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Supplier performance measurement of palm oil industries from a sustainable point of view in Malaysia

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ABSTRACT

The Malaysian palm oil manufacturing is composed of related parts which produce different kinds of products for their customers. Due to the growth of knowledge on sustainability issues in supply chain management, all of components of the chain must have affinity with sustainability paradigm; this includes the suppliers. So, efficient supply chain by sustainable suppliers is inevitable for palm oil industry to meet the rising global demand. Since, the nature of supplier selection is a multi-criteria decision making problem, this paper applies data envelopments analysis (DEA) to select appropriate suppliers. Sustainable supplier selection criteria which derived from interviews are considered as inputs and outputs for DEA model.
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KEYWORDS

INTRODUCTION

Food is one of the basic commodities of man. As such, there is practically no one who is not patronizing food products. This is the reason why the food industry is one of the busiest among the rest of the industries worldwide. While most of these industries experience recession, the food industry is among those which have not been affected at all. Considering the total world population of approximately 6, 802, 000, one could just imagine the amount of food products that all these people would consume. Moreover, if there is a high demand for food, then there would also be a high demand for its supply. To this effect, selection of appropriate suppliers is required in the food industry than in any other place[1-5].

In addition, sustainable development has become a buzzword that received a lot of attentions in supply chain management of many industries such as agriculture & food[6]. Sustainable supply chain management is the management of material, information and capital flows, as well as cooperation among companies along the supply chain, while taking into account the goals from all three dimensions, such as economic, environmental and social, of sustainable development derived from customer and stakeholder requirements[7]. So, to achieve a sustainable supply chain, all of the members in the chain from suppliers to top managers must have affinity with sustainability. This paper is organized to determine the sustainable supplier selection criteria through face to face interviews

FULL PAPER

with procurement teams of palm oil manufacturer. Then, a DEA model is suggested using those criteria onto selecting the best suppliers

Supplier selection criteria in palm oil industry

The traditional approach to supplier selection has solely considered economic aspects for many years. It is not enough because of globalization in business, competitive market situations, and the changing customers' demands in these days. Organizations must add the environmental/ecological and social aspects to the traditional supplier selection criteria such as quality, cost, delivery, and service to remain in the sustainable supply chain[6].

In this work, some meetings were adjusted to have face to face interviews with experts and staffs of procure activities in palm oil industry to derive the vital criteria for supplier selection process. It is worthy to say that sustainable aspects were paid a lot of attention in these meetings. Finally, six criteria in three sustainable groups (economic, environmental, and social) including "cost/price, quality, delivery" (economic aspects), "biodiversity and waste management"(environmental aspects) and "social/humane capital" (social aspects) were considered to select the suppliers. Since, the criteria in economic group (cost/price, quality, and delivery) are traditional criteria in supplier selection[8], there is no need for more explanation and they are obvious. But, there must be more explanation for other environmental and social criteria as below.

Biodiversity: the oil palm, being a perennial tree crop cultivated in the tropical areas, has greater biodiversity than cereals, vegetable and other short term cropping systems of the world biodiversity[9].

Waste management: empty fruit bunches (EFB) can be used for mulching oil palms and also the fiber from the EFB after separation can be used for pulp and paper and production of panel products.

Social/humane capital: reduced the income gap between the rural have-nots and the more affluent town dwellers and the rural poor have a new and better way of life through government-backed land-for-landless schemes.

Evaluation and selection method

Data Envelopment Analysis (DEA) proposed by Charnes, Cooper, and Rhodes (CCR) (1978)[10]. is a

mathematical programming method for assessing the relative efficiency of homogenous decision making units (DMU) with multiple inputs and outputs. DEA is a nonparametric method that lets efficiency be measured without having specific weights for inputs and outputs or specify the form of the production function.

In supplier selection, the performance of a supplier is calculated using the ratio of weighted outputs to weighted inputs. The goal of the firm is to choose one or more suppliers from n candidates. In order to calculate the set of efficiencies for n suppliers, n fractional programming models are solved. The problem can be changed into linear programming. The model for supplier k could be defined as follows equation (1).

$$MaxZ_k = \sum_{r=1}^{s} u_r y_{rk}$$

$$st:$$

$$\sum_{i=1}^{m} v_i x_{ik} = 1 \qquad\qquad (1)$$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0 \ (j = 1,2,...,n)$$

$$u_r, v_i \ge \varepsilon$$

Where: k is the under evaluation unit; s represents the number of outputs; m represents the number of inputs; is the amount of output r provided by unit j; is the amount of input used by unit; and are the weights given to output and input respectively[11].

