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Improving supply chain collaborations and performance of inefficient supply chain

M.Sanei[1*], S.Mamizadeh-Chatghayeh[2]

[1] *Department of Mathematics, Islamic Azad University of Central Tehran Branch, Tehran, Iran*

[2] *Young researches club, Islamic azad university,Central Tehran branch, Tehran, Iran*

Abstract

Modern manufacturing enterprises are required to collaborate by their business partners through their business process operations such as design, manufacture, distribution, and aftersales services. And furthermore performance evaluation is of great importance for effective supply chain man agement. Therefore, DEA can help companies to remove some of the in efficiencies in operational processes in order to become more effective.The current paper develops one approach for determining the DEA projections for inefficient supply chains. Meanwhile this approach aims at providing an easy, efficient and more practical approach based on the performance evaluation for the multi-member supply chain. And ultimately, this model is illustrated by an numerical example of Chinese commercial bank, and case study application to provide of machine-making supply chain.

***Keywords*:** Data Envelopment Analysis (DEA). Supply Chain Management (SCM). Intermediate products. Efficiency.

* *Corresponding author E-mail address: M_sanei@iauctb.ac.ir*

1. Introduction

Supply Chain Management is a systemic, strategic coordination of traditional business functions as well as tactics across these business functions within a particular company and across businesses within a supply chain, for the purpose of improving the long-term performance of individual companies and the supply chain as a whole [5]. In a collaborative supply chain environment, supply chain members work together, share important information, and collaborate efficiently and effectively on activities [3]. Improvement in supply chain performance is of the most frequently mentioned benefits of successful supply chain collaborations. Thus, inefficient supply chains to improve their performance are necessary to yield successful collaborations. Within the context of DEA, there is a number of methods that has a potentiality to be used in supply chain efficiency evaluation. Furthermore, [4], [6] applied DEA methodology to evaluate the performance of different organizations among the supply chain. Therefore, in the section following, we develop one approach for determining the DEA projections for inefficient supply chains and also multi-member supply chain. Section 3 provides an application example to illustrate the efficiency of evaluating supply chain performance. And in the final section, we will have some conclusions and further research.

2. Method

Data envelopment analysis (DEA) has gained great popularity in environmental performance measurement because it can provide a synthetic standardized environmental performance index when pollutants are suitably incorporated into the traditional DEA framework of decision making units (DMUs). Hence, DEA has been utilized worldwide for measuring efficiencies of banks, telecommunications, supply chain utilities and so forth.

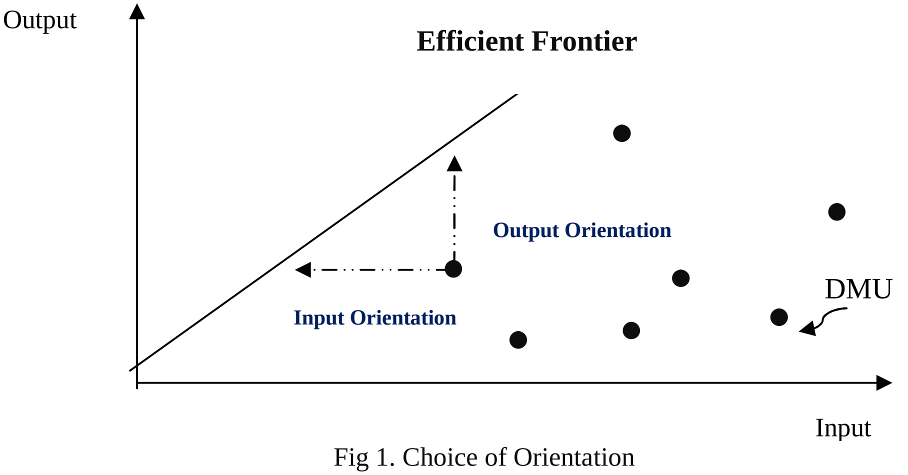

Fig 1. Choice of Orientation

2.1 A Two-stage supply chain

Consider a generic two-stage process as shown in Fig.1. Suppose we have *n* supply chains (hereafter abbreviated *SCs*). Where *S* represents the supplier and *M* represents the manufacturer, and each SC_j, ($j=1,2,\ldots,n$), has *P* inputs to the supplier (S_j), x_{pj} ($p=1,2,\ldots,P$), and *K* outputs from this S_j, i_{kj} ($k=1,2,\ldots,K$). These *K* outputs become the inputs to the manufacturer (M_j), and are referred to as intermediate products. The outputs from the M_j are denoted as $y_{qj}(q=1,2,\ldots,Q)$. The constant returns to scale (CRS) efficiency scores for $SC_j(j=1,2,\ldots,n)$, *S* and *M* stages can be calculated by two CCR model and overall efficiency by [2], but this way fails to improve inefficient *SC*s. Then we introduce i^A_{kd} ($k=1, 2, \ldots, K$), representing a set of new intermediate products to be determined,[1].

