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# Evaluating of the Promotion of Strategic Alliance of Medical Devices Industry with Data Envelopment Analysis

Kuan- Hung CHEN<sup>1</sup>

## Abstract

Applying Data Envelopment Analysis to evaluate efficiency in this study, representative enterprises, in major Medical devices industry production areas of Kaohsiung city, with cooperation with institutional consumers are studied. The research results are summarized as below. according to DEA, 1 DMU presents strong Medical devices industry strategic alliance efficiency, 4 DMUs show the Medical devices industry strategic alliance efficiency between 0.9 and 1, and 5 DMUs reveal the Medical devices industry strategic alliance efficiency lower than 0.9. 2. Sensitivity analysis is utilized for analyzing and finding out key factors in Medical devices industry strategic alliance, and the sensitivity to efficiency is understood by gradually removing inputs and outputs for DEA. According to the results to propose suggestions, it is expected to provide actual assistance for Medical devices industry strategic alliance and reinforce the cooperation between corporate groups and institutional consumers through intra-industry alliance and horizontal alliance.

*Keywords:* medical devices industry, business strategy, strategic alliance, performance evaluation, social competition.

## Introduction

In the globally competitive and changing era, enterprises cannot keep the permanent value of the advantages. Enterprises therefore start to search strategic alliance partners for enhancing the competitiveness to fulfill the corporate blueprint. It is time and energy consuming to select strategic alliance partners in the uncertain future. It would be difficult for an enterprise selecting beneficial “strategic alliance” partners. Enterprises, in order to enhance the ability having a foothold in the market, would create new products, develop new technologies, penetrate markets, create scale, and, due to inadequate resources, would participate in strategic alliances.

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Strategic alliances could result in resources exceeding the possession of any enterprises and risk spread. Furthermore, medical device industry discovers that manufacturers without seeking for innovation opportunities would not succeed in the strategy dynamics and shorter product life cycle. Manufacturers being unfamiliar with technologies and markets would seek for assistance externally. Moreover, enterprises, with limited talents, capitals, information, and management ability, could not cope with the rapidly changing technologies and flooding knowledge. In this case, in addition to focusing on the professional core competitiveness, practicable route, such as reinforcing industrial competitiveness with strategic alliances, should be taken into account. In face of the impact of globalization and trade liberalization, domestic Medical devices industry corporates have to propose strategies to reduce the impact caused by opening up. Current problems for domestic Medical devices industry departments are not simply the production and technique, but the effective integration of resources to create niche. Medical devices industry managers have to understand market changes to break through the dilemma through intra-industry or horizontal strategic alliance. To cope with the impact resulted from the joining in World Trade Organization (WTO) and opening market on enterprise in Taiwan, governments positively promote Medical devices industry strategic alliance policies, expecting to introduce the idea and measures of strategic alliance into Medical devices industry step by step, integrate existing competitive advantage, core competency, and resources of Medical devices, promote Medical devices industry competitiveness, assist in or solve production-marketing unbalance of Medical devices industry products, and maintain corporates' benefits. It is therefore urgent to reinforce the cooperation between corporate groups and institutional consumers through intra-industry alliance and horizontal alliance in order to reduce transaction costs.

## Literature review

### *Strategic alliance*

Zou & Chen (2017) regarded the difference between strategic alliance and cooperation agreement. Strategic alliance was the key strategic selection, based on company strategies, to keep or enhance the competitive advantage that strategic alliance was an important direction for the future development of a company. Simply speaking, strategic alliance occurred in the long-term strategic plans of a company, attempting to improve or change the competitive position. Albers, Wohlgezogen, & Zajac (2016) explained strategic alliance as a enterprise business activity that the combination of two or more than two independent organizations for strategic objectives would share the ownership, responsibilities, risks, and rewards. Lopez & Johnson (2020) pointed out strategic alliance as two or more enterprises engaging in purposive strategic relationship, where resources were

provided by each strategic alliance partner, more than one key technical resource were input to jointly pursue the beneficial goal, the results were shared by each member, the alliance profits were mutually shared, the alliance performance was controlled, and the independent status in the alliance was remained. Saito (2016) mentioned that, for selecting strategic alliance partners, the possessed competitiveness which could match with each other was selected to generate the synergy through alliance; an enterprise therefore would be willing to establish strategic alliance and maintain the cooperation. Brouthers *et al.* (2015) indicated that strategic alliance could reach economies of scale and rationalization of production as well as reduce costs by the complimentary advantages of alliance partners. Vercic, Zerfass, & Wiesenbergs (2015) stated that the strategic objective of joint venture was to obstruct potential competitors entering the market, to weaken competitors' competitiveness, or, as a defensive investment, to avoid risks of future uncertainties. In terms of strategic behavior, strategic alliance referred to the overseas management of pegging or embezzling competitors' potential strategic alliance partners to improve the competitive position and acquire the maximal profits. Kim (2016) explained that an organization, in order to acquire the external resources for the survival, would link the related organizations in the external environment to acquire the resources. Some strategies would be applied to control such essential external resources. Merger, contract, or alliance would be used for the acquisition of resources to control the required elements. Strategic alliance presented lower costs for autonomic management and better power maintenance to become a common cooperation style among organizations.

