# The Methods to Find Organization's Competitive Advantages

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## 1. Introduction

Performance evaluation has long been one of the most important part of management. As a concept of control in the management, it practically can not only show the performance of the past operations but also reveal the direction and amendment of present ones. Generally speaking, there are two categories in performance evaluation---- qualitative and quantitative. The quantitative is objective while the qualitative, though subjective, only can precisely measure key non-numerical measurements. However, in spite of their merits, both of them tend to emphasize too much on the financial measures or scatter non-financial ones , and therefore can't give organization systematic and useful strategic information in this information age in which the competition is much fiercer and strategy must be more often be evaluated than ever. Besides, evaluation is often performed as a within-organization but not a intra-organization style and it's consequently hard to find its competitive advantages. Accordingly, in this research, we combine the Balanced Scorecard, which evaluates the strategy of organizations and industries, and DEA which evaluates the relative efficiency values of organizations of objectives, into a framework and try to find a certain organization's competitive advantages and disadvantages no matter what industry or country the organization is in.

## 2. Introduction to DEA and The Balanced scorecard

### *2.1 DEA*

#### *2.1.1 DEA ----CCR Model*

DEA (Data envelopment analysis), proposed by Ferrell and extended by Charnes, Copper, and Rhodes, is a Linear-Programming mathematical approach to frontier estimation. CCR model (represented by the following equation), one model in DEA, is exercised in this research. Several inputs and outputs can be processed simultaneously to calculate the relative efficiency of DMUs (Decision Making Units) and all efficient DMUs (whose relative efficiency value is one) become the points of the frontier. Otherwise, the inefficient ones( whose efficiency value is less than 1 ) is off it. The equation of the CCR model is shown below.

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$$\text{Max} \quad E_K = \sum_{r=1}^{d} U_r Y_{rk}$$

$$\text{s.t} \qquad \sum_{i=1}^{p} V_i X_{ik} = 1$$

$$\sum_{r=1}^{d} U_r Y_{rj} - \sum_{i=1}^{p} V_i X_{ij} \leqq 0$$

$Y_{rj}$ : r-th output of j-th DMU

$X_{ij}$ : i-th input of j-th DMU

$U_r$ :the weight of r-th output

$V_i$ : the weight of i-th input

$E_k$ :the efficiency value of k-th DMU

*2.2.2 Steps to DEA*

1. Selecting inputs and outputs
2. Using DEA software, such as DEAP, to make an analysis of each DMU

*2.2.3 Limitations of DEA*

1. DEA is numeric performance-evaluation methods and therefore non-numeric data can't be used to calculate the relative efficiency by DEA.
2. The correlation of each input and output should be positive
3. The number of DMUs had better be at least two time that of input and output

*2.2.3 the decision-making information that DEA provides*

1. CCR-Model analysis

Relative efficiency value of each DMU and benchmarking can be found in this analysis.

2. Slack Analysis:

It's only for inefficient DMUs. A linear-programming mathematical approach, it can present the information of slack values of each input and output. We can exercise these slacks to find the numeric improvements on variables.

3. Sensitivity Analysis

It's mainly employed to discover the competitive advantages and disadvantages of individual DMU. In this analysis, we view all inputs and outputs as a combination and create new combinations by deleting only one input or output from the original one at each time. By comparing the increase and decrease of efficiency value of new combination with original one, the key input or output to individual DMU can be easily found.

*2.2.4 Merits of DEA*

1. DEA can simultaneously calculate all inputs and outputs and therefore get a comparable relative efficiency value

2. The more homogeneous DMUs are, the more effective the evaluation is

2.3 The-balanced scorecard

The balanced scorecard (the BSC), proposed by Kaplan and Norton, is a strategic performance-evaluation tool. Instead of measuring the performance only by financial measurements and scattered non-financial ones, and therefore giving outmoded and non-systematic information, the BSC selects measurements from four perspectives--- financial, customer, internal business process and learning and growth. Accordingly, it not only points out the goals that an organization achieved in the past but also offers systematic non-financial information that helps to improve its operations and further make financial success in the future. To achieve the BSC's goal, the following three rules should be followed.

2.3.1. Drivers

Performance measurements are basically of two kinds---lagging indicators and leading indicators (drivers). The former, the result measurements, shows the effects of financial improvement, and the latter, drivers, reveals the ways enterprises can employ to achieve these improvements. A successful BSC contains the two.