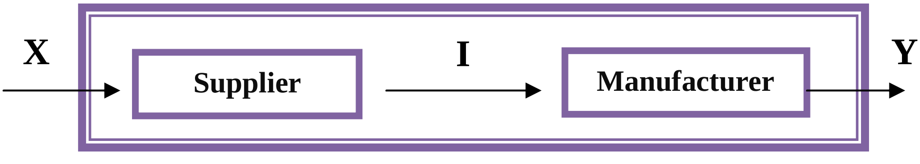

Fig 2. A two-stage supply chain

Therefore, by using potential DEA slacks in the projections and the [1] model, we have model (1):

$$\theta_d = \min \theta - \epsilon\left(\sum_{p=1}^{P} s_p^- + \sum_{k=1}^{K} s_k^+ + \sum_{k=1}^{K} s_k^- + \sum_{q=1}^{Q} s_q^+\right)$$

$$s.t.$$

$$\sum_{j=1}^{n} \lambda_j x_{pj} + s_p^- = \theta \times x_{pd} \qquad p = 1,2,\dots,P$$

$$\sum_{j=1}^{n} \lambda_j i_{kj} - s_k^+ = i_{kd}^{A} \qquad k = 1,2,\dots,K$$

$$\sum_{j=1}^{n} \eta_j i_{kj} + s_k^- = i_{kd}^{A} \qquad k = 1,2,\dots,K$$

$$\sum_{j=1}^{n} \eta_j y_{qj} - s_q^+ = y_{qd} \qquad q = 1,2,\dots,Q$$

$$\lambda_j \geq 0, i_{kj}^{A} \geq 0, \qquad j = 1,2,\dots,n$$

$$s_p^- \geq 0, s_k^+ \geq 0, s_k^- \geq 0,\ s_q^+ \geq 0, \forall\, p,k,q$$

In a similar manner, we can show this approach in the output-oriented case.

2.2 A multi-stage supply chain

In general, a supply chain possibly consists of more than two members, such as suppliers, manufacturers, distributors, retailers, and so on, Fig3. Hence, successful collaborations can benefit participating companies in two distinct ways, namely there are direct benefits derived from the specific task that is the focus of the collaboration efforts and other way a successful collaboration effort will enhance the quality of the relationship between the collaboration partners. Therefore, we propose performance evaluation of multi-member supply chain collaboration by solving the following model:

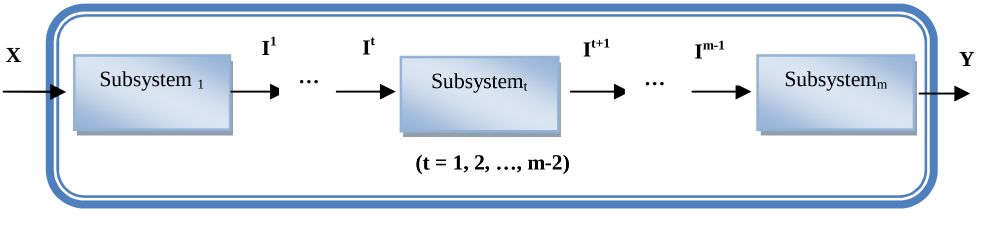

Fig 3. A multi-member supply chain

$$\theta_d = \min \theta - \varepsilon\left(\sum_{p=1}^{P} s_p^- + \sum_{t=1}^{m-1}\sum_{k_t=1}^{K_t} s_{k_t}^{+^t} + \sum_{t=1}^{m-1}\sum_{k_t=1}^{K_t} s_{k_t}^{-^t} + \sum_{q=1}^{Q} s_q^+\right)$$

$$s.t.$$

$$\sum_{j=1}^{n} \lambda_j^1 x_{pj} + s_p^- = \theta \times x_{pd} \qquad p = 1, 2, \dots, P$$

$$\sum_{j=1}^{n} \lambda_j^t i_{k_t j}^t - s_{k_t}^{+^t} = i_{k_t d}^{A^t} \qquad k_t = 1, 2, \dots, K_t, t = 1, 2, \dots, m-1$$

$$\sum_{j=1}^{n} \lambda_j^{t+1} i_{k_t j}^t + s_{k_t}^{-^t} = i_{k_t d}^{A^t} \quad k_t = 1, 2, \dots, K_t, t = 1, 2, \dots, m-1$$

$$\sum_{j=1}^{n} \lambda_j^m y_{qj} - s_q^+ = y_{qd} \qquad q = 1, 2, \dots, Q$$

$$\lambda_j^t \geq 0, \quad i_{k_t j}^{A^t} \geq 0, \qquad j = 1, 2, \dots, n, \; t = 1, 2, \dots, m$$

$$s_p^- \geq 0, \quad s_{k_t}^{+^t} \geq 0, \quad s_{k_t}^{-^t} \geq 0, \quad s_q^+ \geq 0, \qquad \forall\, p, k_t, q$$

3. Application

Consider data of 17 bank branches of China, [7]. That is a typical two-member supply chain process. Table.1 shows overall efficiency scores of supply chain, and reports the improvement performance of supply chains by optimal intermediate products in the input-oriented manner and we also have output-oriented scores in Table 2. A also key to improved supply chain management lies in integration and coordination.