### *Strategic alliance of Medical devices industry*

Strategic alliance of Medical devices industry refers to cooperating organizations, allying partners, and exchanging complementary resources among intra-industry Medical devices industry organizations, including laborers' associations and enterprise partners, and among horizontal Medical devices industry organizations and logistics, processing to achieve the staged growth or win-win and eventually maintain the long-term competitive advantage in the market (Bilgin, 2016).

Jiang, Wan, & D'Alfonso (2015) proposed the following advantages of medical devices industry strategic alliance.

- 1) To develop the benefits to Medical devices industry economies of scale: Generally speaking, the larger business size would appear higher benefits. Strategic alliance could achieve the synergy of one and one larger than two, rather than equal to two or smaller than two (Bergmann *et al.*, 2015).
- 2) To reduce operation costs and risks: After strategic alliance, the larger business size resulted in more resource purchase for higher discounts or offers that the operation cost would be naturally reduced (Lin *et al.*, 2016).
- 3) To expand competitive advantage: After strategic alliance, the larger business

size resulted in more production quantity to present the advantage of market share (Lin *et al.*, 2016).

- 4) To enhance negotiation skills: After strategic alliance, the larger business size enhanced the production quantity to grasp sufficient bargaining chips (Lin *et al.*, 2016).
- 5) To increase marketing resources: After strategic alliance, the marketing was enhanced, due to increasing production or prolonged production period, to more easily control the market (Lin *et al.*, 2016).

### *Performance on strategic alliance*

Zou & Chen (2017) indicated that an enterprise would practice strategic alliance to achieve the company and alliance goals. The evaluation of efficiency and performance after strategic alliance would help measure the effectiveness of strategic alliance. Kim (2016) used the goal of strategic alliance and the satisfaction with alliance operation. Boddewyn (2016) considered that the evaluation of strategic alliance performance could be measured the profitability of the company as well as the satisfaction of interested parties and the quality of company transformation. Lopez & Johnson (2017) took subjective performance indicators of strategic alliance goal achievement and strategic alliance satisfaction as well as objective performance indicators of sales growth rate, net income growth rate, earnings per share growth rate, and revenue growth rate of a company as the research bases. Moghaddam, Bosse, & Provance (2016) measured with subjective measures of anticipated reward in strategic alliance, harmony and mutual trust, and perceived management capability and alliance sustainability. In the discussion of the relationship between strategic alliance management and performance, Wiengarten *et al.* (2015) applied subjective performance on the satisfaction of strategic alliance members, strategic alliance goal achievement, and future cooperation willingness as the measuring variables. Cowan, Paswan, & Van Steenburg (2015) regarded managers' subjective awareness as the measuring standard of long-term performance success. Gomes, Barnes, & Mahmood (2016) mentioned that most studies on strategic alliance performance measured performance with subjective strategic alliance member satisfaction and alliance goal achievement. Shafiq *et al.* (2016) selected sales growth rate and market share as objective performance measuring standards. Komini (2016) measured strategic alliance performance with subjective measures and objective measures. Subjective measures contained overall satisfaction with strategic alliance, management capability of strategic alliance, goal achievement of strategic alliance, satisfaction with strategic alliance partner performance, organizational operation of strategic alliance, and cooperation processes strategic of alliance. Objective measures covered profitability of strategic alliance, sales amount of strategic alliance, knowledge enhancement and technical ability, and return on investment.

## Methodology

### *Establishment of research indicator*

From above performance evaluation indicators for Medical devices industry strategic alliance, Delphi Method is utilized in this study for setting the performance evaluation indicators. Delphi Method, also named expert judgment, is a group decision-making method with both qualitative and quantitative characteristics and focuses on interdisciplinary and future orientation. Aiming at certain issues with inadequate data and unknown situations in the research process, anonymous expert survey is repeatedly preceded for votes and feedbacks till the differences in expert opinions are reduced down to the lowest with a commonly acceptable answer.

