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Assessment of Industrial Cluster with Value-Chain DEA model

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Abstract

Every country actively and initiatively takes all kinds of policy steps to improve the international competitiveness of its industries and therefore improve national integrated competitiveness for the purpose of gaining economic benefits under the context of economic globalization. Therefore, studies of moreover, projects launched by the cluster had to be endorsed by the growers and one criterion in the selection of projects was that the project would demonstrate to the growers the value of collaboration. Therefore, we develop a comprehensive performance measurement framework using the classical and two-stage Value Chain Data Envelopment Analysis models.

Keywords: Data Envelopment Analysis (DEA), Value chain, Industrial cluster, Performance evaluation

1 Introduction

In a national economic system, extensive, complicated, and close economic links exist among industries. In industrial clusters, industries with close economic links come into being. The complication and diversification of economic links among industries generates external economies, which are the bases of regional growth and development. When many industries with close economic links form industrial clusters with each other, it provides a favorable development environment for a regional self-support growth process. Regional economic activities can attract the inflow of production factors from outside regions so that new productive activities can be introduced, production chains can be extended, and multiplier effects of regional productive activities can be remarkably heightened. With further development of regional industrial clusters, multiplier effects become quite strong, and rapid economic growth process accompanies the change in economic structures. Therefore, Industry cluster definition: “:

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"clusters are geographical focus of joined companies and institutes that have set in a determined work and business trend, altogether, [1], [2].
According to Porter's value chain theory, value actions of industries in industrial clusters are links that may produce added value; the interrelationship and value chain of any industry exists in the value system of industrial clusters and is composed of interconnecting value chains of many industries, [3]. In other words, cluster competitiveness has tended to derive from either a network of sectoral linkages or the links between business and sources of research and technological expertise. Hence, clusters have been largely defined in policy as either value chain, [4]. By the same discussion, we propose a performance evaluation methodology based on Data Envelopment Analysis (DEA), which can incorporate multiple inputs and outputs in multiple stages and results in a single relative efficiency measure. Since the conventional DEA models are found to be ineffective in measuring the performance of various supply chain related functions, many multi-stage DEA models have been developed to accommodate various indirect processes and their contribution to corporate performance ([5]; [6]; [7]; [8]). In the current paper, we use the two-stage value chain DEA model. Hence, we develop a comprehensive performance measurement framework using the classical and two-stage Value Chain Data Envelopment Analysis models.
The structure of this study is listed as follows: Section 1, Introduction; Section 2, Value chain; Section 3, Methodology; Section 4, Application; and Section 5, Conclusion.

2 Value chain

The term 'Value Chain' was used by Michael Porter in his book "Competitive Advantage: Creating and Sustaining superior Performance" (1985). The value chain analysis describes the activities the organization performs and links them to the organizations competitive position.
Value chain analysis describes the activities within and around an organization, and relates them to an analysis of the competitive strength of the organization. Therefore, it evaluates which value each particular activity adds to the organizations products or services. This idea was built upon the insight that an organization is more than a random compilation of machinery, equipment, people and money. Only if these things are arranged into systems and systematic activates it will become possible to produce something for which customers are willing to pay a price. Porter argues that the ability to perform particular activities and to manage the linkages between these activities is a source of competitive advantage. Porter distinguishes between primary activities and support activities. Primary activities are directly concerned with the creation or delivery of a product or service. They can be grouped into five main areas: inbound logistics, operations, outbound logistics, marketing and sales, and service. Each of these primary activities is linked to support activities which help to improve their effectiveness or efficiency.

A typical value chain analysis can be performed in the following steps:

- Analysis of own value chain – which costs are related to every single activity
- Analysis of customers value chains – how does our product fit into their value chain
- Identification of potential cost advantages in comparison with competitors
- Identification of potential value added for the customer – how can our product add value to the customers value chain (e.g. lower costs or higher performance) – where does the customer see such potential (www.themanager.org)

