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Hybrid Recommendation Technique Selection Center Donated Bags with Data Envelopment Analysis

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Abstract

The main purpose of this paper to present Natural Disasters problem case study Thailand flood 2554 To hybrid recommendation technique Selection center donated bags is deemed to be one of challenging problems that can be used to imply the management competency due to the fact that it is a difficult and complicated task in logistics supplier function. This article aims to introduce an approach to measuring the Shelters performance by using Data Evaluation Analysis. The DEA is a linear programming-based technique with less complication and exists an available method of simplex algorithms to solve the problem for measuring the efficiency of suppliers. The paper illustrates how to apply the DEA technique by using the data collected from donor bags person plant, which is making contact with 10 center donated bags to provide required for the Shelters plant. To evaluate the performance of the center donated bags, the procurement department employs input criteria of quality, and delivery. The results of the evaluation indicate that there are only center donated bags marked as relative efficient firms and the remaining 10 center donated bags are sorted as non-efficient firms. In addition, the results can be used to create negotiation strategies performance for send bags the Shelters from the inefficient center donated bags by using the value of reference time, weights. Specifically, the inefficient center donated bags will have to reduce the value of the input criteria by the proportion of reference weights in order that the inferior center donated bags could be attained to the benchmark points of relative efficiency.

Keywords: Disaster, Input criteria, Shelter selection, DEA

1. Introduction

Procurement and Recruitment of the Outsourcing or in other word theory reverse Supplier Selecting is one of several significant factors in Logistics Function. Since the Procurement and Recruitment is the process of gathering raw materials, spare parts, and equipments for the production process or service providing process for the clients. Base on the research study data done by the US government office, it states that most organizations have the expenditures on materials and equipments purchasing about 40% to 60% of their income from products selling and service providing for their clients [1]. Whether (If) any organizations could possible find the low cost materials and equipments with high quality and punctual delivery, those organizations would be able to response to the needs of their customers better

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in terms of both product prices and fast products delivery.Based on the study, the suppliers can be divided into three categories, which are [2]

1. Each supplier has slightly different ability
2. Each supplier has highly different ability which the former suppliers with the highest ability would be found in any circumstances.
3. Each supplier has highly different ability whereas the highest ability suppliers in one circumstance might not be the highest one in another circumstance that has been changed.

Efficiency and ability of the supplier have definitely impacts to the Productivity, Quality and Competiveness of the organization. Therefore, the assessment of suppliers' ability for the most suitable supplier selection is crucial. The matter of supplier selection challenges the Administration and Management Section as it is the complicated and difficult issue. Since the problem on decision making to select the suppliers has various factors or criteria in selection *e.g.*, the quality of materials and equipments or services, the Lead Time, the unit price, the flexibility in delivery, frequency/ the smallest size of lot possible to delivery, transportation cost, on time delivery, the ability in information sharing, the ability in cooperate designing, the import/export tax, the exchange rate, and the business stability of the suppliers [3]. This article has aimed to suggest the guideline in the assessment of the suppliers' abilities through the technique of Data Envelopment Analysis or DEA in order to use for support the decision making in selection of the highest ability suppliers. Moreover, this technique also can be used in the strategy making in the negotiation with suppliers based on this analysis results. The following contents will be firstly discussing the concept of the ability assessment in selecting suppliers, then the explanation of the DEA technique will be provided together with the sample cases shown as an example of application of the technique, and finally the conclusion and recommendation will be presented at the end.

2. Theoretical Background

To avoid the failures of the result caused by the fault selection of the inability or low efficiency suppliers, the executives, especially in the Procurement and Recruitment Section must have the active strategy in searching for or identifying the qualifications of suppliers in order to use in Supplier Qualification Screening. The main purpose of screening is to reduce possibilities or chances of the inability suppliers or the suppliers that lack of the required qualifications appear in the assessment process. The secondary purpose is to screen the qualified suppliers which is increasing the confidence that the suppliers, whom the organization will officially work with, have the partner to responsible and be able to respond to the needs effectively [4]. In the ability assessment, the person who is making assessment must identify the dimensions or factors in the supplier assessment which there are several factors as mentioned before. Therefore, the suppliers' ability assessment is considered the Multi-criteria Decision Making Problem. However, the first three dimensions used for the assessment are price, quality, and ability to deliver goods on time and right quantity to the orders. Once the dimensions or factors have been identified, each dimension/factor in each supplier must be scored in order to be ranked according to their abilities. Then, the suppliers with the highest scores will be selected or the organization will identify the quantity of goods purchasing order according to the assessment scores. At present, there are two ways of assessment or scoring the suppliers' ability, which are; Empirical Method, for example Analytical Hierarchical Process or AHP [5] which is making assessment in relative weight according to the significance of assessing criteria in calculating for the highest scores

