No. 12
Supply and transport battalion in S division	94.56	No. 70
Supply and transport battalion in T division	92.06	No. 13
Supply and transport battalion in U division	100.00	No. 10
Supply and transport battalion in V division	92.98	No. 11
Supply and transport battalion in W division	93.95	No. 90
Supply and transport battalion in X division	96.61	No. 50
Supply and transport battalion in Y division	91.16	No. 15
Supply and transport battalion in Z division	91.27	No. 14
Supply and transport battalion in MA division	100.00	No. 10

achieved a 100% efficiency even though the total is 15 units. In comparison with the supply battalions, it was also confirmed that the efficiency values of the supply-transport battalions that did not achieve 100 % are still high with the measured values in the region from 91.16-96.86%. It can be interpreted that the efficiency values were measured evenly because the deviation between the inputs and outputs of the units is not large. Therefore, it is expected that the input factors will be improved more realistically than those of the supply battalions with uneven numbers. The drastic elimination of the inputs for which realistic conditions were not considered is difficult to account for in the actual units. In the same way, it is necessary to derive the improvement requirements of the input factors based on the benchmarked units (P-•U-•MA-division maintenance teams) and to use them as reference models for the performance evaluation.

Derivation of the improvement requirements using the evaluation-result feedback: In the previous section an examination of the efficiency-measurement results of the units was carried out. However, if the efficiency measurement only results in a simple sequencing, this does not benefit the improvement of the efficiency of the military supply support system. Therefore, efforts should be made to benchmark the best units to identify and improve the infrastructure which are the parts of the input data that can be adjusted. Therefore, an improvement requirement for the supply-transport battalions that allows for a relatively easy and realistic reflection of

Table 9: Infrastructure (input factor) adjustment expectation of the supply and transport battalions

Unit (supply and transport battalion)	Best team will be benchmarked	Reduction (Current quantity-expectation) Number of manpower	Number of warehouses	Number of equipment
M	MA	1	4	10
N	U, MA	-	12	2
O	U, MA	-	3	6
P	-	-	-	-
Q	U, MA	1	7	1
R	U, MA	-	10	8
S	U, MA	-	6	9
T	U, MA	-	13	3
U	-	-	-	-
V	U, MA	-1	11	7
W	U, MA	-	9	5
X	MA	-	3	7
Y	U, MA	-	13	9
Z	U, MA	-	15	4
MA	-	-	-	-

the input element is subsequently identified. The infrastructure (input factor)-adjustment expectation of the supply and transport battalions are shown in Table 9 and these were derived in consideration of the sensitivity of the contents.

As a result, the benchmarking of the best team makes it possible to obtain the areas for the improvement of the infrastructure and the adjusted figures of the other teams. In the case of the adjustment of the number of warehouses an improvement of the efficiency of the same work can be expected through the consolidation of the warehouses. It is expected that the completion of a quantity adjustment regarding the equipment will also, improve the work efficiency.

Limitations of the efficiency-evaluation method: The efficiency-evaluation method using the DEA-ANP is a useful method in that it measures the efficiency from the input/output point of view and the infrastructure-improvement requirements can be derived from the measurement data. However, the limitations that have been identified are as follows.

First, the difficulty here regarding the adjustment of the input factors that is due to the fixed-unit organization should be considered. Although, it is possible to reconsider the adjustment of the human resources and equipment in terms of the management of the efficiency of the organization, it is difficult to arbitrarily adjust the structure of the military units and this should be considered.

However, a precedent is relevant here as the military troop-support force was reduced by 20%, since, the diagnosis of the management of the organizational efficiency in early 2015 and the efficiency-enhancement efforts are continuing. Rather than a reduction of the human resources or equipment through the adjustment of the overall organization an overall focus on the efficient deployment of personnel and equipment to the subunits is needed, along with a reference to the results of the efficiency evaluation.

Second, a further analysis of the repair-part data (class-9 items) is needed. Among the munitions data, the repair parts are important in terms of the amount of data and the subsequent logistical support. For this reason, the logistics-innovation pilot project which the military has recently commenced has been promoting the projects for the items of the class-2/4/9. Therefore, in this study, analyses of class-2/4 should have been conducted and further, a data analysis that includes the repair parts is needed in the future.

