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ORIGINAL ARTICLE

A Grey Theory Based Multiple Attribute Approach for R&D Project Portfolio Selection

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Abstract In this paper, the research and development (R&D) project portfolio selection problem is introduced as a multiple attribute decision making problem. Recognizing and modeling the project interdependencies provide valuable cost savings and other greater benefits to organizations. Therefore, besides conventional attributes like cost and outcome, different type of interdependencies are also considered as attributes. Since the decision makers' preferences on the project alternatives or attributes are uncertain, a grey theory based method is proposed to cope with the uncertainty. correspondingly, the preferences and ratings of the attributes are described by linguistic variables, which are further expressed as grey numbers. Consequently, a ranking order of the projects is done using grey possibility degree and is used to determine the portfolio. To explore, an illustration is done by a case study. The methodology proposed here is shown to be an efficient approach to solve the R&D project portfolio selection problem.

Keywords Multiple attribute decision making · Grey number · R&D project portfolio selection · Project interdependency · Grey possibility degree

1. Introduction

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R&D project portfolio selection is one of the most important problems for decision makers in industry as well as in academic research. In today's environment with increasing competition and limitations on financial resources, the way of selection of R&D projects that maximize some utility measure or benefit to the organization has become a critical one. The purposes of project portfolio decision are to allocate a limited set of resources to projects in a way that balances risk, reward and alignment with corporate strategy. However, portfolio decisions are complicated, because of the long lead-time for R&D and market and technology dynamics. In addition, complex project and resource interdependencies make portfolio decisions more difficult. Needless to mention, poor selection of R&D projects could have a significantly negative impact on organizations for decades.

R&D project portfolio decision deals with future events and opportunities. Most of the information required to make portfolio decisions is at best, uncertain and at worst, very unreliable. Project selection is usually described in term of constraint optimization problems. Given a set of project proposals, the goal is to select a subset of projects to maximize some objective without violating the constraints. Though some methods [1-4, 8, 12, 14-19, 25] for R&D project portfolio selection already exist, unfortunately, R&D project managers have not been able to adopt many of these mechanisms.

Interdependent projects render an increase in benefit. When interdependencies occur, the parameters associated with a particular project depend upon which other projects have been selected; so that the total cost and benefit obtained from a portfolio is not equal to the sum of the individual project costs and benefits. Not much research has been done so far in tackling interdependencies. Schmidt [20] presented a model that accounts for the combined effect of benefit, outcome and resource interactions within a single set of projects. The model also allows for the allocation of several different resources. [21] discussed a nonlinear 0 -1 goal programming model for interdependent information system project selection. There, the authors formulated benefit, resource and technical interdependencies among candidate projects. [22] considered three phases of R&D project selection: first, a score based screening process identifies proposal candidates; next, an integer linear programming model determines all efficient portfolios keeping in mind multiple objectives, project interdependencies and time; finally, an interactive procedure matches portfolios with aspired benefit and resource. [7] proposed and demonstrated a methodology to the construction and analysis of efficient, effective and balanced portfolio of R&D project with interactions. Considering outcome, technical, resource and risk interdependencies, [9] proposed a R&D project portfolio selection model based on 0 -1 nonlinear mathematic programming method.

Deng [6] introduced Grey System Theory as an interdisciplinary scientific area. The theory has become quite popular since then with its ability to deal with the systems that have partially unknown parameters. As superiority to conventional statistical models, grey models require only a limited amount of data to estimate the behavior of unknown systems. During the last 30 years, the grey system theory has developed rapidly and has caught the attention of many researchers. It has been widely and successfully applied to various systems such as social, economical, financial, sci-