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suppliers. Another example is Classification Algorithms which is the statistics Empirical Method in order to group the supplier base on the criteria scores [6]. This method called Cluster Analysis, which has the purpose in valuing the different scores of the suppliers in the same group with the lowest score and valuing the different scores of the suppliers in the different group with the highest score. The last method to mention is Monte Carlo Simulation for the weight factors [7], with this method it is possible to clarify the frequency from the weight of each supplier in order to select the suppliers with the least overlap frequency to the clarifying frequency of other suppliers.

Optimization Method, for example, the Mathematics Linear Modeling for Plant Location Modeling [8] by selecting the suppliers with the lowest cost of material purchasing. Another example, the Mixed Integer Nonlinear Programming Model [9], this method has focus function with the grand total of expenditure in logistics. To find the answer of this question, it must run the model $2n$ time according to the numbers of suppliers n. It is obviously that the higher numbers of supplier, the more time consuming in finding the answers. The last method in Optimization Method is developed by Degraeve and Roodhooft [10], this method is creating the Mathematics model to find the lowest cost of the focus function which refers to the total cost in controlling the choices of suppliers including the expenditure in managing the stored goods by using information technology of the Activity-Based Cost.However, both ways of assessment have Pros and Cons [11], the Empirical Method is too much Subjective-Based on the assessors. Each assessor might weight and score differently for the same supplier. It might lead to the conclusion of the best supplier vary different too. While the assessment through the Mathematics method to find the optimized value has been scarcely applied in the industry field seriously since it is complicated in Mathematics model creation to be able to replace the problem and find the solution to the created model.

According to the above mentioned facts, if we could bring both the Empirical method and Mathematics programming model that is not too complicated to apply in the assessment process, it would help the decision making on supplier selection become easier. The Data Envelopment Analysis technique is one of the methods that help minimizing the Cons or disadvantages of both methods. Since the DEA technique is not only relying on the experiences or the past data only, but it is also relying on the uncomplicated Mathematics Linear Modeling and the solution finding through Simplex Method. Therefore, this technique could solve the suppliers' ability assessment problem easily. For the summary details of DEA technique will be explained in the next topic. For more detail information please further read in the References [12] and [13].

2.1 The Data Envelopment Analysis Technique

The Data Envelopment Analysis technique or DEA is the technique that relying on Linear Programming Model in order to use for analysis of the efficiency of an organization. The inventors of this model are Charnes *et al.*, [14] In this model, there are comprising of several factors which replace Multi-Factor that are used for measure the efficiency of the offices or organizations holding the same qualifications. Each organization that is measured will be called Decision-Making Units (or DMUs). These DMUs might be a cluster of hospitals, universities, banks, auto-mobiles manufactures, *etc.* For this study, the DMUs are the group of suppliers those are being assessed their ability.

At present, there are researches and applying of the DEA technique for assessment of several business organizations' efficiency. This can be observed that there are many articles in the academic bulletins around the world have been presenting the study results in applying the DEA technique in various kinds of work. For example, the using of the DEA with the artificial neural network for assessment the efficiency of the office branches of one major bank in Canada [15]. The usage of Benchmarking technique and DEA technique for increasing the rice growing and harvesting [16], and assessment of the efficiency of bio-gas power plant through the analysis of multi-factor and DEA technique [17] are other examples, including, the assessment for comparison of the locations for the high energy Physics Laboratory in Texas [18].

Linear Programming Model that applies DEA technique may be compiled of Multiple Input factors which are used for produce the Multiple Output. This created model will be used for assessing each DMU whether it could possible simulate the problem by Linear Programming Model with a Single Output that used for presenting its efficiency and the multiple input factors that used as criteria to measure the efficiency.

