An efficiency-driven approach for setting revenue target

Hung-Tso Lin *

Department of Distribution Management, National Chin-Yi University of Technology, Taichung County, Taiwan, Republic of China

A R T I C L E   I N F O

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A B S T R A C T

This paper addresses the efficiency measurement and revenue setting problems drawn from a home improvement company with 22 chain stores in Taiwan. The top management attaches great importance to efficiency analysis of their stores. Furthermore, when the proposal to establish a new store is under development, the regional manager must determine what efficiency level the new store should achieve and what amount of business revenue it should earn. An approach by using the imprecise DEA (IDEA) and inverse IDEA models as core techniques is proposed to deal with such problems. A simulated application illustrates the implementation of the proposed approach.

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1. Introduction

In popular management theory, goal-setting and efficiency measurement play a pivotal role, expressed in phrases such as “what gets measured, gets done” [22]. From the viewpoint of management practice, questions related to what level of efficiency an organization needs to achieve and how it should set appropriate efficiency target are some of the main issues for managing organizational efficiency [12, 21].

In this paper, the issue for measuring efficiencies of existing stores and decision-making problem for setting business revenue target of a new store are addressed. These problems are drawn from a home improvement company in Taiwan. The company has established 22 chain stores to sell do-it-yourself products including more than thirty thousand items and to provide professional design and consultation for home improvement. In order to enhance the service competence and decision-making problem for setting business revenue target of a new store, a regional manager must determine what efficiency level the new store should achieve and what amount of business revenue it should earn. Under the target of business revenue, the store manager and the subsidiary workers will devote themselves to develop effective marketing and service plans for delivering the target. Since the company plans to establish new stores each year in different regions, such considerations have become important issues for corporate administration, and so this is thus a problem worthy of investigation.

Each store consumes some resources in implementing the tasks to obtain some concerned results. Conceptually, the relative efficiency of a store is calculated as the ratio of weighted sum of outputs to weighted sum of inputs. Data envelopment analysis (DEA) has been shown to be a powerful tool for measuring the relative efficiencies of the homogenous decision-making units (DMUs). In this study, the chain stores are referred to as homogenous DMUs. DEA and the relevant techniques are employed to deal with the problems under consideration. The rest of this paper is organized as follows. The next section presents the fundamentals of DEA models and the relevant techniques. Section 3 describes the proposed approach consisting of five stages. Section 4 illustrates the implementation of the proposed approach via a simulated application. Finally, conclusions are given in Section 5.

2. DEA models and relevant techniques

DEA is a nonparametric method that can be applied to assess the relative efficiency of each DMU without predetermined weights for the input and output factors and without knowing information on the production function. The CCR model [3] and BCC model [1] are commonly used to evaluate relative aggregate efficiency and technical efficiency, respectively, of each DMU that consumes multiple inputs to produce multiple outputs. For convenience, the momentous notations used in the following description are listed in Table 1. The CCR (Charnes–Cooper–Rhodes) model was developed to establish an
Table 1

Notations.

