Chapter 67
Fuzzy Based Project Time-Cost Optimization Using Simulated Annealing Search Technique

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ABSTRACT

The Project time-cost optimization is inherently a complex task. Because of various kinds of uncertainties, such as weather, productivity level, inflation, human factors etc. during project execution process, time and cost of each activity may vary significantly. The complexity multiplies several folds when the operational times are not deterministic, rather fuzzy in nature. Therefore, deterministic models for time-cost optimization are not yet efficient. It is very difficult to find the exact solution of savings in both time and cost. To make such problems realistic, triangular fuzzy numbers and the concept of α-cut method in fuzzy logic theory are employed to model the problem. Because of NP-hard nature of the project scheduling problem, this paper develops a simple approach with Simulated Annealing (SA) based searching technique. The proposed model leads the decision makers to choose the desired solution under different values of α-cut. Finally, taking a real project, the performance of SA has been tested.

INTRODUCTION

A project is a combination of interrelated activities which must be executed in a certain order before the entire task is completed. The activities are interrelated in a logical sequence which is known as precedence relationship. For the analytical purpose, the activities of a project are represented in a network diagram maintaining precedence relationship to get solutions for scheduling and controlling. The longest continuous path of a project network is called critical path which determines the project duration. The most commonly used project management techniques are Gantt chart, Milestone, Critical Path Method (CPM) and Project Evaluation and Review Technique (PERT). The major objective of project scheduling is to complete the entire project within budget and

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time constraints. Traditional project scheduling problems mainly focus on activities assuming deterministic or probabilistic time durations.

Project scheduling is the conversion of a project action plan in an operating timetable. It serves as the basis for monitoring and controlling project activity. Taken together with the plan and budget, it is probably the major tool for the management of projects. The basic approach for all scheduling techniques is to form a network of activity and event relationships. Critical path of this network is an important issue for project schedulers, because it refers the duration of whole project. Project managers are highly concerned with this critical path for on time completion of a project, especially when an extension will incur a penalty (either in liquidated damages, opportunity costs and goodwill losses). When some delay have been occurred, there may be necessary to compress the critical activity by incrementing the activity resources above the normal level. It is often the case that the performance of some or all activities can be accelerated, or the duration crashed, by allocating more resources at the expense of higher activity direct cost. This crashing of activities can be achieved by multiple shift work, extended work days, using larger and more productive equipment and increasing the size of labor crews. So, project schedule planners mainly focus on finding the most cost effective way to complete a project within a specified completion time. This class of problem is usually called time-cost trade off.

In real construction projects, time and cost of activities may face significant changes due to existing uncertainties such as inflation, economical and social stresses, labor performance, execution errors of contractor, design errors, natural events such as climate changes and etc. Therefore, total time and cost of project may differ significantly because of these uncertainties.

Almost all of the projects, the required information for estimation of project parameters are either unavailable or incomplete. In practice, the majority of construction companies do not systematically record the durations of project activities. In addition, it is commonly known that no two construction projects are alike. Also in many cases the project is done for the first time, this compels us to use expert opinion in forecasting the project parameters. Experts use their own judgment, experience and project information that is available to them. In practice, linguistic terms such as, "approximately", "more or less", or "about" are commonly found in the statements used by these experts. These terms clearly exhibit some sort of imprecision that naturally leads to a range of possible values, rather than a definitive estimate using a single value. So, uncertainty and project parameters are inextricable. In thesis situation, deterministic models of construction time-cost trade off are not realistic. Crisp decision making in uncertain environment causes loss of some parts of information. Use of uncertain models, whish is capable of formulating vagueness of the dynamic conditions of real world gives more stability to solve time-cost trade off problem. Some probabilistic techniques are used in many cases to meet these uncertainties to some extent. But project parameters may not be in statistical manner. That is why fuzzy set theory is appropriate to consider affecting uncertainties in activity duration, direct and indirect cost of a project.

Since different alternatives of possible durations and costs for the activities can be associated with a project, the problem is arisen to search the best solution. As combinatorial optimization problems, finding optimal decisions is difficult and time consuming considering the number of possible permutations involved. Therefore, any analytical procedure may suit for small project, but it will be inefficient for large project because of exhaustive enumeration. To avoid the problem of combinatorial explosion, heuristic models can be used. It does not ensure the optimality but it gives better near optimal solution without mathematical rigor.

This research aimed at development of an efficient heuristic approach with fuzzy activity