

Identifying the Weights Assigned to the Key Bidding Factors by Different Groups of Construction Companies

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In today's competitive business environment, every construction company needs to make the important and complex decision of whether to bid on a project or not; or which project(s) to bid on among candidates. Given that bidding decisions are critical for construction companies, investigating bidding strategies has been a focal point of researchers since the mid-1950s. The purpose of this study is to identify how much value/weight different groups of construction companies (which have been grouped based on their similar attributes) assign to the key bidding factors. For this purpose, 14 key bidding factors were identified based on the literature and a survey instrument was developed and sent to 481 construction companies in the United States. The weights of importance assigned to the key factors by the respondents were combined under each contractor type, sector, and size groups using Group Analytic Hierarchy Process methodology. The results showed that most of the contractor groups under each classification (i.e., Contractor Type, Contractor Sector and Contractor Size) put more value on the overall firm related-internal factors than the overall project related-external factors and that the project duration key factor has the lowest weight for all contractor groups other than the small size contractors.

Key Words: Bidding, Multi Criteria Decision-Making, Group Analytic Hierarchy Process, AHP

Introduction and Purpose

In today's competitive business environment, every construction company needs to make the important and complex decision of whether to bid on a project or not; or which project(s) to bid on among candidates. Bidding decisions are important because poorly made bidding decisions could cause severe and irrevocable problems. For example, not bidding a favorable project could result in lost opportunities for companies to make profit, improve contractor's strength in the industry, and establish a long-term relationship with a new client. On the other hand, bidding a project that actually does not fit the company's profile requires a lot of time, effort, and commitment without a favorable outcome (Ahmad 1990, Wanous et al. 2003). Bidding decisions are complex because the decision-makers need to consider many intangible and tangible factors (Mohanty, 1992).

Given that bidding decisions are critical for construction companies, investigating bidding strategies has been a focal point of researchers since the mid-1950s. The review of literature shows that most of the research focused on the determination of the key factors that influence bidding decisions and the development of supportive decision-making models. To date, more than 100 key factors have been determined and simultaneously, to expedite the process, numerous decision-making models have been proposed. However, there is not much literature on how much value/weight different groups of construction companies assign to those factors. The purpose of this study is to identify how much value/weight different groups of construction companies (which have been grouped based on their similar attributes) assign to the key bidding factors. As such, this study identifies commonalities and differences across the contractor groups in terms of how much value they assign to the key factors that are commonly utilized to make bid/no bid decisions.

Review of Literature

Given the fact that strength of construction companies in the industry partly depends on successful bidding decisions; investigating bidding strategies has been the topic of research since mid-1950s. For this purpose, more than 100 factors that influence bidding decision have been identified; and to simplify the bidding decision process, various bidding decision models have been offered. Bid/No Bid Models can be classified into three categories in the literature (Oo, Drew, & Lo, 2007). Those are:

1. Multi-attribute decision making models
2. Artificial intelligence-based models
3. Statistical models

The first known model was proposed by Friedman (1956), which was concerned with the issues related to the probability of winning and estimating the optimum bid amount by using probabilistic approaches. Since then numerous bid/no bid decision support models have been introduced. Some of those were based on Friedman's (1956) point of view to guide contractors in their bidding decisions, while others have taken a different approach.

Ahmad & Minkarah (1988) discussed inapplicability of the probability models by asserting the heuristic nature of the bidding environment and conducted a survey among 400 general contractors in the USA and determined 31 factors that affect decision making process. Shash (1993) modified the questionnaire by Ahmad & Minkarah (1988) and identified 55 factors affecting decision-making process. The measurement of the factors were made by using "Importance index" and the highest ranked factors that influence contractors bidding decisions were reported as "Need for work", " Number of competitors tendering" and "Experience in such projects". Bageis & Fortune (2009) criticized Ahmad & Minkarah (1988) and Shash's (1993) studies due to the lack of testing in the models based on the various weights of the respondents. 87 factors were determined based on the literature and supported by the pilot interviews. Chua & Li (2000) criticized the reasoning methods of the Ahmad & Minkarah (1988) and Shash's (1993) studies and identified four sub goals that relate to the bid/no bid decision-making process. Those sub goals are: competition, risk, need for work and company's position in bidding. Mohanty (1992) used Analytic Hierarchy Process (AHP) and determined 15 key factors. Jarkas, Mubarak, & Kadri (2014) identified 43 factors based on the literature review and conducted a survey within the contractors in the State of Qatar. The findings of the study showed that "employer" related factors have the most influential affects on the bidding decisions, while the other main groups were ordered by their importance as the following "contractor", "bidding situation", "contract" and "project". El-mashaleh (2010) proposed the Data Envelopment Analysis (DEA) approach to guide decision-makers in their bidding decisions. In DEA, an "efficient frontier" is created based on organizations' historical data and used to identify favorable projects to bid.