TABLE 1 : The data for inputs and outputs

Supplier No.	Inputs			Outputs		
	Cost	Quality	Delivery	Bio-diversity	Waste Management	Social/ Humane Capital
1	0.3289	0.5555	0.75	0.9223	0.5723	0.7223
2	0.4552	0.619	0.5	0.9644	0.4832	0.8644
3	0.3783	0.789	0.75	0.9993	0.7693	0.8993
4	0.5633	0.9751	1	0.9923	0.5041	0.9923
5	0.8821	0.539	0.1	0.9642	0.3475	0.9642
6	0.952	0.7344	0.2	0.9728	0.8925	0.9728
7	0.6323	0.321	0.5	0.9342	0.5223	0.9342
8	0.2793	0.299	0.25	0.8662	0.9918	0.8662
9	0.4536	0.498	0.1	0.9384	0.6723	0.7384

RESULTS AND DISCUSSION

The list of suppliers for palm oil industry in Ma-

laysia and the information about them is shown in TABLE 1. In the DEA model, "cost", "quality", and "delivery" criteria were considered as input variables and "biodiversity"," waste management", and "social/humane capital" as output variables. By applying DEA Excel Solver software considering TABLE 1 as inputs and outputs data, the efficient and inefficient suppliers are identified as shown in TABLE 2. Suppliers 5, 7, 8, and 9 are efficient because their efficiency is equal to one but the others which obtained the efficiency less than one are inefficient. In TABLE 2, the optimal weights for inputs and outputs are shown. But, it is better to shift these weights because in some cases the weights are considered equal to zero. So, the target value for inputs and outputs are calculated as shown in TABLE 3.

TABLE 2 : Efficient and inefficient suppliers

Supplier Name	Input-Oriented CRS Efficiency	Optimal Multiplier					
		Cost	Quality	Delivery	Biodiversity	Waste Management	Social/Humane Capital
1	0.90419	3.04044	0.00000	0.00000	0.98037	0.00000	0.00000
2	0.68314	2.19684	0.00000	0.00000	0.70835	0.00000	0.00000
3	0.85175	2.64340	0.00000	0.00000	0.85235	0.00000	0.00000
4	0.56801	1.77525	0.00000	0.00000	0.57242	0.00000	0.00000
5	1.00000	0.54652	0.00000	5.17915	0.00000	0.00000	1.03713
6	0.79568	0.00000	0.78349	2.12301	0.00000	0.28680	0.55480
7	1.00000	0.01374	3.08821	0.00000	0.00000	0.00000	1.07043
8	1.00000	0.00000	3.34448	0.00000	0.00000	0.00900	1.14416
9	1.00000	0.00000	1.66696	1.69856	1.06564	0.00000	0.00000

TABLE 3 : Target inputs and outputs

Supplier No.	Cost	Quality	Delivery	Bio-diversity	Waste Management	Social/ Humane Capital
1	0.29739	0.31836	0.26619	0.92230	1.05603	0.92230
2	0.31096	0.33290	0.27834	0.96440	1.10424	0.96440
3	0.32222	0.34494	0.28841	0.99930	1.14420	0.99930
4	0.31996	0.34253	0.28639	0.99230	1.13618	0.99230
5	0.88210	0.53900	0.10000	0.96420	0.34750	0.96420
6	0.56224	0.58435	0.15914	1.16494	0.89250	0.97280
7	0.63230	0.32100	0.50000	0.93420	0.52230	0.93420
8	0.27930	0.29900	0.25000	0.86620	0.99180	0.86620
9	0.45360	0.49800	0.10000	0.93840	0.67230	0.73840

CONCLUSIONS

Fierce competitiveness in food global markets exerts pressure on enterprises to provide their products to customers faster, cheaper, and better than the competitors. To do these, selection of appropriate suppliers is very important issue in supply chain management of food industries. In addition, the sustainability issues have become other important dimension in supply chain management owing to the importance of environmental protection and social merits. In this paper, the sustainable supplier selection criteria through interviews with procurement teams of palm oil manufacturer in Malaysia were derive to benefit all other palm oil industries worldwide. Then the DEA model as a multi-criteria decision making method was applied to determine the efficient and inefficient suppliers and calculate the target value for inputs and outputs.

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FULL PAPER

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