2.3.2. Correlation of Cause and Effect

Strategy is an assumption of correlation of cause and effect; therefore, all the measures and objectives in the four perspectives must not only be connected but strengthened by one another as well. For example, a certain logistics company's financial target is to elevate the "revenue". Therefore, when designing the BSC, it views the "revenue" as a result measurement ( goal) in the financial dimension and selects measurements as causes from the other three perspectives. From the perspective of customer of the BSC, the increase of the revenue is probably the outcome of high "customer's satisfaction" and high "customer's satisfaction" may come from the curtail of delivery time. Therefore, it selects the " delivery time" as a measurement in the customer dimension. To shorten the " delivery time", form the perspective of internal process dimension " the cycle of technological process" should be cut down and the quality of process needs to be improved. Accordingly, the "cycle of technological process" is chosen as indicators in the " internal process dimension". And finally, from the perspective of "learning and growth" of the BSC, " employee skills" leads to the efficiency of " the cycle of technological process" therefore it puts the " employee skills" as a measurement in the " learning and growth" dimension. The above cause –and –effect relationship of value chain is shown in Table 1.

2.3.3 Each measurement has to be linked as a cause to financial measures.

Financial success is what the profit-organization pursues. Hence, only the measurements which benefit an organization to identify chances to reap a profit are helpful to the existence of an organization. Each measurement, therefore, has to be linked as a cause to financial measures.

## 3. The framework of combination of the BSC and the DEA

The BSC, the qualitative method, is the strategy-evaluating tool of info era. DEA, the quantitative method ,evaluates "organizations of objectives" and calculates the relative efficiency values of competitors. This research simultaneously combines the two methods as a framework to exercise their merits. The framework, accordingly, not only helps the organization know its relative efficiency but also the strategically competitive advantages and disadvantages when compared with its competitors. The following steps show the way to exercise this framework:

*3.1.1 The selection of DMUs*

According to DEA, the more homogeneous DMUs are, the more precise the results of performance-evaluation will be. Therefore, the homogeneity of DMUs is strongly considered. In this paper, we choose 3PL (Third Party Logistics) as our example to show practice of this framework.

*3.1.2 The selection of inputs and outputs*

There are three steps to be followed.

1. Determining the strategic financial goals and selecting numerical measurements from the four perspectives of the BSC

2. Classifying all the measurements into inputs and outputs

According to DEA, all the measurements should be classified into inputs and outputs. Since we have chosen measurements by the BSC in the first step, we can view all the lagging indicators as outputs and leading indicators as inputs.

3. Calculating the correlation between inputs and outputs and deleting the improper measurements

Due to the restriction of DEA, the correlation between inputs and outputs should be positive. That means: every input has positive contribution to each output. When the correlation is negative, the improper input or output must be deleted

4. Checking the number of DMUs and that of measures

The number of DMUs had better be at least twice that of inputs and outputs in accordance with the rule of thumb of DEA. Therefore, deleting the inputs or outputs with small correlation. In addition, it is easier to interpret the results of evaluation if each dimension of the BSC has at least one measurement.

In the case of the 3PL, we can easily choose the measures by the steps mentioned above. Now, We assume that there are 20 companies with the strategic financial goal to raise their revenues, and we select 14 key measurements by the BSC, draw a chart of the cause–and-effect relationship of value chain ( as Figure 2 shows) and then make all the lagging indicators as outputs and the leading ones as inputs (as Table 1 shows). After the calculation of correlations between inputs and outputs, all the correlations among measurements are positive and hence proper ( as Table 2 shows). However, there are 20 units only so deleting 4 measurements is necessary. In accordance with Table 2, the correlations between X3, X4, X5 and Y2 is lowest and they are also relatively not essential in practice. Hence, Y2 is deleted.

A. The analysis of the framework

The analysis contains three parts.

1. CCR Model

By its relative efficiency value, peers and frequencies in which each DMU is peered ,the model can help find the benchmarking for all DMUs and further discover the efficient units worth a certain inefficient one's learning with similar scale of inputs but obviously more outputs.

The results of unit1 and unit6 of logistics companies' DEA calculation are shown below (Table 3). The average efficiency value is 0.938, and that means only 93.8% volumes of inputs have to be put to gain present outputs. Generally speaking, the DMU whose efficiency value is 1 , such as Unit 6, is efficient; otherwise, the DMU whose efficiency value is less than 1, such as Unit 1, is inefficient. Besides, the benchmarking can be obviously seen by the peer. Peers is efficient DMUs that was compared by inefficient DMUs. Therefore, the more the efficient DMU is, the more frequencies the efficient DMU becomes peers. As a whole, the DMU with the most frequencies as peers, is the benchmarking of all the other 19 companies. The inefficient DMU, such as unit 1, can view all the other units, DMU2, DMU3, DMU6 as the peers that are worth Unit1's learning for their similar scale of inputs and outputs with DMU1 but relatively higher efficiency than DMU1 .