Wanous, Boussabaine, & Lewis (2003) implemented a model by using artificial neural network (ANN) based on 157 real-life projects from Syrian construction companies. 18 key factors were determined through a survey and supported by interviews. The accuracy of the model was found to be 90% for the selected Syrian construction projects. It is important to note that the "accuracy of the model/system" term is used consistently throughout this paper and defines how accurately the models are able to simulate actual bid/no bid decisions. Chua, Li, & Chan (2001), used Case-based Reasoning (CBR) approach by focusing on two reasoning factors namely, Risk and Competition. Egemen & Mohamed (2007) investigated the factors that affect bidding and mark-up decisions of the 80 Northern Cyprus and Turkish construction firms. For the final model, 50 and 44 factors were included in the framework, respectively. The results showed that bidding and mark-up decisions of the small and medium sized companies were significantly different. "Strategically Correct Bid/No Bid and Mark-up Decision" (SCBMD) decision-making tool was also created by Egemen & Mohamed (2008) to contribute to the field of study. 79 questions were nested into the system under eight subgroups to provide bid or no bid advices and markup percentages to contractors. 100 real bidding cases were gathered from Northern Cyprus and Turkish construction companies to validate the study and the accuracy of the system was noted as 86%.

A parametric solution was offered by Wanous, Boussabaine, & Lewis (2000) by determining 18 factors. For this purpose, the data was gathered from 182 Syrian companies and the final model was tested with 20 real bidding cases. The accuracy of the model was found to be 85%. Lowe & Parvar (2004) also determined 21 factors based on the literature review and conducted correlation analysis between the factors and decision to bid. Based on the results, a significant positive linear correlation was found for eight key factors and the contractors' decisions to bid a project. Those factors are strategic and marketing contribution of the project, competitive analysis of the tender environment, competency-project size, competitive advantage-lowest cost, resources to tender for the project, feasibility of alternative design to reduce cost, external resources, and tendering procedures. Oo et al., (2007) investigated unobserved heterogeneity across 18 contractors by implementing random coefficients logistic model. In the study, it was found that there is a significant difference between the contractors' bidding preferences and responses to the factors that affect their bidding decisions even though they were provided with the same bidding conditions. The study was not built on experimental data; however, it provided another approach for contractors to strategize bidding decisions by considering the unobserved heterogeneities of their competitors. Type of client, type of construction work, and size of construction work factors were selected as target key factors; and their impact on the competitiveness of a Hong Kong construction company were investigated by Drew, Skitmore, & Po (2001). Quadratic regression models were created for this purpose and the models were fitted based on 100 bidding proposals from the same company. Oo, Drew, & Lo (2008) conducted the bidding experiment methodology and compared Singapore and Hong Kong construction contractors' decisions based on different market conditions. The results showed that even though there is remarkable similarities between Singapore and Hong Kong bidding conditions, the decision of the contractors in those cities were significantly different in response to the booming and recession conditions.

Methodology

This study identified how much value/weight different groups of construction companies assign to the key bidding factors. As will be discussed later, such groups of construction companies were formed based on those companies' similar attributes. For the purpose of this research, first, a comprehensive literature review was conducted; the identified factors from various pieces of research (Bageis & Fortune (2009), Wanous et al. (2003), Ahmad & Minkarah (1988), Shash (1993), Chua & Li (2000), Mohanty (1992), and Oo et al. (2007)) were listed side by side. To reduce the number of the factors identified in the literature, 46 consolidation groups were created by taking the factor similarities into consideration. The more influential factors on bidding decisions were identified depending on the analysis conducted in those studies (e.g., Principal Component Analysis, Importance Index, Analytic Hierarchy Process). The reader is referred to Akalp (2016) for a detailed description of this process. As a result, 14 most-commonly identified and utilized key bidding factors were determined, and grouped under two main headings as firm-related and project-related factors as shown in Table 1.

