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Modeling contractors' project selection and markup decisions influenced by eminence

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Abstract

To be successful in a competitive environment, contractors have to prepare their bids wisely. The two main decisions they have to make are the project selection decision and the markup selection decision. This paper proposes a new optimization model that combines these two main decisions. It also takes into account the importance of eminence and previous works as the most important non-monetary evaluation criterion used by owners for evaluating bids. These factors combined with the two decisions make this model complex and nonlinear. To solve this model, a customized Genetic Algorithm is developed. Using Monte Carlo simulation, the result of the model is compared to the results of conventional models that only consider bidding markups. The comparison shows that considering eminence can increase the expected profit of the contractor to more than 25% under some evaluation criteria mindsets of the owner.

Keywords: Project management; Project selection; Bidding decisions; Evaluation criteria; Markup decision; Nonlinear optimization; Genetic Algorithm; Monte Carlo simulation; Auctions

1. Introduction

Contracting firms are project-oriented firms in which their profit is related to the number of projects awarded. Contractors have to bid wisely. The procedure of bidding is composed of three main steps: project selection, markup decision and preparation of bidding documents. The first two steps require decision-making. Although these decisions are internal decisions made by the firm's management group, they depend on many exterior factors such as the market and the competitors (Oo et al., 2008), as well as the evaluation attributes used by the project owners. The next subsections will briefly introduce the two decision steps and the evaluation methods.

1.1. Project selection decision

In the literature, three main nomenclatures are used for selecting projects. Deciding whether to bid on a project is commonly referred to as the bid/no-bid decision. Selecting a set of projects is referred to as project selection. For the projects that are not independent from each other, the nomenclature Project Portfolio Selection (PPS), part of Project Portfolio Management (PPM), is used to emphasize the project interdependencies (Killen and Kjaer, 2012).

There are more major differences between Project Selection and Project Portfolio Selection with the bid/no-bid decision. First, the bid/no-bid decision is only about one project, while the project selection problem is usually about selecting more than one project. Second, after the bid/no-bid decision is made, the project is often not awarded to the contractor, as they also need to participate in an auction. In PPS, however, no auction exists because projects are selected from an available pool of projects, usually in-house projects. Based on these differences,

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it can be seen that the bid/no-bid decision has a major shortcoming; that is, it does not consider several projects together.

This selection of a set of projects for bidding occurs because bidding on all projects is not feasible, and blindly bidding has negative effects. The reasons that make up this decision and have a vital role in a contractor's success include:

a) Resource limitations: The firms do not have unlimited resources. They should plan wisely to make the maximum profit possible.
b) The cost of preparing bids: "The development of a comprehensive proposal for a large project should itself be treated as a project for a project-oriented business" (Lin and Chen, 2004). Due to this cost, the importance of bidding wisely increases.
c) The negative effect on reputation: In addition to the monetary cost of bidding blindly, bidding on lots of projects and not winning many of them has a negative effect on a firm's reputation (Gido and Clements, 1999).

1.2. Markup estimation decision

The markup is a major input for calculating bidding prices. It usually consists of general overhead, profit and contingency, which are expressed in percentages (Lee and Chang, 2004). The markup has to fulfill two main objectives. It has to be low enough to increase the probability of winning in the auction. However, it needs to be high enough to ensure a desired profit. Keeping the markup (profit) low is best suitable for situations where the only evaluation criterion is the bidding price. These types of auctions, called sealed bid price auctions, are designed so the project is awarded to the bidder with the lowest cost responsive bid. Not all auctions are sealed bid price auctions, however, and knowing the evaluation criteria can be helpful in the markup estimation decision.

1.3. Auction mechanisms and criterions

Auctions are popular project award mechanisms. Traditionally, auctions were held in sealed bid style where the project was awarded to the firm with the lowest price. However, considering only monetary terms (or the lowest bidding price) would not necessarily lead to a successful project that would be on schedule and within budget. In fact, many projects that are awarded based on the lowest bidding price have huge amounts of cost and time overruns (Conti and Naldi, 2008), which usually result from anomalous bids. To avoid them, the evaluation criteria have been subject to change. In some auctions, the project is no longer awarded to the lowest bidding price. Some of the different proposed mechanisms include: (1) the Vickrey auction (Vickrey, 1961), which is a second bid auction in which the lowest bidder is awarded the project for the second lowest price, and (2) using the average bidding price as a proxy to eliminate anomalous bids (Conti and Naldi, 2008; Skitmore, 2002). Ioannou and Leu (1993) reveal how the average-bid method can benefit both the contractor and the owner. To minimize the risk even further, owners sometimes consider non-monetary capabilities of contractors to find a winner who can lead the project towards its goals. Evaluating contractors based on both monetary and non-monetary criteria is being practiced in many countries. Lai et al. (2004) have explained the process for evaluating bids in the construction industry in China. Padhi and Mohapatra (2010) have discussed the evaluation criteria used in India and have conducted a literature review on different evaluation criteria used in many countries. Decarolis et al. (2010) investigated different auction formats and their applications in Italy.

Knowing these criteria is helpful in making both the bid/no-bid and markup decisions. For example, if the importance of markup is not relatively high, there is no longer a need to outbid all the competitors; hence, the contractor can select a higher markup (more profit) and still win the auction. This behavior on which preferred bidders tend to act is called the preference effect. Because of the preference effect, it may seem that having preferential bidders is more costly for owners. However, when this effect is paired with both the competitive effect and the participation effect, it may reduce overall costs for the owner (Hubbard and Paarsch, 2009).

This paper proposes a model that accomplishes project selection by considering a set of projects as opposed to only one project in the first bidding decision. Some interdependencies among projects are taken into consideration. This model also explains the effect that evaluation criteria of owners have on the decisions of contractors.

The paper is structured as follows: the next section focuses on reviewing the literature related to topics that fall within the scope of this research. The problem and some of its characteristics are described in Section 3. The Genetic Algorithm used for solving this problem is described in Section 4. Section 5 contains the results of different sensitivity analyses and the performance of the model. Finally, Section 6 concludes the results of this research.

2. Literature review

Knowing the evaluation criteria is essential in the bid decisions. To have a good sense of what are the main criteria that owners/clients tend to have in evaluating auctioneers, Watt et al. (2009) examined the management literature and conducted a survey on contractor selection and tender evaluation. The study concluded that "the preferred criteria for evaluating tenders are those that show the contractors' ability in terms of their management and technical capability, past experience and performance, reputation, and the proposed method of delivery or technical solution."

In later research, Watt and his colleagues looked for the most important criteria of tender evaluation by looking at the relative importance of each of the most noticed criteria from their previous research. Based on what contractors believed, the results stated that, "Past Project Performance, Technical Expertise and Cost are the most important criteria in an actual choice of contractor with Organizational Experience, Workload, and Reputation being the least important." Watt and his colleagues stated that the quality of product was the most important criterion of contractor selection. Notably, this criterion was consistent in all industries. Based on their research, bidding price is not the main evaluation criterion. In fact, on average it is only around 15% important. So it is important to consider non-monetary criteria in making either one