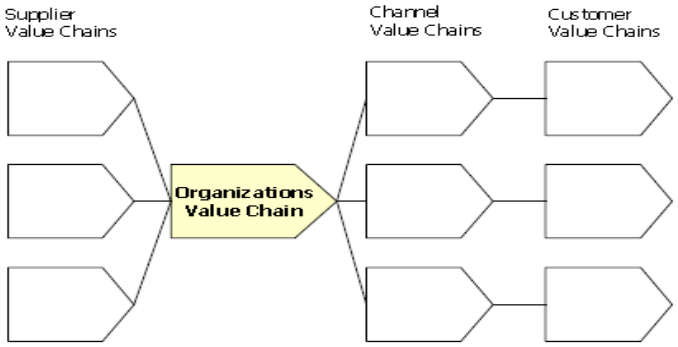

Fig 1. A Value chain of industrial cluster

3 The DEA-Value Chain method

Clusters are constructed by set of the relations among industry and essential for competition. For instance, clusters are constructed by professional inputs producers such as material, services, machinery and providers of main substructures. Clusters have place to use for organizing of area, regional and economic development actions and empirical analyze of national economy with regional and area economic development. Clusters are as a useful concept in area and regional economic description and also, in which of industry have consider as main key in economic development. Therefore, as [9], [10] state: we pointed to four economic developments that cluster analyze have effect on it:

1) Effect of cluster on area economic development,
2) Advantage of focus in human force in determined industry replace to different industry,
3) Effect of cluster on wages rate, and
4) Effect of cluster on poverty and ultimate, in regard to severe global competitions in today world.

Industrial cluster have consider to as a strategies of create to motivation in competition. Hence, performance evaluation of value chain is of great importance for effective Industrial cluster development. Therefore, consider a generic two-stage process as shown in Fig.2. Suppose we have n value chains (hereafter abbreviated *VCs*), and each VC_j, $(j=1,2,\ldots,n)$, has P inputs to the Design (D_j), x_{pj} $(p=1,2,\ldots,P)$, and K outputs from this D_j, i_{kj} $(k=1,2,\ldots,K)$. These K outputs become the inputs to the Product (P_j), and are referred to as intermediate products. The outputs from the D_j are denoted as $y_{qj}(q=1,2,\ldots,Q)$. Also, we introduce i^a_{kd} $(k=1,2,\ldots,K)$, representing a set of new intermediate products to be determined.

Therefore, Design-Product Value chain performance assessment model in industrial cluster can be computed using Model (1):

Also, in this paper we proposes a new value chain DEA models using FDH* aimed at correctly characterizing multi-member value chain operations, [12].

* The nonparametric approaches known as FDH and DEA are based on the idea of enveloping the data, under various assumptions on the technologies like free disposability, convexity or scale restrictions, without imposing any uncertain parametric structure. In addition, the FDH approach was initiated by [11], it relies on only the assumption that PPS_{FDH} is freely disposable for the inputs and the outputs and is appropriate for the efficiency measurement at the patient level.

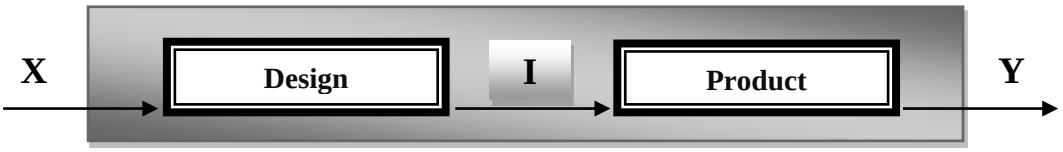

Figure 2. A two-stage Value Chain

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

$$s.t.$$

$$\begin{aligned}
&\sum_{j=1}^{n} \lambda_j\, x_{pj} + s_p^- = \theta^{VC} \times x_{pd} && p = 1, 2, \dots, P \\
&\textstyle\sum_{j=1}^{n} \lambda_j\, i_{kj} - s_k^+ = i_{kd}^{\alpha} && k = 1, 2, \dots, K \\
&\sum_{j=1}^{n} \eta_j\, i_{kj} + s_k^- = i_{kd}^{\alpha} && k = 1, 2, \dots, K \\
&\sum_{j=1}^{n} \eta_j\, y_{qj} - s_q^+ = y_{qd} && q = 1,2,\dots, Q
\end{aligned} \tag{1}$$

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

$$\lambda_j \epsilon \{0,1\}, \;\; \eta_j \epsilon \{0,1\}$$

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

(The value-chains model originally measures the first-stage efficiency by expending multiple-inputs to generate multiple-intermediates, and the second-stage efficiency is measured by consuming the multiple-intermediates, which are entirely generated from the first stage, in order to produce multiple-outputs. However, the assumption in the factors (input, intermediate, and output) of the value-added chains may not be so simple in real-life production processes.)