Here, we consider to performance of the seven machine-making multi-members chain so that these chains include of the three members such as supplier of machine-making pieces, machine manufacturer and finally, distributor of product's producer .The supplier of machine-maker's pieces consume to the factors such as the members of employee, finance and the numbers of shares as input and it achieve to the output with selling of its products to profit manufacturer in this phase. In the following, manufacturer suffer to spend of expense for buy to products and primary materials of supplier and it produce the output as validity in producing chain and the distributor will have two the kinds of output through consuming of validity input; one, the profit which it get through cash selling of machine and the other, the profit which it get through payment selling of machine. It's necessary to cite that the factors of selling of the machine-making pieces and validity taken into chain as intermediate products, and the Overall efficiency are provided in Table3.

Table 1. Overall efficiency and improve inefficient supply chain, Input-oriented

NO	θ_d	FA	EM	EX	CR	IL
1	1.0000	1.0168	1.2210	1.2215	166.9755	8.3098
2	0.4510	0.2668	0.2756	0.2146	29.3337	1.4598
3	0.4309	0.3118	0.2779	0.2612	35.6552	1.8230
4	0.2911	0.1499	0.1415	0.1095	14.9526	0.7695
5	0.7342	0.3506	0.3862	0.2825	38.5833	1.9596
6	0.4979	0.3050	0.2026	0.1696	23.1052	1.2413
7	0.5177	0.4096	0.3665	0.2282	31.1495	1.5936
8	0.2947	0.3643	0.2101	0.1635	22.3229	1.1358
9	0.1369	0.0611	0.0606	0.0468	6.37970	0.3406
10	0.2146	0.2678	0.1369	0.0982	13.4180	0.6678
11	0.2578	0.1817	0.1482	0.1040	14.2138	0.7168
12	0.3100	0.1998	0.1339	0.1244	16.9923	0.8537
13	0.1285	0.0930	0.0655	0.0477	6.51240	0.3260
14	0.3363	0.1862	0.1486	0.1196	16.3357	0.8226
15	0.1434	0.0482	0.0462	0.0335	4.56120	0.2424
16	0.1963	0.1311	0.0830	0.0681	9.29940	0.4770
17	0.08270	0.02830	0.02120	0.01320	1.796200	0.09650

Table 2. Overall efficiency and improve inefficient supply chain, Output-oriented

NO	φ_d	CR	IL	LO	PR
1	1.0000	166.9755	8.3098	122.1954	3.7569
2	2.2173	65.0405	3.2368	43.1994	1.4634
3	2.3209	82.7506	4.2309	79.8668	1.7901
4	3.4349	51.3607	2.6430	52.4866	1.1002
5	1.3621	52.5527	2.6690	47.6595	1.1483
6	2.0085	46.4072	2.4932	65.4325	0.9271
7	1.9316	60.1668	3.0781	58.3983	1.3004
8	3.3934	75.7497	3.8543	69.9085	1.6505
9	7.3020	46.5845	2.4873	63.0396	0.9405
10	4.6598	62.5253	3.1117	43.0351	1.4068
11	3.8792	55.1380	2.7806	46.6167	1.2173
12	3.2261	54.8195	2.7541	44.5621	1.2169
13	7.7832	50.6874	2.5375	39.6640	1.1309
14	2.9732	48.5700	2.4459	40.4608	1.0745
15	6.9737	31.8082	1.6905	41.7048	0.6472
16	5.0952	47.3825	2.4303	47.0532	1.0201
17	12.0878	21.7121	1.1665	30.6136	0.0689

Table 3. Overall efficiency of Machine-making Supply chain

No.	Efficiency
Machine-making Supply chain (1)	0.4198
Machine-making Supply chain (2)	0.4358
Machine-making Supply chain (3)	0.3433
Machine-making Supply chain (4)	0.2582
Machine-making Supply chain (5)	0.2398
Machine-making Supply chain (6)	0.2097
Machine-making Supply chain (7)	1.0000

4. Conclusion

Supply chain managers have a tremendous impact on the success of an organization, Because supply chain managers touch so many different parts of the business, they are in a unique position to help other functions execute their strategies. Hence,this paper develops models for determining the DEA frontier projections for inefficient supply chains under two-stage processes and multi-member supply chain collaboration. These evaluation results help supply chain to improve its operation efficiency, as a result, the focus of this paper will be on the impact of effective SCM on the organization's productivity and competitiveness. Further study is VRS inefficient supply chain and network supply chain case.

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