Table 1

<table>
<thead>
<tr>
<th>Index and input parameters</th>
<th>Notations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xi</td>
<td>input factor, i = 1, 2, ..., m.</td>
</tr>
<tr>
<td>Yi</td>
<td>output factor, i = 1, 2, ..., s.</td>
</tr>
<tr>
<td>xij</td>
<td>input amount of Xi of DMU j, j = 1, 2, ..., n.</td>
</tr>
<tr>
<td>yij</td>
<td>output amount of Yi of DMU j, j = 1, 2, ..., n.</td>
</tr>
<tr>
<td>e</td>
<td>a non-Archimedean small number.</td>
</tr>
<tr>
<td>nij</td>
<td>number of workers in rank r of DMU j.</td>
</tr>
<tr>
<td>BP</td>
<td>basic payment of salary and bonus of a worker in rank r.</td>
</tr>
<tr>
<td>EE</td>
<td>extra expenditures of a worker in rank r.</td>
</tr>
<tr>
<td>(\delta(r)/v)</td>
<td>total amount of resource consumed by a worker in rank r,</td>
</tr>
<tr>
<td>(\delta(r)/v+EE)</td>
<td>and (\delta(r)/v+EE+\delta(r)/v+1) + (\delta(1)) =BP,</td>
</tr>
<tr>
<td>(\pi)</td>
<td>a value to reflect the degree of worker level intensity between</td>
</tr>
<tr>
<td>(v_{ij})</td>
<td>ranks r and r’ + 1.</td>
</tr>
<tr>
<td>(u_{ij})</td>
<td>unit value of (y_{ij}).</td>
</tr>
<tr>
<td>(w_{ij})</td>
<td>weight attached to (y_{ij}).</td>
</tr>
<tr>
<td>(v_{ij}r)</td>
<td>weight attached to (w_{ij}), where (v_{ij}r = v_{ij}\delta(r)/v).</td>
</tr>
<tr>
<td>(y_i^0)</td>
<td>a variable used to discriminate the status of returns-to-scale</td>
</tr>
<tr>
<td>(v_{ij}r)</td>
<td>of the DMU under evaluation.</td>
</tr>
<tr>
<td>(y_i^0)</td>
<td>amount target for adjusting or revising (y_i^0).</td>
</tr>
</tbody>
</table>

Decision variables

\(E_k^f\) aggregate efficiency of DMU k.

\(E_k^f\) technical efficiency of DMU k.

\(E_k^f\) scale efficiency of DMU k.

\(v_i\) weight attached to \(X_i\).

\(u_i\) weight attached to \(Y_i\).

\(w_{ij}\) weight attached to \(Y_i\), where \(w_{ij} = v_{ij}\delta(r)/v\).

\(y_i^0\) a variable used to discriminate the status of returns-to-scale of the DMU under evaluation.

\(y_i^0\) amount target for adjusting or revising \(y_i^0\).

Efficiency frontier based on the Pareto optimum concept. The aggregate efficiency of the DMU under evaluation, say DMU k, can be calculated by the following output-oriented DEA-CCR model:

\[
E_k^f = \min_{v_{ij}} \sum_{i=1}^{m} v_{ij}X_{ik}
\]

s.t. \[
\sum_{i=1}^{m} v_{ij}X_{ij} - \sum_{r=1}^{s} u_{ij}Y_{ij} \geq 0, \quad j = 1, ..., n,
\]

\[
\sum_{r=1}^{s} u_{ij}Y_{ir} = 1,
\]

\[
u_i \geq \varepsilon.
\]

By the restriction of the above constraints, the efficiencies of all DMUs have a lower bound of 1. DMU k is aggregate efficient when \(E_k^f\) is equal to 1 and aggregate inefficient if \(E_k^f\) is greater than 1. The value of \(E_k^f\) equals 1 indicating that DMU k lies on the efficiency frontier and is regarded as relatively efficient. Alternatively, DMU k does not lie on the efficiency frontier and is regarded as relatively inefficient. Regarding the determination of weights \(v_i\) and \(u_i\), each DMU is allowed to select the most favorable weights in measuring its relative efficiency provided that all DMUs with the same weights will not be resulted in efficiency score of less than 1. However, to prevent unfavorable factors from being ignored in the evaluation by setting a weight of zero to them, all weights should be greater than a non-Archimedean small number \(\varepsilon\).

In model (1), when the objective function (Eq. (1.0)) is set as \(E_k^f = \max \sum_{s} u_{ij}y_{ij}\) and the 2nd constraint (Eq. (1.2)) as \(\sum_{i=1}^{m} v_{ij}x_{ij} = 1\), then the model is known as input-oriented DEA-CCR model and the efficiencies of all DMUs have a upper bound of 1.

The main advantage of CCR model is that it can be used to measure the aggregate efficiency of each DMU for evaluating its performance of resource utilization. However, the limitation of CCR model is that it is based on the assumption of constant returns-to-scale. In order to establish a variable returns-to-scale efficiency frontier for measuring the technical efficiency, the BCC (Banker–Charnes–Coo-
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