Literatures suggestion that the so-called “experts” should present the following conditions (Delbari *et al.*, 2016): (1) Interests in participating in Delphi Method survey. (2) With rich information for sharing. (3) Being approved the knowledge and techniques in specific fields. (4) Presenting specialties on the surveyed topic, including practical experience and theoretical research. (5) Agreeing that the research result include the possessed special information. Mishra & Chatterjee (2018) indicated that experts should present knowledge, reliability, and accuracy and show deeper understanding of the industry so that expert judgment was closer to the fact than it of general people. The value of Delphi Method was based on such answers.

### *Establishment of evaluation indicator*

The evaluation indicators in this study are established based on Delphi Method. The definitions are shown as below.

*Inputs:* (1) Finance dimension: including personnel costs, Medical devices industry supplies costs, pension, overtime pay, and welfare fee; (2) Alliance size: containing number of strategic alliance and number of employees.

*Outputs:* (2) Customer dimension: covering strategic alliance market share and strategic alliance Medical devices industry product growth rate; (2) Profit rate: gross sales of Medical devices industry products of strategic alliance as the performance output.

### *Research method and object*

Medical devices, contain sub-industries of diagnosis and medical imaging equipment (e.g. computed tomography, magnetic resonance imaging), surgical instrument, and distinct equipment for plastic surgery. The advance of medical technology and the enhancing standards in past years allow the rapid development of various innovative software integrated medical device sub-industries. The export of top 10 medical devices in Taiwan is about 66% of the total export

volume, with slight increase annually. It reveals that single item in Taiwan could be affirmed by the market and develops the advantage to create economies of scale. It is worth noticing that advantage items in Taiwan are changing with time and market needs. Since global medical device industry is mostly occupied by big channels and big brands, while most medical device manufacturers in Taiwan are small and medium enterprises with large difference in capital and scale from international manufacturers, they could not contend with the brand channel and marketing focus. For this reason, under the effective integration in strategic alliances, replacing individual products going it along with the collective war with complementary advantages could enhance the promotion. Moreover, in addition to horizontal integration, the establishment of channel brand could facilitate vertical integration. The establishment of agents with complete product lines is also an integrated solution to enhance the overall sales. Representative enterprises, in major Medical devices industry areas of Kaohsiung city, with cooperation with institutional consumers are selected as the research subjects in this study. "Delphi Method" and "Data Envelopment Analysis" are utilized; the open data in the annual reports of enterprises are used for selecting inputs and outputs for data analysis; and, the performance is provided for the reference of improvement. Aiming at enterprises, 12 DMUs are evaluated in this study.

#### *Efficiency evaluation analysis*

Data Envelopment Analysis (DEA) is applied to evaluate efficiency in this study. Different from traditional regression analysis, which merely searches for the mean path of the points in a series of data, DEA envelops various sample data and attempts to find out the relationship that it presents the advantage for being a good efficiency evaluation model. With linear planning technique, factors in the measurement of performance among various DMUs are taken into account; and, units with similar characters are compared the performance.

## **Results and discussion**

### *Performance evaluation analysis of strategic alliance of Medical devices industry*

By substituting various inputs/outputs into CCR and BCC models, the overall production efficiency and pure technical efficiency of Medical devices enterprises in this study are calculated. The return on scale of the Medical devices enterprises could be acquired by dividing the two. The overall production efficiency, pure technical efficiency, and scale efficiency are organized in *Table 1*.

From *Table 1*, Xingyi Medical devices industry Supplies Enterprise, with the overall production efficiency=1, is relatively the most efficient Medical devices

industry enterprise; the rest Medical devices industry enterprise show low overall production efficiency, especially Yongmao Medical devices Equipment appears the lowest overall efficiency, as relatively the most inefficient Medical devices industry enterprise. In other words, 11 DMUs, except 1 DMU with the relative overall production efficiency=1, are relatively inefficient. The reason for the inefficiency might be not effectively applying inputs or not achieving the optimal production scale. It requires further analysis.

Table 1. Relative efficiency of Medical devices industry enterprises

Medical devices industry enterprise	overall efficiency	technical efficiency	scale efficiency
Kangtai Medical devices industry	0.88	0.87	0.89
Xingyi Medical devices industry Supplies	1.00	1.00	1.00
Liang Chao Medical devices Equipment	0.91	0.91	0.90
Weikang Medical devices industry Supplies	0.98	0.98	0.98
Shun'an Medical devices Instrument	0.84	0.85	0.83
Shenghui Medical devices Equipment	0.82	0.82	0.81
Fankai Medical devices Instrument	0.93	0.94	0.93
Wang Hong Medical devices Equipment	0.86	0.86	0.85
Lund Medical devices Equipment	0.95	0.96	0.95
Yongmao Medical devices Equipment	0.74	0.73	0.74
Evergreen Medical devices Equipment	0.80	0.80	0.80
Shang Yang Medical devices Equipment	0.78	0.77	0.79

