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# Solving time-cost trade-off problem using multi-objective decision environment

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Abstract

This paper proposes a multi-objective decision environment for the well-known schedule compression problem. For this purpose, the method uses the Analytical Hierarchy Process (AHP) to model this multi-objective decision environment in which, activities are queued for crashing based on priorities established in that environment. A wide range of methods are introduced in the literature to perform schedule compression utilizing genetic algorithms, heuristic rules, Harmony search, and analogy with the direct stiffness method for structural analysis. Although all these methods consider only cost in the process of schedule compression, a recently conducted survey, by the authors, indicates that project managers consider more than one factor in this process. In fact, the lack of consideration of factors that are important to contractors has been attributed to the limited use of the existing methods. To address this need, the newly developed method accounts for factors identified to be important from the conducted survey. A numerical example is analysed to demonstrate the use of the developed method and to illustrate its practical features.

**Keywords: Analytical Hierarchy Process, Project schedule compression, Time-cost trade-off analysis, Schedule crashing, Project acceleration**

## 1. INTRODUCTION

The time-cost trade-off analysis is usually needed in the execution phase of projects. This analysis is usually performed to establish the delicate balance between the overall cost of a project and its respective duration. That analysis typically leads to rational estimation of project least-cost duration, which is not necessarily identical to the original contractual duration. This analysis is also performed to reach targeted milestones imposed by owners, or to make up for lost time due to delays experienced on site.

A number of methods were introduced in the literature for solving the time-cost trade-off problem using optimization and heuristics. Optimization-based methods convert the problem into mathematical programming models using linear or dynamic programming e.g. [3; 6]. These models obtain the optimal solution of the problem but need considerable computational effort. Heuristic methods, however, provide a way to obtain good solutions but do not guarantee optimality. Different models have also been proposed in the literature using Genetic Algorithm [10], Harmony Search [4], analogy with the direct stiffness method for structural analysis [8] and iterative crashing process e.g. [1; 5; 7]. Recently, solutions for the problem have been expanded to take into account the time value for money using discounted cash flow model [2] and to consider project's profit as a vital objective that often determines the project success or failure, instead of its cost in performing the trade-off [13].

All the methods cited above, consider only activities 'cost in performing the trade-off and shortening project's duration. The lack of consideration of additional factors that are likely to be important to contractors and project managers when planning to accelerate their projects has been attributed to the limited use and uptake of these methods in practice [12]. This paper presents a method that accounts for not only cost but also for other factors utilizing the Analytical hierarchy process (AHP). The developed method also generates execution plans by assigning different weights for the decision variables. This provides contractors with flexibility of examining different plans and selecting the most suitable one. A numerical example is analyzed to demonstrate the additional features of the developed method and to illustrate its capabilities.