4 Application

In this section consider examines the effect of Value chain within 17 pairs of Design-Product relationships in industrial cluster, Table 1.[*]

[*] *Design inputs(For example):*Average operating costs/period (AOC), These are the costs associated with equipment purchasing and maintenance, holding costs, order costs and other operating costs and another input, number of employees (EMP), The total number of employees involved in the supply process. *Design outputs & Product inputs (Intermediate products)* Product quality (PQ), the quality level of the supplied product expressed as a percentage, and On-time deliveries/period (OTD). *Product outputs*, Product options (PO), the number of product options provided by the manufacturer. Overall quality level (OQL) The overall quality level of all the product options expressed as a percentage, and so on.

The Table 2 reports the Value Chain efficiency scores of the two stages (Design-Product) Value Chain process, (The columns 2). And also reports the improvement performance of value chain by optimal intermediate products, (The columns 3, 4).

Table 1
Data of 17 Value Chain of Design-Product in industrial cluster

NO.	$\mathbf{X_1}$	$\mathbf{X_2}$	$\mathbf{X_3}$	$\mathbf{I_1}$	$\mathbf{I_2}$	$\mathbf{Y_1}$	$\mathbf{Y_2}$
VC1	1.0168	1.221	1.2215	166.9755	8.3098	122.1954	3.7569
VC2	0.5915	0.611	0.4758	50.1164	1.7634	19.4829	0.6600
VC3	0.7237	0.645	0.6061	48.2831	3.4098	34.4120	0.7713
VC4	0.5150	0.486	0.3763	35.0704	2.348	15.2804	0.3203
VC5	0.4775	0.526	0.3848	49.9174	5.4613	34.9897	0.8430
VC6	0.6125	0.407	0.3407	23.1052	1.2413	32.5778	0.4616
VC7	0.7911	0.708	0.4407	39.459	1.1485	30.2331	0.6732
VC8	1.2363	0.713	0.5547	37.4954	4.0825	20.6013	0.4864
VC9	0.4460	0.443	0.3419	20.9846	0.6897	8.6332	0.1288
VC10	1.2481	0.638	0.4574	45.0508	1.7237	9.2354	0.3019
VC11	0.7050	0.575	0.4036	38.1625	2.2492	12.0171	0.3138
VC12	0.6446	0.432	0.4012	30.1676	2.3354	13.8130	0.3772
VC13	0.7239	0.510	0.3709	26.5391	1.3416	5.0961	0.1453
VC14	0.5538	0.442	0.3555	22.2093	0.9886	13.6085	0.3614
VC15	0.3363	0.322	0.2334	16.1235	0.4889	5.9803	0.0928
VC16	0.6678	0.423	0.3471	22.1848	1.1767	9.2348	0.2002
VC17	0.3418	0.256	0.1594	13.4364	0.4064	2.5326	0.0057

VC: Value Chain

Table 2. Performance evaluation of 17 value chain in industrial cluster

NO	θ^{VC*}	i_1^{a*}	i_2^{a*}
VC1	1.0000	166.9755	8.3098
VC2	0.8609	45.3145	2.2299
VC3	0.8155	45.3145	2.2299
VC4	1.0000	23.1052	1.2413
VC5	1.0000	49.9174	5.4613
VC6	1.0000	23.1052	1.2413
VC7	0.8732	45.3145	2.2299
VC8	0.7377	49.6443	2.5829
VC9	1.0000	20.9846	0.6897
VC10	0.7449	23.1052	1.2413
VC11	0.8688	23.1052	1.2413
VC12	1.0000	30.1676	2.3354
VC13	0.9358	22.1848	1.1767
VC14	1.0000	22.2093	0.9886
VC15	1.0000	16.1235	0.4889
VC16	1.0000	22.1848	1.1767
VC17	1.0000	13.4364	0.4064

5 Conclusions

In the recent years, industrial clusters have received considerable attention from economists and industrial analysts, because they are seen as the main reason for economic growth and success of certain economic region. Meanwhile with rapid development of industrial cluster, the performance evaluation of value chain (Design-Product), which may in turn be part of value chain clusters, is still in absence. Therefore, we propose a comprehensive performance measurement framework using the classical and two-stage Value Chain Data Envelopment Analysis models. Further researches will shed light on the performance evaluation of value chains Fuzzy Analytic Hierarchy Process as the analytical tool.

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