Table 1. The key factors that affect bid/no bid decision as determined from the literature review

Firm Related (Internal) Factors	Project Related (External) Factors
1) Current workload	8) Project size
2) Experience in similar projects	9) Project duration
3) Availability of equipment, materials and human resources	10) Location of the project
4) Financial ability	11) Project type
5) Need for work	12) Contract conditions and type of contract
6) Technical knowhow	13) Owner identity
7) Compliance with the business plan	14) Competition

In the second step of the study, the weights of importance given to the above mentioned key factors by different construction companies were identified. Analytic Hierarchy Process (AHP) is used as the main approach in this study to be able to identify the weights of importance construction companies assign to different bidding factors. AHP is a multi-criteria decision making model that was developed in the mid-1970s; it has been used as a subsidiary decision-making tool to solve complex decision-making problems since then. To date, it has been used in various industries for different purposes such as choosing best policy alternative, allocating resources, ensuring system stability, and conflict resolution (Saaty & Vargas, 1991). In the AHP methodology, the problem is divided into hierarchies; the elements under each hierarchy can be named as level, cluster or stratum; the top element is the goal of the decision. More discussion on AHP methodology can be found in Saaty (1980). The AHP methodology is also a very commonly used methodology in the construction industry. Jato-Espino et al. (2014) revealed that AHP is the most commonly used decision-making tool used in construction for both single and hybrid approaches.

As a part of the AHP process, a survey instrument (the pairwise comparison tool) was developed and sent to construction companies. The survey instrument (see Figure1) composed of pairwise comparisons of the 14 key factors and resulted in 43 pairwise comparisons (including the pairwise comparison of Firm Related-Internal and Project Related-External factors at an upper level). Under two main hierarchy levels, the pairwise comparison list were provided in the excel format. The pairwise comparisons were constructed by using the columns, named A and

B; and the respondents were asked to identify which factor is more important to consider (when bidding on a project) using those columns. The 1-9 AHP scale options (see Saaty & Vargas (1991) for a detailed explanation of the AHP scale) were also provided as a dropdown menu list and the respondents were asked to indicate their scale selections indicating the degree by which one factor is more important than the other one. In Level 1, the respondents were asked to compare Firm Related-Internal and Project Related-External Factors in general. In Level 2-A, the pairwise comparisons of the firm related internal factors were provided, while the comparison of the project related external factors were completed in Level 2-B. Due to page limitations, only Level 1 and a part of the Level 2-A comparisons are presented in Figure 1.

Levels	Factors		More Important Factor	Scale
	A	B	A or B	(1-9)
Level 1	Firm Related-Internal Factors	Project Related-External Factors		
Level 2-A Firm Related Internal Factors	Current workload	Experience in similar projects		
	Current workload	Availability of equipment, materials and human resources		
	Current workload	Financial ability		
	Current workload	Need for work		
	Current workload	Technical knowhow		
	Current workload	Compliance with the business plan		

Figure 1. Pairwise comparison tool.

The sample was selected from construction companies who have a relationship with the Department of Construction Management at Colorado State University; and the pairwise comparison tool was sent to 903 individuals (representing 481 construction companies). As a result, a total of 48 responses were collected. While the response rate was low, no statistical inferences were made. The demographic information of the participants was also collected to be used in the analyses. For this purpose, a Company Profile Questionnaire was provided to the respondents along with the pairwise comparison tool. A detailed breakdown of the demographic characteristics of the respondents and more information about the Company Profile Questionnaire can be found in Akalp (2016).

The demographic data was utilized to separate the respondents into groups based on the following three different main classifications:

- Contractor type (i.e., general contractor vs. subcontractor),
- Contractor sector (i.e., residential, commercial, industrial, and heavy/highway), and
- Contractor size, which was determined based on the quartiles of revenue (i.e., small, small-medium, medium-large, large size).

The data was first collected with the pairwise comparison tool individually from each respondent representing different construction companies. Then, individual weight given to each factor by each respondent was calculated using the AHP process. Finally, using the Group AHP process (Saaty 1989), for each factor, the weights given to that factor by multiple respondents were combined into one final weight for each group under contractor type, contractor sector, and contractor size classifications.

