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ScienceDirect

Procedia - Social and Behavioral Sciences 226 (2016) 35 – 42

Procedia
Social and Behavioral Sciences

29th World Congress International Project Management Association (IPMA) 2015, IPMA WC 2015, 28-30 September – 1 October 2015, Westin Playa Bonita, Panama

Modeling and solving project portfolio and contractor selection problem based on project scheduling under uncertainty

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Abstract

In this paper a new formulation of the project portfolio selection problem based on the project schedules in uncertain circumstances have been proposed. The project portfolio selection models usually disregard the project scheduling, whereas is an element of the project selection process. We investigate a project portfolio selection problem based on the schedule of the projects, so that the minimum expected profit would be met in the shortest possible time period. Also due to uncertain nature of durations of the activities, this duration considered as the semi-trapezoidal fuzzy numbers. Finally, a fuzzy linear programming model is developed for the problem, where the results indicated the validity of the presented model.

Peer-review under responsibility of the organizing committee of IPMA WC 2015.

Keywords: Portfolio management**,** Project portfolio selection, Project scheduling, Contractor selection, Fuzzy linear programming.

1. Introduction

The managers of the project-based organizations, confront the limited financial resources where they always face a project portfolio selection and scheduling problem. Various experimental and analytical mechanisms are developed and presented for project portfolio selection problem. Most of these tools prioritize projects based on the expert opinions about value, importance and available resources of the projects. In the different industries the common approaches and methods of the project selection mainly consists of two steps: First, all of the projects are evaluated separately and then the optimal set of the projects will be selected using a greedy algorithm. These

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Peer-review under responsibility of the organizing committee of IPMA WC 2015.
doi:10.1016/j.sbspro.2016.06.159

projects are selected and prioritized by the series of predetermined criteria (Henriksen & Traynor, 1999; Linton, Walsh, & Morabito, 2002; Meade & Presley, 2002). Second, the projects are selected one by one according to their priorities until the resources are finished. These methods and approaches are easy and thus are widely used in practical. Nevertheless, it should be noted that the composition of the projects with higher priorities would not necessarily lead to more profitable portfolio (Chien, 2002). The major key in this model is the evaluation of the projects and the assessment of their objective value. One of the project selection policies is the selection process based on the evaluation and ranking of each project. For the ranking of the projects, there are different evaluation methods. The most widely used method is the economic analysis, in which the projects are ranked according to their present net value. On the other hand, in order to overcome the weakness of focusing on the individual criteria in the project ranking, the ranking models are proposed and used based on the several criteria to evaluate the projects (Klein, 2000). As seen the project portfolio selection models usually disregard the project scheduling, whereas is an element of the project selection process. In this paper we propose a mathematical model to consider the project portfolio selection based on the scheduling of the projects as well as the contractor selection possibility for each one of the current activities.

The rest of this paper is organized as follows. The literature is reviewed in Section 2. In Section 3, the proposed mathematical model is presented. In Section 4, the problem solving approach is proposed. As an illustration of the model, we present a numerical example in Section 5. The model results analysis is discussed in Section 6. This paper is concluded in Section 7.

2. Literature review

Many models are suggested to help the organizations to choose and schedule their projects. Dos Santos (1989) tries to represent a policy with ranking technique. The ranking method is a structured policy, which simultaneously consider several factors such as economic profit, business goals and so on. Lootsma, Mensch, & Vos (1990) and Lucas & Moore (1976) suggested the scoring method for the project selection. The scoring model can afford all of the important factors in the process of project selection and provide the theoretic indicator to select between different projects.

The mathematical models are the optimization models, which apply the mathematical programming techniques for the optimal selection of projects through the nominee projects. The selection is function of the maximization of the objective and satisfaction of the resource constraints. Badri, Davis, & Davis (2001) proposed a goal programming model for project portfolio selection in the information system projects.

Stummer & Heidenberger (2003) suggested a model and searching approach for Pareto optimal project portfolio in multi-stage decision-making process. The value assessment of the proposed portfolios are widely studied by the multidisciplinary weighting models. Gabriel, Kumar, Ordonez, & Nasserian (2006) have introduced the multi-objective optimization model with regard to the probability distribution of the costs. Abello & Michalewicz (2014) examined a special case of the resource constraint project scheduling problem, in which the number of applicable activities changes over time. In other words, unlike the common models of the resource constraint project scheduling problem, in which the number of activities is predetermined, in this case the number of activities is not fixed and varies in the progress of the project. Since the issue of the project portfolio selection and scheduling is categorized in NP-hard problems (Doerner, Gutjahr, Hartl, Strauss, & Stummer, 2004), in the recent years the meta-heuristic algorithms such as evolutionary algorithms (Medaglia, Graves, & Ringuest, 2007) and colony algorithms (Doerner, et al., 2004) are used to solve these problems. Stummer & Heidenberger (2003) applied an ant colony optimization approach to solve software project scheduling problem. In this proposed approach, with respect to the implementation of the software oriented project activities by some individuals, a mechanism is presented for the distribution of the activities and assigning them to the implementing agents.

Ghorbani & Rabbani (2009) developed a two objective model to maximize the productivity of the projects and minimize the total deviation of the allocated resources in two successive periods and for the problem solving introduced the algorithm based on the genetic algorithm, which is compared with NSGA-2 algorithm. Tasan & Gen (2013) intended to solve the project portfolio selection and scheduling problems simultaneously in separate networks, which are independently examined for the project portfolio selection and scheduling by the integrated genetic algorithm method. In this presented approach, the multi-stage decision-making approach is used. Minku, Sudholt, & Yao (2014) studied a variety of approaches for the problem of the project scheduling through the efficiency analysis and finally reached an improved approach to solve these types of the problems. This approach