1.1 The Slack Analysis

It's particularly for the inefficient DMUs. Slacks represent the amount by which the available amount of the resources exceeds its usage by the activities (Taha, 1997). Input slack means that when the present amount of outputs is given, the extra amount of inputs can be reduced. Output slacks indicate that after the extra amount of inputs was reduced, the previous amount of outputs can be increased. Individual DMU thus can exercise slacks to adjust their inputs and make more efficiency. Strategically, all the measurements are chosen from the four perspectives of the BSC; therefore, for individual DMU, the dimension where slacks occur is the weakness of its strategy.

Take DMU1 as an example. Unit 1, as Table 4 shows, has slacks both on the input and output side. The input slacks of X1 and X2 reveal that too much amount of investment in the Information Technology Assets and too much time spent on the delivery lead to its inefficiency. To be efficient, Unit 1, therefore, must cut down its present amount of investment in the Information Technology Assets (X2) from 3000 NTs to 2,689,163 NTs(=3000-310.837, 310.837 is slacks), shorten its delivery time( X1) from 48 to 47.912(48-0.088, 0.088 is slacks) and thus gain more revenues of 10000 NTs (1000 is slacks). Strategically, since the slacks of Unit 1 appear in the " internal process" and " customer" dimensions of the BSC, DMU1 has to be thoroughly inspected in this two dimensions.

## 4. Sensitivity Analysis

It's primarily exercised to discover individual's competitive strategic advantages. In this analysis, we view all inputs and outputs as a combination and create new combinations by deleting only one input or output from the original ones at each time. If a certain DMU's efficiency value of new input-deleted combination is higher than the original one, the deleted input has relative low contrbution to its efficiency value, and thus should be decreased; from the perspective of the BSC, the dimension of the deleted input is the DMU's comparatively strategic disadvantageous dimension; otherwise, it should be increased and the dimension of the deleted

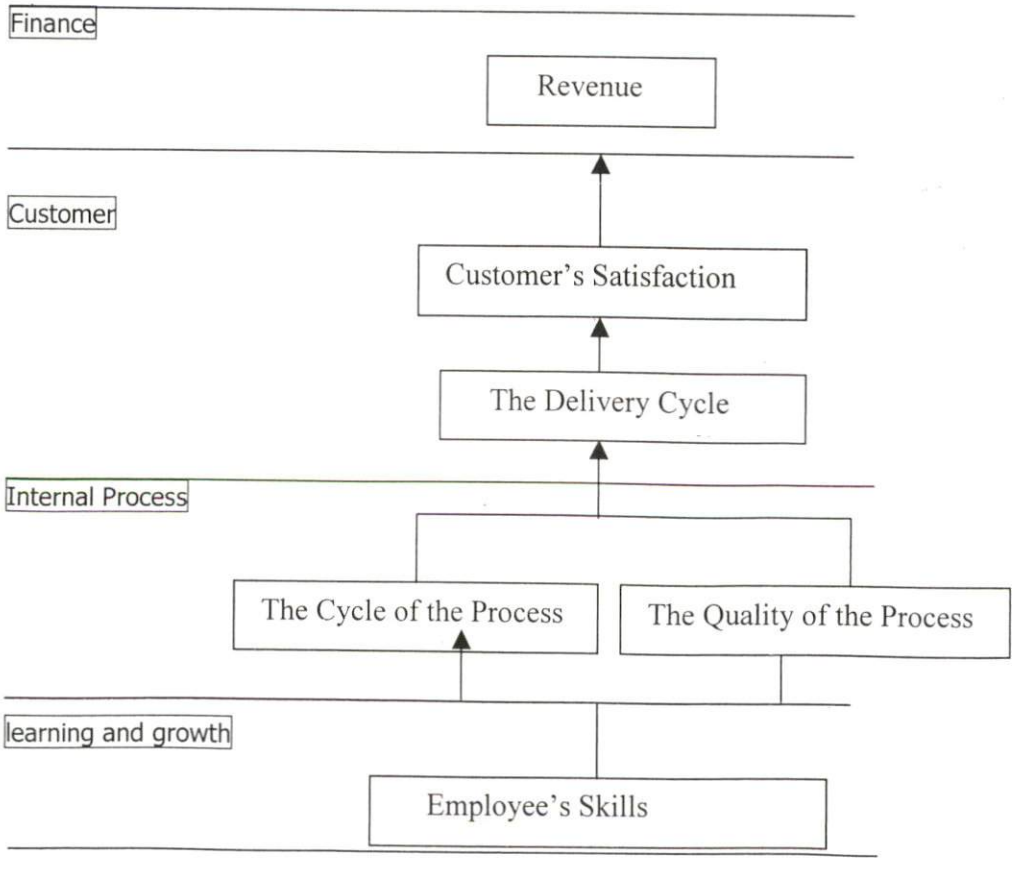
input is the DMU's comparatively strategic advantageous dimension. Similarly, If a certain DMU's efficiency value of new output-deleted combination is higher than the original one, the deleted output has relative high contribution to its efficiency value, and therefore should be increased and the dimension it belongs to, strategically, is the DMU's strong dimension otherwise, it should be decreased and the dimension it belongs to is the weak dimension.