Results

As was mentioned above, the importance weights given to the key factors by the construction professionals were collected individually and combined using the Group AHP approach into one final weight for each demographic classification for each key factor. In simple terms, the companies were grouped based on their demographics and the individual results of those companies were combined with those who are in the same demographic group using the Group AHP approach. This analysis is mainly done for three classifications (contractor type, contractor sector, and contractor size) and their groups. The combined judgments of the respondents are provided in Table 2, Table 3 and Table 4 for contractor type, contractor sector, and contractor size respectively. It is important to note that for each group, the weights assigned to each factor will add up to 1 as per the AHP methodology. In the tables below, there are just a few instances where the totals go slightly above 1 (e.g., 1.002) or slightly below 1 (e.g., 0.999) due to rounding errors. This negligible error does not affect the overall results and findings of this study.

Table 2. The Group AHP results based on the contractor type classification

	Key Factors	General Contractors	Subcontractors
Firm Related Internal Factors	Current workload	0.066	0.080
	Experience in similar projects	0.090	0.055
	Availability of equipment, materials and human resources	0.096	0.079
	Financial ability	0.074	0.067
	Need for work	0.116	0.131
	Technical knowhow	0.078	0.061
	Compliance with the business plan	0.102	0.053
	Total	**0.622**	**0.526**
Project Related External Factors	Project size	0.023	0.027
	Project duration	0.016	0.028
	Location of the project	0.031	0.086
	Project type	0.048	0.077
	Contract conditions and type of contract	0.093	0.124
	Owner identity	0.107	0.069
	Competition	0.060	0.063
	Total	**0.378**	**0.474**
	Number of Respondents	38	10

Table 3. The Group AHP results based on the contractor sector classification

	Key Factors	Residential	Commercial	Industrial	Heavy/Highway
Firm Related Internal Factors	Current workload	0.139	0.070	0.042	0.059
	Experience in similar projects	0.115	0.079	0.071	0.059
	Availability of equipment, materials and human resources	0.113	0.102	0.049	0.104
	Financial ability	0.088	0.066	0.036	0.125
	Need for work	0.125	0.118	0.078	0.115
	Technical knowhow	0.090	0.070	0.055	0.075
	Compliance with the business plan	0.062	0.118	0.056	0.051
	Total	**0.732**	**0.623**	**0.387**	**0.588**
Project Related External Factors	Project size	0.031	0.021	0.038	0.024
	Project duration	0.018	0.017	0.023	0.018
	Location of the project	0.028	0.032	0.085	0.036
	Project type	0.064	0.041	0.111	0.052
	Contract conditions and type of contract	0.041	0.107	0.122	0.090
	Owner identity	0.057	0.112	0.105	0.102
	Competition	0.029	0.049	0.128	0.091
	Total	**0.268**	**0.379**	**0.612**	**0.413**
	Number of Respondents*	5	23	7	9

* Note that the number of respondents in different groups do not add up to 48 (sample size) because there were 4 contractors whose sector could not be determined based on the responses they have provided.

Table 4. The Group AHP results based on the contractor size classification

	Key Factors	Small	Small-Medium	Medium-Large	Large
Firm Related Internal Factors	Current workload	0.075	0.095	0.060	0.041
	Experience in similar projects	0.040	0.095	0.089	0.100
	Availability of equipment, materials and human resources	0.128	0.105	0.063	0.073
	Financial ability	0.101	0.102	0.036	0.061
	Need for work	0.137	0.121	0.124	0.082
	Technical knowhow	0.047	0.092	0.066	0.084
	Compliance with the business plan	0.037	0.108	0.106	0.115
	Total	**0.565**	**0.718**	**0.544**	**0.556**

	Project size	0.030	0.016	0.030	0.023
	Project duration	0.033	0.011	0.023	0.014
Project Related External Factors	Location of the project	0.062	0.024	0.047	0.031
	Project type	0.079	0.035	0.059	0.050
	Contract conditions and type of contract	0.067	0.078	0.121	0.142
	Owner identity	0.097	0.070	0.106	0.124
	Competition	0.068	0.047	0.070	0.059
	Total	**0.436**	**0.281**	**0.456**	**0.443**
	Number of Respondents	11	13	12	12

Discussion

Based on the results provided in Table 2, Table 3 and Table 4, it was identified that the importance given to the overall firm related-internal factors is higher than the importance given to the overall project related-external factors for all but one of the contractor groups. Only the companies that belong to the industrial construction sector placed higher importance to the overall project related-external factors than the overall firm related-internal factors.