### *Sensitivity analysis*

The risk evaluation in this study aims to analyze and find out key factors in Medical devices industry strategic alliance through sensitivity analysis. The inputs and outputs are gradually removed for DEA to understand the sensitivity to efficiency. The research results are based on the change of sensitivity, including the factors of finance, alliance size, customer, and profit rate. From Table 2,



- 1) All DMUs decrease the efficiency after removing “finance” that finance reveals higher importance on all DMUs.
- 2) All DMUs decrease the efficiency after removing “alliance size” that alliance size appears higher importance on all DMUs.
- 3) All DMUs decrease the efficiency after removing “customer” that customers show higher importance on all DMUs.
- 4) All DMUs decrease the efficiency after removing “profit rate” that profit rate presents higher importance on all DMUs.

Table 2. Sensitivity analysis of gradual removal of inputs and outputs

DMU	original relative efficiency	remove financial dimension	remove alliance size	remove customer dimension	remove profit rate
Kangtai Medical devices industry	0.88	0.83	0.82	0.84	0.80
Xingyi Medical devices industry Supplies	1.00	0.93	0.90	0.92	0.88
Liang Chao Medical devices Equipment	0.91	0.85	0.82	0.86	0.83
Weikang Medical devices industry Supplies	0.98	0.90	0.88	0.92	0.85
Shun’an Medical devices Instrument	0.84	0.80	0.76	0.81	0.75
Shenghui Medical devices Equipment	0.82	0.76	0.73	0.75	0.72
Fankai Medical devices Instrument	0.93	0.86	0.83	0.85	0.80
Wang Hong Medical devices Equipment	0.86	0.80	0.78	0.79	0.75
Lund Medical devices Equipment	0.95	0.90	0.88	0.91	0.86
Yongmao Medical devices Equipment	0.74	0.70	0.66	0.68	0.63

Evergreen Medical devices Equipment	0.80	0.75	0.71	0.74	0.70
Shang Yang Medical devices Equipment	0.78	0.73	0.68	0.71	0.66
No. of efficient DMU	1	0	0	0	0

*Data source: self-organized in this study*

## Conclusion

According to the efficiency acquired from DEA and the information of variables, 1 DMU, 8% of all DMUs, shows strong efficiency on the Medical devices industry strategic alliance performance, efficiency=1, revealing the better efficiency of Medical devices industry strategic alliance; 4 DMUs, 33% of all DMUs, present marginal inefficiency on the Medical devices industry strategic alliance performance,  $0.9 < \text{efficiency} < 1$ , revealing the efficiency could be more easily promoted; and, 5 DMUs, 58% of all DMUs, appear obvious inefficiency of the Medical devices industry strategic alliance performance, efficiency  $< 0.9$ , where Yongmao Medical devices Equipment shows the lowest efficiency of Medical devices industry strategic alliance performance. With the principles of persistence, innovation, management, and approach in the sustained-yield management, Xingyi Medical devices industry Supplies Enterprise integrates Medical devices industry production, forms the big management model through organizational operation, and creates the industry ERP (Enterprise Resource Planning) management system to directly serve consumers with safety control and direct sales. Apparently, the promotion of Medical devices industry strategic alliance could develop economies of scale, reduce production and marketing costs, promote product quality and specifications, as well as expand domestic and overseas new markets. The enterprise marketing of strategic alliance could reinforce bargaining skills to effectively achieve market segmentation and promote product competitiveness. After Medical devices industry strategic alliance, information sharing could avoid vicious competition among alliance members, promote mutual learning through consensus or activities, and precede experience exchange.

### Recommendations

Aiming at Medical devices industry strategic alliance, the following suggestions are therefore proposed in this study.

1. Although strategic alliance contains mutual investment or merger, more flexible or strategic contracts should be adopted in the beginning of the development. the relevant authorities therefore should promote the contents of Medical devices industry strategic alliance to those with alliance intentions and provide proper alliance method and contract examples for both parties to enhance the strategic alliance between juridical persons and non-juridical persons related to industry.
2. Medical devices industry strategic alliance partners could arrange members with more ideas to propose issues for discussion and opinion exchange in workshops, or ones with better knowledge to consist clubs similar to book clubs for collecting data and sharing ideas about Medical devices industry, production, local management, governmental policies, new technology knowledge, and time trend, as well as enterprise discussion and growth to enhance local atmosphere.
3. Medical devices enterprises should keep in touch with industry, officials, and academia, read journals and magazines, pay attention to government regulations, dynamics in Medical devices industry, and Medical devices industry development in neighboring countries, visit other enterprises or Medical devices industry websites, and understand the management of Medical devices industry in various areas in order to cope with market changes.

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