O

Optimization Approaches to Assess Manufacturing Agility

P. G. Saleeshya
Amrita Vishwa Vidyapeetham (University), India

INTRODUCTION

The results obtained with the help of AHP and OARM based studies, reported in the previous chapter provided logical bases for comparing the 26 organizations under consideration in the view point of what can be related to agility. These two analyses were primarily in the category of empirical studies. As the outcome of these studies are largely dependent upon the input given by the personnel from the organizations. It was realized that there was scope for application of further analysis which may have its relevance to optimization.

Data Envelopment Analysis (DEA), Goal Programming (GP), Interpretive Structural Modeling (ISM)….were identified suitable, and applied for further analyses. The results obtained using DEA (Charnes et al., 1978) clearly indicate where significant attention should be paid to realize the desired agility. Goal programming (Ignizio, 1976) method has been identified suitable to for optimization. *We have also extended our studies to assess the agility of manufacturing supply chain (Second phase),* the details of which is presented in the following sections.

A COMBINED AHP- AND DEA-BASED APPROACH TO MEASURE AGILITY OF MANUFACTURING SYSTEMS

The author proposes an approach to measure the agility of manufacturing systems by combining the Analytical Hierarchy Process (AHP) and the Data Envelopment Analysis (DEA) methodologies. DEA was used to compare and find out the priorities of various units of organizations, which is essential for the optimum deployment of resources among these units, and hence to achieve maximum agility, by making use of the values of EI and Importance Index for agility.

Data Envelopment Analysis (DEA) is a method for assessing the relative efficiency of decision-making units (DMUs) having, in the general case, multiple incommensurate inputs to produce multiple incommensurate outputs. The relative efficiency of a DMU is defined as the ratio of the sum of its weighted outputs to the sum of its weighted inputs, the weights having been determined so as to show the DMU at maximum relative efficiency (Bousso Glance et al., 1991).

Here we have different organizations identified as DMUs. These DMUs have common multiple inputs (x_i) and outputs (y_r). The values of these inputs and outputs in terms of index of importance and index of effectiveness respectively are also known. In order to achieve *B* maximum efficiency each DMU has to deploy its resources in the most effective way. For this the optimum values of the weightages given to different inputs $(v_1, v_2 \ldots)$ and outputs $(u_1, u_2 \ldots)$ have to be found out. The solution of this model will give the values for these weightages. In this model the objective is to maximize the output by keeping the input at a constant level and hence to increase the overall efficiency of the system.

DEA-AHP Model

The formulation used in the present study makes use of the following model reported by Charnes et al (1978).

Max: $\sum_{r=1}^{m} u_r y_r$ ...　　　　　　　　(1)

Subject to

$\sum_{i=1}^{m} v_i x_i = 1$ ...　　　　　　　　(2)

$\sum_{r=1}^{s} u_r y_r - \sum_{i=1}^{m} v_i x_i \leq 1$ ...　　　(3)

$u_r \geq 0$

$v_i \geq 0$

r = 1 … s i = 1 … m

where

- **s:** Is the number of outputs.
- **m:** Is the number of inputs.
- **u_r:** Weight given to the rth output.
- **v_i:** Weight given to the ith input.
- **y_r:** The rth output.
- **x_i:** The ith input.

DEA to Manage Organizational Agility

In order to use the DEA model, it is required to have the appropriate data representing both input and output for each unit and its sub units. In a typical organization, the input may be in the form of material, manpower, machines, information, technology, space, capital etc., whereas the output in the form of goods and services measured in appropriate units. In a DEA model, it is also possible to convert all the inputs and outputs into a common measure such as monetary value or equivalent hours etc. In the present study the focus is on agility which is difficult to quantify in exact measure. In order to deal with the problem on hand, two different approaches developed and reported in the previous sections have been used.

With the help of AHP method, the relative importance of each factor was found out. It was also perceived that their assessment of importance was based on the degree of focus these factors must be getting in the organizations. Logically the degree of focus that a factor gets should be reflected by the resources that are deployed for these factors. Therefore the index of importance obtained by AHP for each enabler (factors) can be linked to the resource deployed, which in the case of DEA model is related to the input.

The Effectiveness Index for Agility (EI) reflects the effectiveness of various sub systems, KPAs and PO in terms of output performance.

Both these studies used the data relevant to the 26 organizations considered in the present study. Each of these organizations can be subjected to analysis using the DEA concept. Each organization has been identified to have different sub units, which are termed as the enablers in AHP based study and sub systems / KPAs / POs in the OARM related study. An important sub-unit is one which can contribute to increase the performance efficiency and effectiveness of the DMU to the maximum attainable level. In this study the AHP-score of sub-units obtained from the AHP-model is an indication of the degree of importance of various sub-units to the DMU. While allocating the companies available input resources to various sub-units this factor of importance should be considered. The Effectiveness index obtained by the OARM model is an indication of the amount of output produced by each of the sub-unit and hence to increase in the ability to realize the overall agility of the system (DMU). The DEA-output oriented model tries to increase the efficiency of a unit by extracting more output for a fixed input. To do so, we have to select amount of input required to obtain maximum output and hence to increase the overall efficiency, optimally.

RESULTS

The results obtained using DEA clearly indicate where significant attention should be paid in terms of input initiatives and output initiatives to realize the desired agility. Analysis of the re-

8 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/optimization-approaches-to-assess-manufacturing-agility/107362

Related Content

Critical Barriers to Business Intelligence Open Source Software Adoption
Placide Poba-Nzaou, Sylvestre Uwizeyemunguand Mariem Saada (2019). *International Journal of Business Intelligence Research (pp. 59-79).*
www.irma-international.org/article/critical-barriers-to-business-intelligence-open-source-software-adoption/219343

A Systematic Literature Review on Hospitality Analytics
João Paulo Rodrigues, Maria José Sousaand Ana Brochado (2020). *International Journal of Business Intelligence Research (pp. 47-55).*
www.irma-international.org/article/a-systematic-literature-review-on-hospitality-analytics/256929

Simulation of Stock Prediction System using Artificial Neural Networks
Omisore Olatunji Mumini, Fayemiwo Michael Adebisi, Ofoegbu Osita Edwardand Adeniyi Shukurat Abidemi (2016). *International Journal of Business Analytics (pp. 25-44).*
www.irma-international.org/article/simulation-of-stock-prediction-system-using-artificial-neural-networks/160436

Analysis of Operation Performance of Blast Furnace With Machine Learning Methods
Kuo-Wei Hsuand Yung-Chang Ko (2019). *Utilizing Big Data Paradigms for Business Intelligence (pp. 242-269).*
www.irma-international.org/chapter/analysis-of-operation-performance-of-blast-furnace-with-machine-learning-methods/209574

Re-Shaping Business Strategy in the Era of Digitization
Deniz Palalar Alkan (2020). *Handbook of Research on Strategic Fit and Design in Business Ecosystems (pp. 76-97).*
www.irma-international.org/chapter/re-shaping-business-strategy-in-the-era-of-digitization/235569