Supposing that *n* is the numbers of Shelters which are being assessed their efficiency, while *m* is the number of input factors used as criteria to measure the efficiency. Thus, Programming model that is used for simulation is

$$\text{MinZ} = \alpha_k - \varepsilon \sum_{i=1}^{m} s_i \qquad (1)$$

Under the condition

$$\alpha_k - x_{jk} \sum_{i=1}^{n} \lambda_i x_{ij} - s_i = 0 \qquad \forall i = 1,\dots,m \qquad (2)$$

$$\sum_{i=1}^{n} \lambda_i = 1 \qquad (3)$$

$$s_i \geq 0 \qquad \forall i = 1,\dots,m \qquad (4)$$

$$\lambda_i \geq 0 \qquad \forall j = 1,\dots,n \qquad (5)$$

α_k is the product or result that used as a measurement of efficiency of Shelters Number *k*

λ_i which is the reference weight for the Shelters Number *j*. When comparing the Shelters Number *k* which is being assessed its efficiency.

x_{ij} is the value of factor *i* which is being used by the Shelter Number *j*

ε is the number of value which is very small

s_i that is Slack value of the factor (that)/(Number)……

DEA technique is the method of efficiency assessment in terms of Relative Efficiency for various factors in the group of DMUs by identifying DMUs with the highest Relative Efficiency equals the standard value for measuring the efficiency is 1 (α_k = 1) and there is Slack value of all factors as zero (s_i = 0). It can be specifically mentioned that the less standard value for measuring the efficiency means the less efficiency and the Slack value of any input factor has high value means the less efficiency of that particular input factor. This can be explained in a form of graph representing the efficiency as that the Shelters with the highest Relative Efficiency equally will be located on the line of Efficiency Frontier. Therefore, any Shelters on this line are considered the efficiency units, on the other hand, any Shelters are fallen behind the line will be considered as the low efficiency units.

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For the readers to understand easier and better,

The author (I) would like to give an example of the efficiency assessment of 7 Shelters (Shelters named A B C D E F and G) who proposed very close time of the materials. Here there are 2 dimensions of considering factors which are the percentage of mistaken delivery time and the percentage of damage goods There is the line representing the efficiency (Bold line) of Shelter A, B and C. Since these three Shelters have the equal Relative Efficiency which means the Shelter A has a lower percentage of damage goods of Shelter B and C, but it had higher percentage of possibility to mistake or delay goods delivery than Shelter B and C. While Shelter B had a lower percentage of mistaken or delayed goods delivery than Shelter A and C but it had higher percentage of damaged goods than Shelter A and C. For Shelter C , when compared with Shelter A, it had lower percentage of mistaken or delayed goods but it had higher percentage, and when compared with Shelter B, it showed that Shelter C had lower percentage but higher percentage of mistaken and delayed goods.

To explain by a mathematics term of linear stated that any Shelter with Slack in any factor in compared with other Shelters. This showed that particular Shelter had efficiency in comparative factor which was lower than other s. it was seen that Shelter G had efficiency in comparative factor, the percentage of damaged goods was equal that of Shelter A but the Shelter G had efficiency and percentage of mistaken or delayed good delivery lower than Shelter A. Because of the Slack value in this factor, so Shelter G had to reduce its Slack value in the factor of mistaken delivery in order to move toward the linear to show efficiency which caused Shelter G to have efficiency in comparative equally to Shelter A, B and C.

In the same way, Shelter F had to reduce Slack value in percentage of factor of damaged goods in order to move toward the linear to show its efficiency. For Shelter D and E must reduce Slack value in percentage of factor of mistaken or delayed delivery and percentage of damaged goods. To be specific, Shelter D must reduce both Slack value I both factors in order to move towards to linear to show efficiency between Shelter A and C While Shelter E must reduce Slack value of both factors to move towards the line to show efficiency between Shelter B and C.

From the above idea, we can compare the results of efficiency as a tool in making negotiation for procurement. For example, we negotiate with Shelter G in order to increase reliability in goods delivery to be on time for Shelter G to move towards the line of efficiency. For the same reason, we might negotiate with Shelter D and E to increase reliability in punctual goods delivery and reduce goods price so both Shelters moved towards to the line of efficiency.

2.2 Applied DEA technique Case Studies

Information used in this case study in order to present the application of DEA came from Purchasing section in the Thailand flood 2554. The purchasing section contacted 10 Shelters for selecting the highest efficiency. The selected Shelter must deliver 1000 units of Donated Bag. In the efficiency assessment of these 10 Shelters, the procurement criteria of input factors were time, quality and ability in punctual delivery. From two mouth collected data during the mouth October 2554- December 2554, plus the experiences of Purchasing section connected with 10 Shelters concerning these three factors were shown in Table 1.