DMU5, for example in the table 5, has decreased efficiency values in combination 1 and combination 2 and increased efficiency values in combination 5 and combination 6. Therefore, the X1 and X2 have negative contribution to its outputs and should be decreased; Y4 and Y5 have positive contribution to its efficiency values and should be increased. Strategically, the dimension that X1 and X2 belong to is DMU5's weak dimension and the dimension that Y4 and Y5 belong to is DMU5's competitive strong dimension.

***Conclusion***

Different from other performance evaluation methods, this research provides organizations not only with systematic strategic information but also relative advantages and disadvantages among competitors. In addition, although the data of competitor is hard to get, organizations still can use this framework to easily recognize its competitive advantages even by secondary data of competitors.

**Figure 1** The cause-and-effect relationship of the value chain



**Figrure 2** The cause-and-effect relationship of the value chain of 3PL

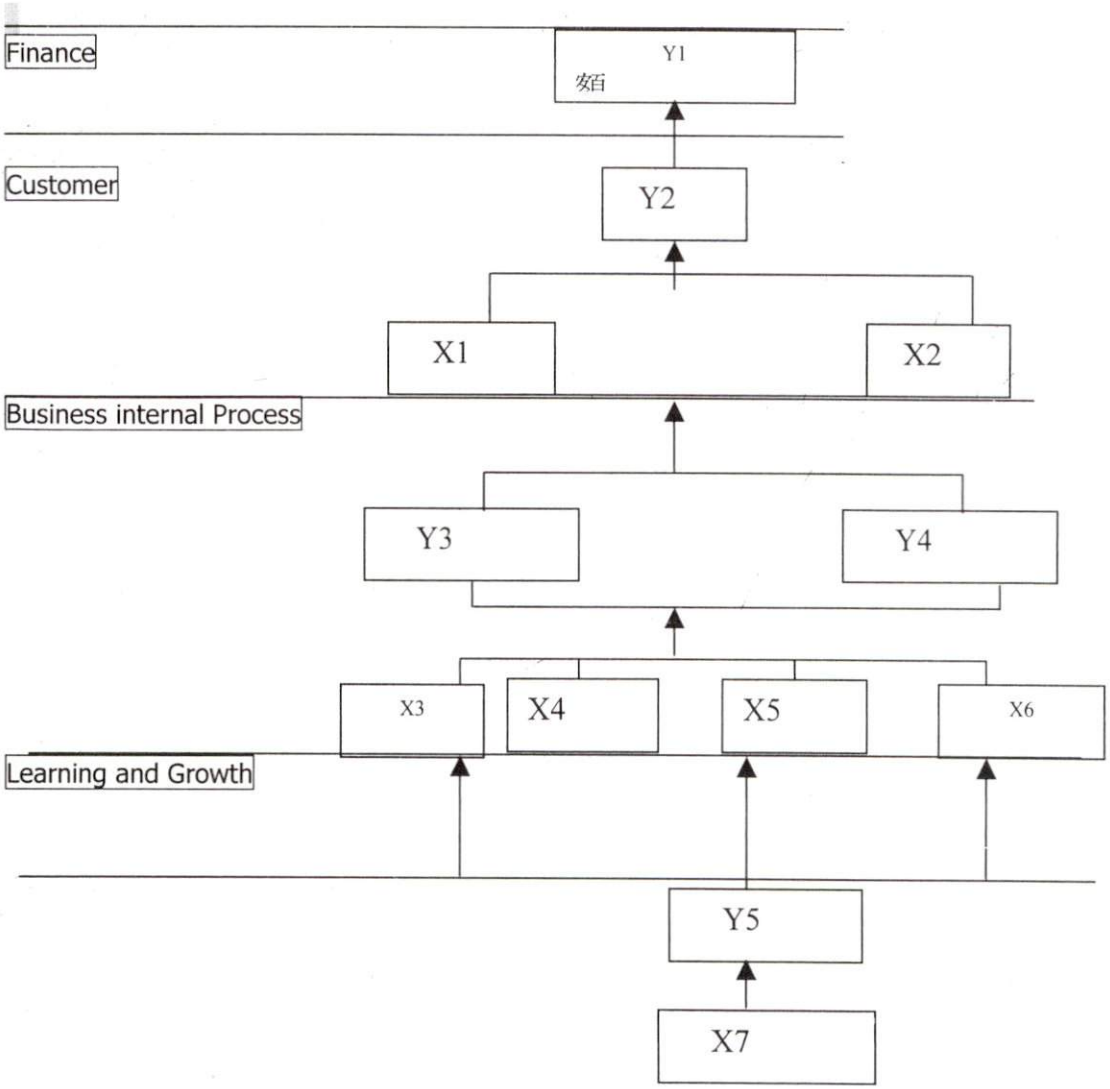


**Table 1.** Selected Inputs and Outputs and the dimension they belong to

| Code | Output [or Input] | Dimension of the BSC | **Details** |
|---|---|---|---|
| X1 | Input | Customer | Delivery Time |
| X2 | Input | Customer | Average Time for Failure Recovery |
| X3 | Input | BIP | The Number of Trucks |
| X4 | Input | BIP | The Number of Temperature layer of logistics equipment |
| X5 | Input | BIP | The number of Daily Completed Orders from Customers |
| X6 | Input | BIP | Information Technology Assets/ Total Assets |
| X7 | Input | L&G | The Yearly Budget for Training Program/ The Number of Employees |
| Y1 | Output | Finance | Yearly Revenue |
