Chapter 7

A New Integrative Approach Based on Balanced Scorecard, Data Envelopment Analysis, and Management Performance to Prioritize Research and Development Projects

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ABSTRACT

The objective of this chapter is to propose a new approach for evaluating Research and Development (R&D) projects at different stages of their life cycle. The approach is based on the integration of the balanced scorecard, Data Envelopment Analysis (DEA), and Multiple Objective (MO) linear programming. An interactive MO-DEA model is presented to incorporate Decision Maker’s (DM) preference to effectively establish a common basis for fully ranking projects. The approach is illustrated on 50 R&D projects from the literature to highlight the effectiveness of the approach to fully rank all competing projects, hence increasing the discrimination power of DEA approach.

INTRODUCTION

The balanced scorecard (BSC) is a model for the analysis of strategic management performance in all types of organization. It was developed by Kaplan & Norton (1992), and it has been the subject of much research attention as a tool for strategic management. The BSC is composed of a collection of attributes, arranged in groups, and denoted as cards. The attributes are related to four BSC original perspectives (financial, customer, internal-business processes, learning and growth): A new uncertainty perspective

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is introduced into BSC for the selection among competing R&D projects. This importance of considering the cost-benefit and risk-opportunity quantitative analysis for the evaluations of short and long term performance and impact analyses of organizations, people and systems were highlighted in the introduction of new COBRA framework in Osman et al (2014a) and the IMEET framework where COBRA and DEA are combined in Osman et al. (2014b) to determine an overall valuation from all perspectives.

BSC combines financial and operational measures, and focuses both on the short-and long-term objectives of an organization. The cards offer a balanced evaluation of the organizational performance along financial, marketing, operational and strategic dimensions. Both DEA and BSC are used for the evaluation of research and development (R&D) projects including, Rickards (2003), Tsang et al., (1999), Rouse et al., (2002), Banker et al., (2004), and Wang & Huang (2007). Eilat et al., (2006) combined DEA and BSC models to analyze the efficiency, effectiveness and balance R&D projects. The evaluation method was executed in seven phases: resource allocation, individual project evaluation, projects variability control, generation of portfolios, applying an accumulation function to determine the inputs and outputs of the candidate portfolio, evaluating alternative portfolios, sensitivity analysis, commencing with a distribution of resources among the categories associated with the main areas of strategy (product lines, technology areas, etc.). Once the resources have been distributed, the R&D projects were considered as decision making units (DMUs) for their relative evaluation and ranking by the DEA–BSC model. The score evaluations are then obtained to select the list of candidate projects for executions. Subsequently Eilat et al., (2008) developed a study integrating DEA and BSC models for the evaluation of R&D projects in different stages of their life cycle. The measurement of the inputs and outputs was integrated with BSC cards of R&D projects. This analytical framework was then applied in a research laboratory to select and execute a large number of research projects on a yearly basis.

In this paper, a multi-criteria approach is presented for R&D projects evaluation based upon the integration of two different innovative strategic management and measurement methodologies with the addition of management preference on projects in the analysis. The reason addition is that the original DEA model proposed by Charnes et al., (1978) does not include a decision maker (DM)’s preference structure or value judgments when evaluating the relative efficiency among alternative projects. Value judgments were defined by Allen et al., (1997) as “logical constructs, incorporated within an efficiency assessment study, reflecting the DM’s preferences in the process of assessing efficiency.” To incorporate DM’s preference information in DEA modeling, various techniques have been proposed including: the goal and target setting models, (Golany, 1988; and Athanassopoulis (1998); weight restrictions imposing bounds on individual weights (Dyson & Thanassoulis, 1988); assurance region (Thompson et al., 1990); restricting composite inputs and outputs, weight ratios and proportions (Wong & Beasley, 1990); and the cone ratio concept by adjusting the observed input–output levels or weights to capture value judgment belonging to a given closed cone (Charnes & Cooper, 1990; Charnes et al., 1994). Alternative approaches include Thanassoulis & Allen (1998) whose model adopts the unobserved DMUs derived from paretto-efficiencies of DMUs to incorporate value judgments; Zhu (1996) also integrated preference information into a modified DEA formulation, while Golany & Roll (1994) used hypothetical DMUs to represent preference information.

All the above-mentioned techniques would require priority preference knowledge, which are subjective in most cases. A constructive method to incorporate preference information without requiring a priori judgment or target setting is considered. An interactive decision making technique encompassing both