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# Bidding model incorporating bid position for determining overhead-cum-markup rate

Li-Chung Chao[a,]*, Shinn-Jye Liaw[a]

[a]*National Kaohsiung First University of Science and Technology, Yanchao, Kaohsiung 824, Taiwan ROC*

**Abstract**

The direct cost of a construction project constitutes the majority of a contractor's bid, with the remaining part being its overhead cost and markup. Contractors often apply a combined rate of overhead and markup on top of the direct cost for producing a bid. Extending previous researches on overhead rate estimation and bid markup determination, this research aims to develop an improved bidding model incorporating the bid position for determining the minimum overhead-cum-markup rate so as to prevent an inadequate bid. Since factors influencing the overhead rate level may also influence the markup level, it is suggested to build a regression equation from actual bid data for estimating the overhead-cum-markup rate in the winning bid that is used to estimate the probability of winning for a bid. With assessments of probabilities of winning and those of making a loss for various bid levels, fuzzy inference systems that incorporate the bidder's positions in the fuzzy rules regarding the need for work and attitude toward risk are proposed. The model is illustrated using an example involving 406 projects. The suggested bids from the model for two cases of bidding are compared with those from other methods and the actual bids to examine its soundness. The results show that the model can differentiate the bid positions under varying scenarios and suggest minimum bids consistently.


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## 1. Introduction

The bid for a construction project comprises the contractor's estimated direct cost and overhead cost plus its applied markup, i.e. profit. The contractor's direct cost refers to all expenses for labor, equipment, materials, and subcontracts required for completing the project elements and it constitutes the majority of a bid. The contractor's

* Corresponding author. Tel.: +886-9-28728694; fax: +886-7-6011017.
*E-mail address:* chaolc@nkfust.edu.tw


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overhead cost consists of the site overheads for supporting the project and the project's share of the home-office overheads for running the firm. Although the site overheads can be estimated based on a construction program, such detailed estimation is not favored by many contractors, who often use an experience-based rate of the direct cost to cover all site overheads. The project's share of the home-office overheads is usually determined also as a fixed rate according to the ratio of the firm's annual total home-office cost to its annual total revenue. The markup portion of the bid is business-oriented and a higher or lower level may be charged as deemed appropriate, which is usually determined also as a rate based on the conditions of the project, the firm, and the market. Thus, contractors often use an overhead-cum-markup rate on top of the direct cost for producing a bid as in Eq. (1):

$$b = \bar{d} + \bar{o} + p = \bar{d} \times (1 + \frac{\bar{o} + p}{\bar{d}}) = \bar{d} \times (1 + r) \tag{1}$$

where $b$ = bid amount; $\bar{d}$ = estimated direct cost; $\bar{o}$ = estimated overhead cost (site overheads plus project's share of home-office overheads); $p$ = charged profit (markup); $r$ = overhead-cum-markup rate applied in $b$.

In Eq. (1), $1+r$ equals the $b/\bar{d}$ ratio and, with $\bar{d}$ and $r$ established, $b$ is obtained readily. Such a simple method is naturally prone to inaccuracy, if the applied rate ($r$) is selected subjectively. Because project owners usually award a construction contract based on the lowest bid, contractors often have to cut their bids to compete but undoubtedly increase the risk of making a loss in completing a job, if the winning bid is exceeded by the actual total cost. Using an overhead-cum-markup rate in competitive bidding without a sound approach certainly involves a greater risk. To avoid suffering an unworthy loss, the bid should achieve a balance between the chance of winning and loss risk according to the bidder's position. Although bidding in construction has attracted much research interest over the years, how to determine the minimum $r$ for a contractor with certain position has not yet been addressed.

Existing bidding models focus on bid markup determination. In traditional models such as Carr [1], the optimum markup is suggested as one with the maximum expected profit, where the expected profit for a markup is defined as the product of it and its probability of winning. However, the bid thus produced tends to give too low a chance of winning for contractors who sacrifice profit to compete. Meanwhile, various multi-criteria markup models have been proposed, e.g. the multi-attribute utility model by Dozzi et al [2] and the case-based reasoning model by Chua et al [3]. They offered various methods for producing an optimum markup for a project, yet they did not determine how low a bid could be and provide a rational solution under intense competition.

Chao and Liou [4] developed a probabilistic approach to determining the minimum markup based on minimization of overall loss risk. Chao [5] proposed a fuzzy logic model for determining the minimum markup that incorporates the position of the bidder. These two models considered the chance of winning versus the risk of making a loss in evaluating various bid levels, but they did not include the contractor's overhead cost in the scope and neither did they establish a connection between project attributes and the probability of winning for a bid. A case-based reasoning model for supervision cost estimation was developed by Chen et al [6], but it did not cover other overheads. Chao [7] developed a decision support system approach for estimating the overhead rate from project attributes, but it did not cover the markup to be applied in a bid.

Clearly, there exists a gap among existing models. The present research aims to develop an improved bidding model that incorporates the bid position for determining the minimum overhead-cum-markup rate $r^{\#}$ for a project in competitive bidding so as to prevent an inadequate bid. The proposed model is built upon previous researches by Chao [5] on fuzzy logic for bid markup determination, Chao [7] on overhead rate estimation, and Chao and Kuo [8] on the probabilistic approach to determining the overhead-cum-markup rate. The reason for using fuzzy logic is that it is tolerant of imprecise and uncertain data and appears potentially useful for modeling consistently the difficult and risky overhead-cum-markup rate decision, in which the bidder's position plays a large part.

## 2. Description of proposed model

The first step of the model is to estimate the probabilities of winning ($P_w$) for various $r$ applied in the bid for a project. One estimating method is based on assuming a normal probability distribution for the ratio of the winning bid ($b^*$) to $\bar{d}$. The estimate of $P_w$ for $r$ applied on top of $\bar{d}$ can be made as a parallel to that of the probability of