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A Heuristic Algorithm for Project Scheduling with Fuzzy Parameters

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Abstract

The project scheduling is of particular importance among project management issues. With the passage of time and the progress of science and the emergence of concepts such as stochastic and non-stochastic uncertainties and the need to consider these concepts in scheduling and project management, Critical Path Method has also developed as a new method with fuzzy approach, preserving its basic concepts. In this paper, the literature on calculations of project scheduling network with fuzzy approaches is reviewed, subsequently, an algorithm for project scheduling with fuzzy time and resources is developed. This algorithm first calculates the latest start times of activities under fuzzy environment, then, construct a feasible schedule by using the parallel scheduling method. In order to show the effectiveness of the proposed algorithm, a project scheduling problem is solved with certain amount of resources. Finally, an example was solved by the algorithm, considering fuzzy activity durations and resources.

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Keywords: Fuzzy Project Scheduling; Critical Path Method; Parallel Scheduling Scheme

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1. Introduction

The project scheduling is one of the most important and widely used planning fields. The application of theories in practice and the extent of studies in this field, indicate its importance more than before. The project scheduling includes a wide range of issues and classifications. For each type of project scheduling problems, various methods have been proposed by several researchers. Since the project scheduling problems are known as NP-hard, different heuristic and metaheuristic algorithms are presented for solving these problems. Researchers tries to incorporate the real-world conditions such as uncertainty into the project scheduling models. However, in many practical problems due to lack of information or lack of access to data, accurate estimate of the parameters of the model is impossible. With the introduction of fuzzy theory and its applications in the planning and the need to consider these concepts in project scheduling, the Critical Path Method (CPM) were also developed retaining its original concepts. One of the new methods in this field is the Fuzzy CPM. The principles of this method are like the conventional CPM, except that instead of crisp numbers, fuzzy numbers are used for activity durations. This means that the project is scheduled based on forward and backward passes by using fuzzy numbers and the earliest start times and latest finish times of activities are calculated.

The important parameters of the project scheduling are such as activity duration, levels of access to different resources, activities' requirements for resources etc. can be mentioned. In many researches, only activity duration is assumed to be uncertain. In this study, activity durations as well as resources are considered to be uncertain. This paper is structured as follows. A brief review of the related literature is conducted in section 2. In section 3, the proposed algorithm is presented under fuzzy activity durations and resources. Two numerical examples are given to show the validity of the algorithm in section 4. Finally, conclusions and recommendations for further research are made in section 5.

2. Research literature

After the introduction of fuzzy logic by Professor Lotfi Zadeh to the world of science, its applications quickly spread in various branches of science, including project management. Chanas and Kamburowski (1981) applied fuzzy logic to project scheduling problems [1]. They used time intervals for project activity durations considering triangular fuzzy numbers. Lorterapong and Moslehi (1996) applied fuzzy durations to the CPM [2]. Yao and Lin (2000) used the CPM with the new ranking formula based on alpha-cut and splitting the time interval into two parts corresponding to α and (α-1) [3]. Chanas and Zielinski (2001) applied LR fuzzy numbers to the CPM [4]. Blue *et al.* (2002) used fuzzy logic theory and possibility theory in the CPM [5]. Yao and Lin (2003) proposed a new fuzzy ranking method based on fuzzy numbers interval [6]. Han *et al.* (2006) presented an algorithm for the simplification of the Fuzzy CPM with its application in an airport construction project [7]. Soltani and Haji (2007) presented a linear programming approach for the CPM considering trapezoidal fuzzy numbers [8].

Chen and Hsueh (2008) proposed a similar method to Haji and Soltani's method [9]. Kumar and Kaur (2010) combined the method introduced by Kaufman and Gupta with the technique proposed by Dobios and presented a new formula for fuzzy rankings [10]. 11.Shakeela and Gansean (2011) as well as Haji Yakhchali (2011) introduced new formula for ranking fuzzy numbers [11,12]. Morovatdar *et al*. (2013) proposed an algorithm for the Fuzzy CPM using piecewise numbers [13]. Elizabeth and Sujatha (2013) developed a new formula for ranking fuzzy numbers based on a new vision in simultaneous control of both random uncertainties (by risk management) and non-random uncertainties (by fuzzy ranking). However, their studies were merely theoretical, as they did not attempt apply their formula to an actual case study [14]. Chandra and Kumar (2014) developed fuzzy ranking in the FCPM [15].

Few studies were conducted on resource-constrained project scheduling problems (RCPSP) [17]. Hapke and Slowinski (1996) developed priority rules in sequential and parallel-based scheduling methods for fuzzy parameters [17]. Hapke and Slowinski (2000) applied Simulated Annealing algorithm to solve the fuzzy multi-objective RCPSP problems [18]. Wang and Kerre (2001) proposed a fuzzy approach to solve the problems with the objective of minimizing risk [19,20]. Wang (2004) used Genetic Algorithm to solve the RCPSP problem [21]. Bhaskar *et al.* (2011) proposed a new heuristic approach to solve the RCPSP with fuzzy durations based on priority rules. They used parallel scheduling scheme and proposed a new priority rule based on the critical path and resource demand [22]. At any