

Bidding AHP Model for Iranian Construction Contractors to Select the Best Bidding Project

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Abstract

In today's competitive environment of construction industry, bidding decision is highly important. Selecting one or several projects among all possible options and winning them without considering systematic bidding decision process may seriously endanger the profit of construction contractors. For any project, contractor should intelligently and rationally decide on bid/no bid. To make a rational decision that maintains both long and short term profit of the company, all factors that may affect contractor's decision to bid/no bid for a project should be considered and evaluated. In this paper by reviewing available literature and also gathering opinions of experienced contractors, 38 factors are selected as the most important factors affecting bidding decision making of construction contractors in Iran. These factors are categorized under 11 categories and 4 groups. All factors are weighted by experienced contractors by distributing questionnaires. All participants are ranked as first-grade contractors by Iran President Deputy Strategic Planning and Control (IPDSPC) and undertake large size projects. Then, analytical hierarchy process method (AHP) employed to produce a model for prioritizing bidding opportunities. In this method, the weight of each factor is achieved by pair comparison logic. The proposed model helps contractors involved in construction projects in Iran to prioritize bidding opportunities and make the best decision to bid/no bid for a project considering resource limitations and companies' strategy.

Keywords

Bid/no bid, decision making, analytical hierarchy process, Iran

1. Introduction

With each bidding opportunity, the contractor should decide on a rational basis whether he should join the bidding or not. To make such a decision, the contractor should evaluate all factors that will affect his bidding decision such as Project related factors, company related factors, portfolio and correlation factors, and market rules related factors (Moosavi 2011).

Entering and winning a bid at a certain project without considering the importance of the bid/no bid decision- making process may lead to quality problems and huge losses to the contractor.

Although the determination of the factors that affect bidding is very important, the contractor should be careful in selecting the decision support model that he is going to use to analyze those factors, insuring a rational basis for bid decision.

The bid/ No- bid decision is very important as it has profound effects on day- to- day operations and the long term performance of the construction firm (Ahmed 1990).

1,1 Problem Statement

It was evident from the findings of a questionnaire survey conducted among US top 400 contractors in 1986 as well as Iranian 150 contractors in 2011 that the bid/No – bid decision was made without any reasonable basis Ahmed 1968; Moosavi 2011).

The basis upon which decisions should be made is usually not clear to bidders. The usual practice is to make bid decisions on the basis of intuition derived from a mixture of gut feelings, experience, and guesses (Moosavi 2011). Joining and winning a bid without weighting the bidding decision on a rational basis may prevent the sequence of difficulties, which may prevent the contractor from fulfilling his/her contractual obligations fully and bid offers represent a substantial loss of investment.

The complexity of the bid/ No- bid decision problem is so overwhelming that even experienced contractors feel that the industry should have a better technique for arriving at bid decisions (Moosavi 2011).

1,2 Research Objective, Scope and Limitations

The objective of this research is to develop a structured methodology supported by a computerized decision support model to help contractors to make their decision on bid/ no bid.

2. Previous Studies

This chapter covers the literature related to the Bid/no-bid decision problem and the applications of Analytic Hierarchy Process (AHP) in construction industry.

2.1 Bid/No-Bid Decision Problem

Researchers have been concerned with the problem of bidding strategy since the mid-1950s, when Friedman (1956) proposed a competitive- bidding strategy model with the objective of maximizing the total expected profit. The difficulty in determining the expected profit lies in determining the probability of winning as a function of the bid amount. The probability of winning can be determined when there is enough previous data to establish a bidding distribution curve of potential competitors. The probability of being lower than a certain competitor by bidding X is the area to the right of the ratio X/C on that competitor bidding distribution curve, where C represent the estimated cost of fulfilling the contract. The probability of beating a known number of competitors is the product of probabilities of beating those

competitors separately. In the case of unknown competitors, Friedman suggested the use of the average bidders bidding distribution curve. Also, he demonstrated how his method can be applied when bidding on a single contract or on several contracts simultaneously.

Gates (1967) treated seven different competitive bidding situations. Some of the strategies are foreseen by one contractor against competing contractors, and some can be used by contractors against the owner. The concurrent use of some of those strategies is also possible. For example, unbalanced bid strategy can be used with known bidders strategy. The most frequent situation is when the contractor bids against two or more competitors. Gates illustrated the use of each strategy by an example.