For both the general contractors and subcontractors (see Table 2), the need for work factor has the highest importance and the project duration and project size key factors have the lowest importance. The owner identity key factor has the second highest weight for the general contractors. When compared to the general contractors though, the owner identity key factor does not have as much of an importance for the subcontractors. For the subcontractors, it was found that the contract conditions and type of contract key factor has the second highest weight.

As can be seen in Table 3, the groups under the contractor sector classification do not show a pattern for the highest weights given to the key factors. As a matter of fact, companies belonging to different construction sectors value bidding key factors very differently, indicating that different sectors have different approaches in making bid/no bid decisions. Notwithstanding this, the project duration key factor has the lowest weight regardless of the sector.

In the contractor size classification (see Table 4), all of the contractor groups but one assigned the highest importance to the need for work key factor. The large size construction companies did not rank the need for work key factor as highly and instead placed the highest importance to the contract conditions and type of contract key factor, which is also an important decision-making factor for the medium-large size construction companies. This shows that as companies grow in size, they do not primarily base their bidding decisions on their need for work, but instead the suitability of contract conditions. It can also be seen that the availability of equipment, materials and human resources key factor is a significantly more important key factor to make bidding decisions for the small and small-medium size construction companies when compared to medium-large and large size construction companies. This is expected, as constraints with respect to those resources tend to diminish as the companies grow in size. Regardless of the size of the companies, the lowest weights were assigned to the project duration and project size key factors.

Conclusions

This purpose of this study was to identify how much value/weight different groups of construction companies (which have been grouped based on their similar attributes) assign to the key bidding factors. As such, this study identified commonalities and differences across the contractor groups in terms of how much value they assign to the key factors that are commonly utilized to make bid/no bid decisions. AHP is used as the main approach to be able to identify the weights of importance construction companies assign to different bidding factors. For the purpose of this research, a literature review was conducted to determine the most commonly identified and utilized factors when making bid/no bid decisions. As a result, a total of 14 key factors were determined and grouped under two hierarchies as firm-related and project-related factors. The data was collected with a pairwise comparison tool as well as a Company Profile Questionnaire. The weights of importance assigned to the key factors by the respondents were combined under each contractor type, sector and size groups using Group AHP methodology. This study is a part of a larger study in which a decision-making framework was developed to assist decision-makers with bid/no bid decisions. More information about this framework can be found in Akalp (2016).

An important finding of this study is that most of the contractor groups under each classification (i.e., Contractor Type, Contractor Sector and Contractor Size) put more value on the overall firm related-internal factors than the overall project related-external factors. It is also identified that the project duration key factor has the lowest weight for all contractor groups across all classifications with the exception of the small size contractor classification. In terms of variability within classifications, the groups under the Contractor Sector classification had the most amount of variability in how much they value different key factors. The size of the companies also has an impact on the assigned importance to the key factors as the larger size construction companies assigned higher importance to the contract conditions and type of contract key factor, while smaller size companies identified the need for work and availability of equipment, materials and human resources key factors to be more important than other factors in making their bid/no bid decisions.

Since the 1950s, many bid/no bid decision-making models have been proposed which rank influential factors on bidding decisions; however, previous models have mainly focused on the individual decision-making processes. This research contributes to the construction management body of knowledge by introducing Group AHP approach to combine the weights of importance given to the bid/no bid decision-making key factors of the construction professionals. Combining judgments considering contractor type, contractor sector and contractor size classifications enables performing analyses at the aggregate level as opposed to individual level and provide an overview of different classification of contractors with respect to how they value/weigh key factors. Given that making bid/no bid decision is not necessarily the responsibility of a single individual, but requires the judgments from a group or a committee, combining judgments of different decision-makers could provide more realistic bid/no bid decisions.

A limitation of this study is the small response rate (n=48), which prevents conducting a thorough investigation. Therefore, the findings of this study cannot be generalized to the larger population of contractors. Nevertheless, this research presents an approach which can be replicated by other researchers in the future using more data points to be able to derive more generalizable results. This research will hopefully promote further research on the topic, as additional research with more data points can help reach conclusions that are more definitive and identify more prevalent commonalities and differences across the contractor groups.

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