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IERI Procedia 10 (2014) 274 – 279

Procedia IERI

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2014 International Conference on Future Information Engineering

Contractor Selection in Gas Well-drilling Projects with Quality Evaluation Using Neuro-fuzzy Networks

Roya M. Ahari[a,*], S.T.A. Niaki[a]

[a] *Dept. of Industrial Engineerin, Sharif University of Technology, Tehran, Iran*

Abstract

Contractor selection for a project is an important decision, one for the project time and cost, next for the quality obtained by the project. Although the project managers can easily determine the project time and cost, the quality is usually undefined especially for un-experienced managers. With a learnable property, an approach is first introduced in this paper to quantify the quality obtained for a gas well drilling project. Then, based on these three objectives (time, cost, and quality), a contractor selection problem is converted to an optimization problem. Next, the NSGA-II algorithm is utilized for solution. At the end, a sensitivity analysis is performed to select the parameters of the algorithm.

Selection and peer review under responsibility of Information Engineering Research Institute

Keywords: Contractor selection, Quality evaluation, Multi-objective optimization, Gas well drilling project, Multi- objective Genetic Algorithm.

1. Introduction

A common decision in the project management is the selection of contractors to simultaneously optimize three objectives in project's triangle. This issue becomes more important if there is more monetary value involved or there is limited number of capable contractors. Contractor selection is primarily based on certain criteria such as time, cost and quality of work performed. However, as these criteria do not generally work in a unique direction, it makes the selection decision difficult. A contractor who performs the projects on time may have higher cost and lower quality. Given that there are a certain number of contractors for each task group and having three measures to evaluate them makes the contractor selection problem equivalent to a discrete multi-objective optimization problem.

Selection and peer review under responsibility of Information Engineering Research Institute
doi:10.1016/j.ieri.2014.09.088

In project management environment, the contractor selection is known as the time-cost-quality trade-off problem, in which the aim is to select a contractor that performs the project with the highest quality and minimum cost and time. Moreover, with multi-objective optimization models, the model with two-dimensional objects can be developed and more aspects of evaluation could be added such quality. [El-Rayes and Kandil, 2005]. One model developed separate mathematical models, each optimizing one of the related three criteria by bounding on the other two [Tarighian and Taheri, 2006]. Another one optimized these tree objectives by a weighted single-objective model [Wang and Feng, 2008].

Many researchers proposed various evolutionary optimization algorithms tested global search capabilities to solve the trade-off problem. These algorithms are mainly genetic algorithm (GA) [Xingfu et. al, 2007], ant colony optimization (ACO) [Afshar et. al, 2007], Pareto optimal front (POF) [Iranmanesh et. al, 2007], electromagnetic scatter search (ESS) [Tarighian and Taheri, 2007], and particle swarm optimization algorithm (PSO) [Zhiyong et. al, 2007]. Moreover, many researchers proposed a multi-objective GA to solve different multi-objective problems such as transportation problem [Lau et. al, 2009], selection of partners in a supply chain problems [Yeh and Chuang, 2011], constrained multi-objective optimization problems [Li and Du, 2013], determining optimal resource levels in surgical services [Lin et. al, 2013] and so on.

In this paper, a neuro-fuzzy network with learning capability is first proposed to quantify the quality of gas well-drilling projects. Then, a trade-off optimization model is developed to select the best contractor. Finally, an algorithm named NSGA-II is used to solve the problem. This paper is organized as follows: Section 2 presents developing the multi-objective optimization model. Section 3 provides the details of simulation methods and results. In Section 4, conclusion is addressed.

2. Developing the multi-objective optimization problem

This research involves a company that is working on Gas well-drilling projects in Iran. The company is obliged to make decisions such as to select a contractor, evaluate the quality of work, and to make trade-offs among the time, cost and quality of well drilled. This section demonstrates the steps involved to formulate the contractor selection problem with respect to their time, cost and quality.

2.1. Quality grade of gas well-drilling project

A gas well-drilling project begins after many preparation works at a platform. At first, engineering research-works are performed to identify gas resource area and then many types of equipment are required to be located at the determined place. The South Pars project located in the southern part of Iran performed by the PetroPars company is selected as a case study of this research. The South Pars gas field contains about 50% of Iran's gas resources. The PetroPars is the leading oil and gas development company in Iran.

In oil projects, like all expensive projects, selecting a suitable contractor is a highly challenging decision. Different contractor selection for the tasks directly affects time, cost, and quality of the project. The history of the projects and the background of a contractor used as raw data to begin the selection process. In consideration of different modes of performing a task group, one can assumes every task to have different alternatives having time, cost, and quality respectively. This assumption is acceptable for the contractors that do several projects repeatedly. It assumed all task groups of a project can be done in a few reasonable modes. Although the project cost and time of all contractors are known, the project quality is usually expressed using a fuzzy term. Consequently, a neuro-fuzzy model called LLNF is used in this paper to evaluate and quantify this parameter. This learnable model evaluate a function to extract the gas well-drilling tasks quality grade from (1) the cost compliance percentage with plans, (2) the time compliance percentage with plans, (3) the percentage of quality failure in all operational failures, (4) the number of HSE incidences, and (5) the number