Benjamin (1979) reviewed the features of the Gates and Friedman models and traced the controversy between a numbers of writers who evaluated the correctness of these models in competitive bidding for construction contracts. He described a Monte Carlo simulation experiment performed at the University of Missouri-Columbia to compare results obtained by the application of both models to an actual sequence of jobs. He concluded that Friedman's model always finds a smaller optimal markup to apply to the cost estimate than does Gates' model and the probability of winning at the optimal markup is less by Friedman than by Gates.

Based on the basic modeling approach of Friedman, Sugrue (1980) provides the practicing decision maker with an easily implemented method of approximating the bid which will maximize the expected value of the bid. Implementation of the model would require the compilation of past bidding data in order to compute estimates of the mean - and standard deviation of the distribution of the lowest competitor bid to cost ratios.

Carr (1982) presented a general bidding model which is not limited to the assumptions on which Friedman and Gates models depend and it is applicable to any competition for which a contractor's cost distribution and opponents' bid distributions can be estimated. He claimed that his model fits the construction industry better than Friedman's model, because construction contractors' relative costs are random variables and represent the major variation among bids. Friedman's model is applicable to those competitors whose relative costs are constant and whose bids vary only in their markups.

The problem situation is simplified in models presented above by assuming that profit is the only consequence and the index to be maximized is the expected value of profit.

Willbrock (1973) provides guidelines which can be used to determine the utility functions of contractors involved in bidding situations. He presented a set of axioms that should be satisfied to guarantee utility function for the contractor's decision maker. He demonstrated graphically three basic shapes of utility function that can represent a contractor preference in different economic conditions. He illustrated by an actual example on how the utility functions of a contractor can be obtained. The resulting utility functions of the contractor in the example indicated that he tended to be risk averse when confronted with markup decisions on large size projects and inclined to gamble when making decisions involving small or large markup on small size projects but risk averse in situations which represented a favorable markup level.

Moselhi (1993) developed a decision-support system that aids contractors in preparing competitive bids in building projects. The system used neural networks for markup estimation that derive solutions for new bid situations based on analogy with past projects information. The system also provides the decision maker with some indications about the implications of the mark-up decision. These indications are win/lose possibility, estimated difference between the winner and second-lowest bidder, anticipated actual profitability project potential for change orders and claims, and expected extension of duration.

From what was presented in the literature, it is found that the problem has always been treated as one of determining the probability of winning. Although determining the probability of winning is an important part of a bidding strategy, but it is not all. It should come as the second stage, since the contractor's first stage is to decide whether to bid or not to bid on a certain bidding opportunity. The bid/ no bid decision

should reflect the contractor's preference. Very little, if any, attention has been given to the preference of the contractor.

Ahmed (1988) presented the findings of a questionnaire survey conducted among the US top 400 contractors. The purpose of the survey was to identify the factors that affect bid decision. Eight factors were identified.

Abdul-hadi (1990) investigated the factors affecting bid/no -bid and markup decisions and studied their relative importance to contractors operating in Saudi Arabia. Thirty seven factors affecting the contractor's decision to bid or not to bid on a certain project were identified. These factors were classified into - project characteristics, project documents, company characteristics, bidding situation, and the economic situation.

By using 38 factors obtained in a research by Abdul – Hadi, Abdullah (1995) provided an actual model for Saudi contractors by using AHP technique.

2.2 The Analytic Hierarchy Process (AHP) Applications in Construction

The practical nature of the AHP for solving complicated problems has led to applications in highly diverse areas and has created a voluminous body of literature (Fatemeh 1986). Some specific applications of AHP were listed by Fatemeh (1986) & Vargas (1990).

In the engineering field, Hanratty (1992) illustrated the use of AHP for solving the problem of a chemical laboratory reactor selection. AHP was utilized to discriminate between many different reactor configurations. Mitta (1993) used AHP to rank a set of five computer interfaces designed for an automated part recognition system. The objective was to rank these interfaces on the basis of the user's perceptions regarding two interface characteristics: usability and learn ability.

