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Cost/time trade off investigation of spherical storage tank construction projects using MOPSO/NSGAII

Vida Arabzadeh
Industrial Engineering Dept.
Islamic Azad University, Qazvin Branch
Qazvin, Iran
vida_ar@live.com

S.T.A. Niaki
Department of Industrial Engineering
Sharif University of Technology
Tehran, Iran
Niaki@Sharif.edu

Vahid Arabzadeh
Process System Engineering Dept.
Aalto University
Helsinki, Finland
vahid.arabzadeh@aalto.fi

Abstract—**This paper proposes two multi-objective evolutionary algorithms of multi-objective particle swarm optimization (MOPSO) and non-dominated sorting genetic (NSGA-II) to solve the time-cost tradeoff problem of spherical storage tank construction projects. Using multi-objective algorithms to optimize the cost and the time of construction project enables one to obtain a Pareto front solution as a set of optimum solutions for project completion with different options of time and cost.**

Keywords- Spherical storage tank; Construction projects; Multi-objective PSO algorithm; NSGA-II algorithm

I. INTRODUCTION

Spherical storage tank construction can be considered a multi-mode project, as there are different sub-contractors and vendors with different options to complete activities regarding their costs and times. Like any other construction projects, there are severe constraints on completion of the project with respect to its time and budget. However, since there is a high possibility on reworks and repairs due to forming metals and welding that are performed based on some restricted regularities on construction and inspection, the project usually cannot be finished on time within a pre-specified budget. In other words, increasing the quality usually accompanies with increase in time and cost. As a result, the aim is to make a balance among the time, the cost, and the quality of spherical storage tank constructed. In this paper, an optimization model is developed and is solved based on this goal.

The stochastic time-cost trade-off problem concerns how to modify the project activities in stochastic environments such that the project can be completed in time; meanwhile the project cost is minimized. It considers the trade-off between the project cost and the project completion time, which is a particular type of the project scheduling problem. For project decision-makers, the analysis of the time-cost trade-off is one of the most important aspects of project scheduling and control [1].

The early time/cost trade-off models assumed linear non-decreasing functions for the direct activity cost. The objective was to determine the activity durations and schedule in order to minimize project costs including the direct activity and the time-dependent indirect project costs, within a specified project deadline. Therefore, the activity costs were assumed a function of activity durations, bounded from crash duration to normal duration [2].

Kelley [3] was the first who performed research on this special type of project scheduling problem in 1961. In the following 40 years, research on the time-cost trade-off problem mainly focused on the problem with deterministic environments [3,4]. To solve the deterministic time-cost trade-off problem, the common analytical methods were linear programming and dynamic programming [5,6]. Besides, some heuristic algorithms, such as genetic algorithm [7–9], were also developed to solve more complicated problems.

II. PROBLEM DEFINITION

In a construction project, it is a common practice to have different options regarding the time and cost as there is variety of selections among executive teams. Hence, it is vital for a decision maker or project manager to know all activities as well as all possibilities to complete every single activity. Besides, extending the working time or dividing working teams into different groups to work in 2 or 3 shifts a day are other possibilities.

Products such as butadiene, butane, propylene and many other chemical and petrochemical products, which are gasses at normal atmospheric temperatures and pressures and require specific and remarkable pressure to become liquid, are stored most economically in spherical pressure tanks. A typical scheme of a spherical storage tank is illustrated in Figure 1 The main parts of a spherical storage tank are