| Y2 | Output | Customer | Growth Rate of New Customers |
| Y3 | Output | BIP | The number of Customers with Long-term( more than one year) contract/ The number of Customers with contacts |
| Y4 | Output | BIP | The Number of the Provisional Orders Completed Within a day |
| Y5 | Output | L&G | Yearly Revenues/ the Number of All Employees |

BIP: Business Internal Process

L&G: Learning & Growth

**Table 2** Correlation of Inputs and Outputs

| Inputs / Outputs | X1 | X2 | X3 | X4 | X5 | X6 | X7 |
|---|---|---|---|---|---|---|---|
| Y1 | 0.5569 | 0.4458 | 0.5699 | 0.6658 | 0.2587 | 0.2587 | 0.3369 |
| Y2 | 0.5584 | 0.2587 | 0.0036 | 0.0021 | 0.1121 | 0.6689 | 0.2587 |
| Y3 | 0.8852 | 0.5987 | 0.6598 | 0.4487 | 0.6588 | 0.9658 | 0.5287 |
| Y4 | 0.2587 | 0.5587 | 0.4459 | 0.6587 | 0.58741 | 0.5897 | 0.2587 |
| Y5 | 0.2258 | 0.5987 | 0.6587 | 0.5487 | 0.9968 | 0.6658 | 0.5558 |

**Table 3** DEA Results of 2 companies among 20's

| Code of DMU | Relative Efficiency Value | Peers | Frequencies of Peers |
|---|---|---|---|
| 6 | 1.000 | 6 | 4 |
| 1 | 0.811 | 6.2.3 | 0 |
| Average | 0.938 | | |

**Table 4** Slacks of DMU1

| Code | X1 | X2 | X6 | X7 | Y1 ' | Y3 | Y4 | Y5 |
|---|---|---|---|---|---|---|---|---|
| The Dimesion of the BSC | Customer | Customer | BIP | BIP | Finance | BIP | BIP | Customer |
| DMU1 | 0.088 | 310.837 | 0.000 | 0.000 | 1000.000 | 0.000 | 0.000 | 0.000 |

**Table 5** Efficiency Value of New Combination

| DMU5 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Original Value | 0.6685 | | | | | | | |
| Number of combination | 1 | 2 | 6 | 7 | 1 | 3 | 4 | 5 |
| The Dimesion of the BSC | Customer | Customer | BIP | BIP | Finance | BIP | BIP | Customer |
| DMU1 | 0.1254 | 0.5688 | 0.6685 | 0.6685 | 0.6685 | 0.6685 | 0.7413 | 0.9965 |