Table 1. Specification Three factors, Time, Defect, Delivery

Shelters j	Time avg (min)	Defect rate. (%)	Delivery rates of the number (%)
1	1200	0.0	0.0
2	900	1.2	5.0
3	550	2.1	7.0
4	800	0.8	0.0
5	500	2.1	6.0
6	700	0.0	0.0
7	1500	1.1	6.0
8	1200	0.5	7.0
9	700	0.8	0.0
10	800	0.0	2.0

Since in this study, there were 10 Shelters had been assessed their efficiency, so n = 10 and by the index *j* and *k* had run an order from 1 to 10. Also, there were three input factors according to the criteria of efficiency assessment, so m = 3 and by the index *i* had run an order from 1 to 3. The other value were identified as follows;

i = 1 means Time minute

i = 2 means Rate of damaged goods

i = 3 means Rate of wrong numbers delivery

From the model simulating the efficiency assessment of Shelters in formula (1) to formula (5) and with the data in Table 1.We used 10 simulating model in this study according to numbers of Shelters that were assessed efficiency in comparative as following:

Shelters Number 1 (k = 1): Min $Z = \alpha_1 - \varepsilon\,(S_1 + S_2 + S_3)$

Under condition:

$$1200\alpha_1 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(0)\alpha_1 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(0)\alpha_1 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

Shelters Number 2 (k = 2): Min $Z = \alpha_2 - \varepsilon\,(S_1 + S_2 + S_3)$

Under condition:

$$900\alpha_2 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(1.2)\alpha_2 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(5)\alpha_2 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

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Shelters Number 3 (k = 3): Min $Z = \alpha_3 - \varepsilon\ (S_1 + S_2 + S_3)$

Under condition:

$$550\alpha_3 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(2.1)\alpha_3 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(7)\alpha_3 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

Shelters Number 4 (k = 4): Min $Z = \alpha_4 - \varepsilon\ (S_1 + S_2 + S_3)$

Under condition:

$$800\alpha_4 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(0.8)\alpha_4 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(0)\alpha_4 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

Shelters Number 5 (k = 5): Min $Z = \alpha_5 - \varepsilon\ (S_1 + S_2 + S_3)$

Under condition:

$$600\alpha_5 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(2.1)\alpha_5 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(6)\alpha_5 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

Shelters Number 6 (k = 6): Min $Z = \alpha_6 - \varepsilon\ (S_1 + S_2 + S_3)$

Under condition:

$$700\alpha_6 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(0)\alpha_6 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(0)\alpha_6 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

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Shelters Number 7 (k = 7): Min $Z = \alpha_7 - \varepsilon(S_1 + S_2 + S_3)$

Under condition:

$$1500\alpha_7 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(1.1)\alpha_7 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(6)\alpha_7 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

Shelters Number 8 (k = 8): Min $Z = \alpha_8 - \varepsilon(S_1 + S_2 + S_3)$

Under condition:

$$1200\alpha_8 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(0.5)\alpha_8 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(7)\alpha_8 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

Shelters Number 9 (k = 9): Min $Z = \alpha_9 - \varepsilon(S_1 + S_2 + S_3)$

Under condition:

$$700\alpha_9 - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(0.8)\alpha_9 - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(0)\alpha_9 - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

Shelters Number 10 (k = 10): Min $Z = \alpha_{10} - \varepsilon(S_1 + S_2 + S_3)$

Under condition:

$$800\alpha_{10} - (1200\lambda_1 + 900\lambda_2 + 550\lambda_3 + 800\lambda_4 + 550\lambda_5 + 700\lambda_6 + 1500\lambda_7 + 1200\lambda_8 + 700\lambda_9 + 800\lambda_{10}) - S_1 = 0$$

$$(0)\alpha_{10} - (0\lambda_1 + 1.2\lambda_2 + 2.1\lambda_3 + 0.8\lambda_4 + 2.1\lambda_5 + 0.0\lambda_6 + 1.1\lambda_7 + 0.5\lambda_8 + 0.8\lambda_9 + 0.0\lambda_{10}) - S_2 = 0$$

$$(2)\alpha_{10} - (0\lambda_1 + 5\lambda_2 + 7\lambda_3 + 0\lambda_4 + 6\lambda_5 + 0\lambda_6 + 6\lambda_7 + 7\lambda_8 + 0\lambda_9 + 2\lambda_{10}) - S_3 = 0$$

$$\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_6 + \lambda_7 = 1$$

$$S_1, S_2, S_3 \geq 0$$

$$\lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, \lambda_6, \lambda_7, \lambda_8, \lambda_9, \lambda_{10} \geq 0$$

For the result, the efficiency value *k* of all 10 Shelters in this study was brought specific program to solve the linear program called LINGO version 6.0 in order to calculate the result

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of all 10 mathematics linear models. This mentioned program can be installed into personal computer which had CPU belong to Pentium centrino core 2 duo (fast rate 1600 MHz) RAM 2024 MB. For the result in running LINGO language program to solve the problem of efficiency assessment of these 10 Shelters, the simulating mathematics linear model of this problem shown in Table 2.