In the construction industry in specific, Reza (1988) proposed an integrated approach to project evaluation and selection. He overcame the drawbacks at goal Programming by using AHP to set priorities and trade-offs among objectives. Mustafa (1991) overcame the limitations of the traditional approaches currently used by contractors to assess project risks during the bidding stage, by using AHP. He applied it in the assessment of the riskiness of constructing Jainuna multipurpose bridge in Bangladesh.

Jeffery (1994) described a practical means for integrating technical, cost, and schedule risk components in a project management environment. The methodology depends on AHP as basis for eliciting utility functions representing the project manager's relative preference for technical, cost and schedule success.

John (1990) used AHP to view competitive bidding from a multiple criteria optimization perspective in which he considered capital exposure, work force continuity, risk reduction and profit as the decision maker's total utility.

Ibrahim (2005) provided a decision support system to select proper project delivery method by using AHP.

By utilizing AHP, Saut Gunham (2005) provided US construction companies with a model for decision to expand into international market.

3. Methodology

3.1 Factors Affecting the Bid/No-Bid Decision Problem:

Through review of the literature was conducted for the purpose of assessing the factors that will affect contractors' bid/No-bid decision in Iran.

These include both the contractual internal and external factors. By aggregating experts' opinions, the methodology will use the list of reported factors in the research (Moosavi 2011).

Through literature review, thirty eight potential influence factors grouped into eleven categories and four groups were found that can affect the contractors bid/ No-bid decision in Iran (Moosavi 2011) as shown in table 1. By devising a questionnaire, the identification of the relative importance of these factors was carried out via structured interviews with selected experts to make sure that the survey result had enough practicality and were realistic. In addition, the number of agencies which could be contacted by mail was not enough to secure a representative number of replies, therefore, structured interviews were conducted with selected experts from the industry who fulfilled conditions such as 15 years experience in the construction industry and at least 5 years of experience in bidding field. Experts were selected from top ranking constructions firms qualified by Iran president Deputy strategic planning and control (IPDSPC).

Sixteen interviews were carried out for this purpose. An analysis was carried out using the AHP approach to determine their relative importance.

3.2 Concept of Analytical Hierarchy Process (AHP)

Thomas Saaty (1988) developed the mathematical foundations of the analytical hierarchal process (AHP) at the University of Pittsburgh. With the advent of the personal computer during the 1980s and 1990s, this decision support tool, as implemented in several software packages, especially Expert choice developed by Forman, Saaty, Selly and Waldron (Forman, 2000) has become very popular. Increasingly, AHP's power has been validated in empirical use. Chang, Ibbs and Crandall (Chang, 1992) extended by research and expanded by new theoretical insights as reported in series of international symposia devoted to AHP.

Professional Expert Choice (2000) was implemented to develop the proposed decision system for solution bid/ no – bid in this paper.

In professional Expert choice, the decision - maker first structures the problem into different hierarchical levels. Top down structuring is best used when the objectives are more known than the alternatives.

The model is built from the top starting with the groups (most general objectives), the objectives, then the more specific (sub- objectives), and finally the alternatives of choice. At the top of the hierarchy, the goal of the decision can be clearly stated, which is defined in this paper as the "bid/ no – bid decision".. Then, the evaluation groups, criteria which were called objectives and sub- criteria are clearly represented.

Four groups are included in the first level of hierarchy and then eleven objectives are in the second level and 38 sub- objectives in the third level, as shown in Table 1.

Table 1: Factors affecting the Iranian contractors' strategic decisions on the decisions on the bid/Nobid problem