Third, it is necessary to consider the application of the detailed classifications and weightings of the personnel, equipment and warehouses that are dedicated to the supply support system. As previously mentioned, the human resources were identified and classified based on the unit duties but it is necessary to further investigate the actual work allocation using due diligence. The equipment including the forklifts is applied here without a classification of the vehicle type but it is necessary to conduct this classification in consideration of the frequency and the mission of the standard and commercial vehicles. It is also, necessary to analyze the warehouses in consideration of the circumstances under which the future mission assignments will be changed.

RESULTS AND DISCUSSION

The significance of this study can be explained as follows. First, it suggests that an evaluation method that is based on the output viewpoint as well as that of the input can be utilized in an information system that is related to the supply support system. Second, it is proposed that the excellent troops are benchmarked using the evaluation-result feedback. In order to further develop the results of the study in the future, the following two studies need to be added. First, the characteristics of the input factor are subdivided and applied to the model of this study. For example, if we quantify the size of warehouses and storage facilities as well as the number of warehouses, we can get more sophisticated results than the current results. In the case of equipment, it is also, necessary to quantify the loading capacity of the equipment and apply it to the model.

Second, future studies should consider measuring the effectiveness of upper supply support systems. It is also, necessary to measure the efficiency of the upstream supply system from the supply supplier to the supply depot of the military command separately and compare the measurement results with the efficiency results of the lower supply support systems in this study. An efficiency assessment of the upper/lower supply support system can enable the efficiency measurement of the entire supply chain manegement.

CONCLUSION

Measurements of the efficiency of a military supply chain were performed for this study using the DEA-ANP Model consisting of the DEA-AR and the ANP which had been through several previous courses. According to the results, 3 out of the 15 units showed a 100% efficiency. It was necessary to derive the improvement requirement of the input element based on the benchmarked unit (3 supply and transport battalions with 100% efficiency) and to use it as a reference for the performance evaluation. It was also necessary to benchmark the best units that can identify and tune the infrastructure for its improvement. Any reduction of the numbers of the human resources, warehouses and equipment should take into account the sensitivity of the contents.

As a result, the best team was benchmarked to propose adjustment values for the infrastructure items that can be improved. In the case of the adjustment of the number of warehouses, the same efficiency can be expected through a consolidation of the warehouses compared with the preconsolidation period. In fact among the tasks of the logistics-innovation pilot project, promotion has been undertaken for a project that will integrate the warehouses of the logistics-support units for the improvement of the efficiency. A quantity adjustment regarding the equipment should also, improve the work efficiency.

REFERENCES

Banker, R.D., A. Charnes and W.W. Cooper, 1984. Some models for estimating technical and scale Inefficiencies in data envelopment analysis. Manage. Sci., 30: 1078-1092.

Berg, V.S., 2010. Water Utility Benchmarking: Measurement, Methodology and Performance Incentives. International Water Association, London, UK., ISBN: 13-9781843392729, Pages: 171.

Charnes, A., W.W. Cooper and E. Rhodes, 1978. Measuring the efficiency of decision making units. Eur. J. Operat. Res., 2: 429-444.

Jung, C. and C. Moon, 2016. Evaluating the management efficiency of military golf courses by using data envelopment analysis. Q. J. Defense Policy Stud., 112: 171-196.

Jung, C., 2013. An efficiency analysis of Korea military organizational operations: Focus on DEA model. Q. J. Defense Policy Stud., 99: 232-253.

Moon, J., S. Kang and D. Kim, 2014. Study on improving the data efficiency in national defense financial information. J. Korea Inst. Inf. Commun. Eng., 18: 1764-1776.

Saaty, T.L., 2004. Decision making-the analytic hierarchy and network processes (AHP/ANP). J. Syst. Sci. Syst. Eng., 13: 1-35.

Seo, M. and I. Song, 2010. A study on measuring the efficiency of the army Supply-transport battalions. J. Mil. Oper. Res. Soc. Korea, 36: 85-106.

Thompson, R.G., F.D. Singleton Jr, R.M. Thrall, B.A. Smith and M. Wilson, 1986. Comparative site evaluation for locating a high-energy physics lab in Texas. Interfaces, 16: 35-49.