Table 2. Result Performance 10 Shelters

Shelters j	α_k	s_i	λ_i
1	$\alpha_1 = 0.9944$	$S_1 = 0.0000$ $S_2 = 0.0011$ $S_3 = 0.0000$	$\lambda_5 = 0.011$ $\lambda_1 = 0.014$
2	$\alpha_2 = 0.9811$	$S_1 = 0.0000$ $S_2 = 0.0054$ $S_3 = 0.0000$	$\lambda_7 = 0.5669$
3	$\alpha_3 = 1.0000$	$S_1 = 0.0000$ $S_2 = 0.0000$ $S_3 = 0.0000$	$\lambda_4 = 1.0000$
4	$\alpha_4 = 0.9795$	$S_1 = 0.0000$ $S_2 = 0.0230$ $S_3 = 0.0000$	$\lambda_8 = 0.0567$
5	$\alpha_5 = 0.9889$	$S_1 = 0.0000$ $S_2 = 0.0065$ $S_3 = 0.0000$	$\lambda_3 = 0.3347$ $\lambda_1 = 0.1231$
6	$\alpha_6 = 1.0000$	$S_1 = 0.0000$ $S_2 = 0.0000$ $S_3 = 0.0000$	$\lambda_6 = 1.0000$
7	$\alpha_7 = 0.9643$	$S_1 = 0.0000$ $S_2 = 0.0243$ $S_3 = 0.0000$	$\lambda_7 = 0.3135$ $\lambda_8 = 0.2347$ $\lambda_{10} = 0.2345$
8	$\alpha_8 = 0.9787$	$S_1 = 0.0000$ $S_2 = 0.0154$ $S_3 = 0.0000$	$\lambda_5 = 0.2125$ $\lambda_7 = 0.3123$
9	$\alpha_9 = 1.0000$	$S_1 = 0.0000$ $S_2 = 0.0000$ $S_3 = 0.0000$	$\lambda_9 = 1.0000$
10	$\alpha_{10} = 0.9895$	$S_1 = 0.0000$ $S_2 = 0.0058$ $S_3 = 0.0000$	$\lambda_2 = 0.1224$ $\lambda_3 = 0.1130$

The result shown in Table 2 identified that only the Shelters number 3, 6, and 9 had comparative efficiency since the supplier number 3 had efficiency value equal 1 ($\alpha_k = 1$) and Slack value of all factors equal 0 ($s_i = 0$). For the rest 7 Shelters (number 1, 2, 4, 5, 7, 8, and 10) had no efficiency value less than 1. Moreover, we could develop strategy to use in making negotiation for purchasing with Shelters with less comparative efficiency by the result of reference weight (λ_i) shown in Table 2 aw well. That meant the lower comparative efficiency must be reduced the factor x_{ij} with the reference weight *j* in order to upgrade the less

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efficiency suppliers to the status of the comparative efficiency or reached the line of efficiency.

3. Conclusion

The selection of Shelter is one of many factors which is important to logistics works since the procurement is the process to get the raw materials, parts and materials for the goods manufacturing or services providing for the customers. If any organizations could procure materials and equipments in the cheap price, high quality and punctual delivery and could response to the needs of customers better in term of price, and fast delivery. Thus, the efficiency assessment of Shelters in order to select the most suitable Shelter, it is the significant matter. The issue of Shelter selection is challenge the ability of managers since Shelter selection is complicated and difficult problem.

The decision making in Shelter selection had factors and several criteria for consideration. However, the first three dimensions for assessment are price, quality and ability in delivery goods on time and right amount as order. At present, there are 2 ways of Shelters' efficiency assessment, which are the Empirical Method and Optimization Method. The both methods have pros and cons. This article had the objective to present the guideline of Shelters' efficiency assessment through the analysis technique called The Data Envelopment Analysis or DEA. The DEA technique is not only relied on experience or past data but also on the modern mathematics linear model that is not too complicated, together with the available Simplex Method is applied in finding solution of the efficiency Shelter selection easily.

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