Project related factors					Company related factors		Portfolio and correlation related factors	Market roles related factors		
Bid conditions	Client	Consultant	Project specifications	Monetary issues of project	Company strategies	Company recourses	Interaction between projects and project port folio management considerations	Interior conditions and rules	International conditions and rules	Market conditions
Bid type (open, limited, negotiated)	Client's characteristics (credit, reputation, open insight, honesty, technical know-how, managerial capability)	Consultant's characteristics (credit, reputation, independence, authority, managerial capability, technical knowledge)	Project location and geographical situation	Rate of project profit compared to the Amount of other profitable projects currently in progress within the market	Project type and its homogeneity with predefined company's strategies, policies and vision	The existence of skilled and technical labor and the need to employ labor with certain specialties	Project geographical proximity to previous ongoing projects	Disability in governmental laws, regulations and policies	International sanctions and their impacts on purchase, opening LC, procurements, importation and exportation of goods and machineries	Availability of project needed basic goods (i.e. cement and iron)
Type and number of competitors	Cooperation background with client (or lack of it)	Existence or nonexistence of proper and qualified consultant for contribution (in EPC and DB contracts)	The number of challenger on project execution path Project	Contract price or project size	Public exposure (Project importance to acquire credit, prestige, ranking promotion, resume and future of the company and its impact on getting new markets and proper relations with project client)	Possessing enough number of qualified managerial staff	concurrent deployment of resources (technical and managerial forces, labor, equipment, machineries)	Customs laws which may make problems in this project	Stability of political situations, monetary status and laws of host country (in overseas projects)	Availability of the required materials and equipment within the region
Distrust to bid health and existence of rent and cross-legal factors in getting projects	Client's financial capacity and well record in paying statements on time (decreasing the risks of capital investments)		Project technical complexity and certain technology which should be utilized in construction	The method of payments and its impact on cash flow and turnover	Senior managers' supports	Having qualified materials and equipment suppliers	Contractor's capacity and the need to a new project	The existence of some Cumbersome laws (labor laws, taking approvals and permissions, ...)	The relations between Iran and host country especially banking relations (in overseas projects)	The existence of work in the market and the possibility of work existence in future
	The importance of the project for client		The rate of need to special machineries and equipment and costs of their purchase or rent			Having qualified subcontractors	Sameness of client or contractor with exiting and ongoing projects of the company	Government shifts (presidency elections)		
			Availability of required qualified labor within the region (especially in oversea projects)							

Table 2: Linguistic measures of importance (Saaty, 1988)

Intensity of importance (1)	Definition (2)
1	Equal importance
3	Weak importance
5	Strong importance
7	Demonstrated importance
9	Absolute importance
2,4,6,8	Intermediate values

Once the hierarchy structure is established, the decision - making process takes place. The decision- maker derives ratio- scale (as shown in Table 2) priorities reflecting the relative importance of sub- objectives via pair-wise comparisons with respect to the goal of the problem. Similarly, the decision- maker derives ratio- scale priorities reflecting the relative preference of alternatives relative to each sub- objective. Finally, the judgments are further synthesized to provide a ranking of the alternatives for the best choice. A further refinement of these decisions is provided by sensitivity analysis. Sensitivity analysis enables the decision- maker to see how the final priorities will be affected by changes in the relative importance of the sub-objectives. In Expert choice this option is supported by graphics.

3.3 Scoring Affecting Factors Method

Initially, 11 homogenous matrices were constructed for 38 affecting factors on bid/ no – bid decision shown in table 1. Then, all experts were asked to score in the format of pair wise comparison for all factors in each matrix. For example, if a respondent thought "bid type (open, limited, negotiated)" is five times more important than "type and number of competitors", the response would be

5 bid type (open, limited, negotiated)
Type and Number of competitors

If a respondent thought "type and number of competitors" is three times more important than "bid type (open, limited, negotiated)" is five times more important than "type and number of competitors ", the response would be

3 type and Number of competitors
Bid type (open, limited, negotiated)

4. Finding and Discussion

Obtained average values from pair wise comparisons for all matrices were inserted into Expert Choice software. The obtained overall significant ratio was 0.06. It is less than 10% ratio suggested by Saaty (1988) which proves that all judgments are rationally significant. Any matrix-related factors are discussed in next paragraphs.

4.1 Project Related Factors

Bid conditions related factors: a 3×3 matrix was drawn. The most important factor is "distrust to bid health and existence of rent and cross – legal factors in getting projects" with a relative weight of 36.15% followed by "type and number of competitors" with a relative weight on 33.11% and "bid type (open, limited, negotiated)" all computed by Expert Choice.

The important point is that in interviews with experts, "distrust to bid health and existence of rent and cross – legal factors in getting projects" is also considered as a vital factor due to experiences of Iranian contracting firms.

Client related factors: based on Expert Choice computations, the most important factor is "client's financial capacity and well record in paying statements on time (decreasing risks of capital investments)" with a relative weight of 31.60% followed by "client's characteristics (credit, reputation, open insight, honesty, technical know – how, managerial ability)" with a relative weight of 24.43%, "cooperation background with client (pr lack of it)" with a relative weight of 22.14% and "the importance of project for client" with a relative weight of 21.76%.

Due to financial problems and not paying a part of receivables from previous clients, many Iranian contractors evaluate client's financial capability through asking other contractors who have records of cooperation with client. Experts believe timely nonpayment by clients has caused close-off and downsizing. Hence, contractors prefer not to bid if they understand in their researches before bidding decision that client suffers weak financial capability.

Consultant related factors: according to contractors, high important traits of consultants are technical knowledge and reputation. Consultant's technical knowledge can highly facilitate project construction when project faces with paramount technical complexities. Most contractors are interested in cooperating consultants with high credit, reputation and technical knowledge. Based on Expert Choice computations, the most important factor is "consultant's characteristics (credit, reputation, independence authority, managerial capability, technical knowledge" with a relative weight of 52.80% followed by "existence or nonexistence of project and qualified consultant for contribution (in EPC and DB contracts)" with a relative weight of 47.11% are consultant related factors which affect on bid/ no – bid decision.

Project specification related factors: all experts emphasize that geographical location play an important role in contracting firms' bid decision. Access roads and climate of project site decrease the tendency of some contractors to bid. The existence of various challenges leads into delays in starting project operation. In the meantime, in project life cycle, challenges are always considered as problem factors. Experts pose less priority on technical complexity, the rate of need to special machineries and availability of qualified labor than project locate and possible challenges. On this basis, the most important factor is "project location and geographical situation" with a relative weight of 26.91% followed by "the number of challenges on project execution path "with a relative weight of 23.00%, "project technical complexity and certain technology which should be utilized in construction" with a relative weight of 19.09%, "the rate of need to special machineries and costs of their purchase or rent" with a relative weight of 17.55%, and "availability of required qualified labor within the region (especially in oversea projects) with a relative weight of 13.40%.

Monetary issues of project related factors: turnover is highly important for contracting firms. To the same reason, the most important factor computed by Expert Choice is "contract price and project size" with a relative weight of 40.22% followed by "the method of payments and its impact on cash flow and turnover" with a relative weight of 31.17% and "rate of project profit compared to the amount of other profitable projects currently in progress within the market" with a relative weight of 28.59%. According to experts, contracting firms pay more attention to client's payment methods than project profit to survive, because that if project is highly profitable but the client makes paramount delays in payments, project profit would

decrease seriously due to fluctuation rate in project life cycle and in some case, the project would come to an end by financial losses.

4.2 Company Related Factors

Company strategies related factors: Usually, many Iranian contracting firms are operating in their specialized field. For example, if a firm has a 30-year experience in building construction sector, it regulates its policies and specialties homogenous with building construction field and/or if a company has a long term record in dam-building, it devises its outlook for this field. Hence, according to computations by Expert Choice, "project homogeneity with predefined company's strategies, policies and vision" with a relative weight of 35.97% as an affecting factor on bid decision by contracting firms' senior managers. On the other hand, experts believe that contracting firms need to enhance their ranks in order to increase that capability to obtain new projects so the second important factor is "public exposure (project importance to acquire credit, prestige, ranking promotion, resume and future company and its impact on getting new markets and proper relations with project)" with a relative weight of 33.33%. Considering the strategies of any company, managers treat various projects differently and they usually play the role of leader and balancer. So, the third important factor is "senior managers' supports" with a relative weight of 30.66%.

Company resources related factors: according to experts, the existence of qualified and experienced managers in different levels leads into contracting firms' remarkable growth and blossom. Qualified managers who dominate managerial techniques are able to use the full capability of their subordinated experts and this is a winning factor for all contracting firms. Hence, based on Expert Choice computations, the most important factor "possessing enough number of qualified managerial staff" with a relative weight of 24.53 followed by "the existence of skilled and technical labor and the need to employ labor with certain qualities". According to experts, the availability of material suppliers is a local challenge in many projects. Sometimes, it is observed that suppliers collude to enforce project owner to purchase more expensive materials. In many constructing companies, human resources non development and the availability of subcontractors are considered as affecting factors on bid decision. So, "having qualified materials and equipment suppliers" rated third with a relative weight of 22.14% and "having qualified subcontractors" rated fourth with a relative weight of 20.70%.

4.3 Portfolio and Correlation Related Factors

The possibility to establish and balance financial and human resources and experiences of company in this project and other ones: All experts believed that simultaneous usage of resources, geographical proximity between projects and client's sameness are highly affecting on profitability. However, these three factors are conditioned to contractor's blank capacity whose importance is less than other three factors. Based on Expert Choice computations, the most important factors is "concurrent development of resources (technical and managerial forces, labor, equipment, machineries)" with a relative weight of 29.91% followed by "project geographical proximity to previous ongoing projects" with a relative weight of 24.87%, "sameness of client or contractor with existing and ongoing projects of the company" with a relative weight of 24.73% and "contractor's capacity and the need to a new project" with a relative weight of 20.53%.

4.4 Market Roles Related Factors

Interior conditions and rules related factors: presidency election and government shifts are considered as a vital and key factor in construction plans defined by ministries. By government shifts, many contractors either grow increasingly or become large and wealthy or they are highly weakened so that they are destroyed in some cases. Instability of governmental laws and policies also play a vital role for Iranian contractors. According to experts, the existence of problematic customs laws and cumbersome regulation can partly impact on bid decisions. Based on Expert Choice computations, the most important factors is "government shifts (Presidency elections" with a relative weight of 32.10% followed by "disability in governmental laws, regulations and policies" with a relative weight of 30.22%, "customs laws which may make problems in this project" with a relative weight of 19.46%, and "the existence of some cumbersome laws (labor laws, taking approvals and permissions)".

International conditions and rules related factors: according to experts, international sanctions, stability of monetary situation of host country and banking relations between Iran and other countries are almost close to each other in terms of their importance. Thus, based on Expert Choice computations, the most important factors is "stability of political situation, monetary status and laws of host country (in overseas projects) with a relative weight of 33.65% followed by "the relations between Iran and host country especially banking relations (in overseas projects)" with a relative weight of 33.30% and "international sanctions and their impacts on purchase, opening LC, procurements, importation and exportation of goods and machineries". Paramount problems on opening LC by Iranian contracting firms has caused that they loose the opportunity of building construction in many countries.

Market (domestic/international) conditions related factors: according to experts, the survival of a contracting firm depends on the existence of work in the market. In the meantime, supplying basic goods such as cement and iron are also influential. Hence, based on Expert Choice computations, the most important factor is "the existence of work in the market and the possibility of work existence in future" followed by "availability of project needed basic goods (i.e. cement, iron)" and "availability of required materials and equipment within the region."

5. Conclusion

In present study, the findings of a questionnaire were used to which 70 Iranian contractors responded.

By accumulating experts' opinions, 38 affecting factors were selected from total 78 identified factors in a research by Moosavi Seyed Hamed (2011). These factors were categorized into 4 main groups and 11 subgroups.

An analytical approach was implemented by using AHP to identify the relative importance of various affecting factors on bid/no bid decision. A questionnaire was devised and 38 selected factors via interviews with experts were weighted by pair wise comparisons (between 1 and 9).

Factors' relative weights were computed by Expert Choice software. The most important factors in all 11 main groups include:

- Distrust to bid health and existence of net and cross – legal factors in getting projects

- Client's financial capacity and well record in paying statements on time (decreasing the risks of capital investments)
- Consultant's characteristics (credit, reputation, independence, authority, managerial capability, technical knowledge)
- Project location and geographical situation
- Contract price or project size
- Project type homogeneity with predefined company's strategies, policies and vision
- Possessing enough number of qualified managerial staff
- Concurrent development of resources (technical and managerial forces, labor, equipment, machineries)
- Government shifts (presidency elections)
- Stability of political situation, monetary status and laws of host country (in overseas projects)
- The existence of work in the market and the possibility of work existence in future

Iranian contractors should develop certain strategies to survive and prosper in Iranian economic system. The existence of a proper strategy prevents scattering of construction firms. Identifying affecting factors as well as paying attention to their weights help senior manager to avoid irrational bid/no bid decisions. They can select the ideal bid through a smart decision and enter a competitive environment.

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