A QUALITATIVE BIDDING MODEL

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Competitive bidding is one of the most critical activities for contractors in the construction industry. Contractors must first decide whether to bid or not and, if the bid decision was made, a suitable mark up percentage needs to be selected. The usual practice is to make these decisions on the basis of intuition derived from a mixture of gut feelings, experience and guesses. Numerous factors are involved in this process making it very difficult even for experienced contractors to always make the right decision within the available time. Thus it is necessary to have some type of structured solution for the bidding problem.

Many models have been developed for the second part of the bidding problem, i.e. the mark up selection. However, very few publications can be found about the bid/no-bid decision, which should be made first before selecting a proper mark up. The development process of a qualitative bidding model is reported. First, the most important bidding criteria in Syria were identified and a parametric model was developed for each one. A new bidding situation was evaluated in terms of these criteria and a bidding index was produced for it. Based on this index, the model will recommend to bid or not to bid on the project under consideration. The proposed model was tested against one hundred and eighty two real bidding situations and proved 92.86% accurate in simulating the contractors' decisions.

Keywords; bid/no-bid criteria, qualitative bidding, Syria, tendering.

INTRODUCTION

Contractors' survival is strongly dependent on being able to deal successfully with different bidding situations. Bidding for an unsuitable project could result in a disaster, large losses or consuming time and resources that could be invested in more profitable projects. Not bidding for a suitable project could result in losing an opportunity to make considerable profit, improve the contractors' strength in the industry, gain a new relation with a new client etc.

Also, if a contractor decided to bid for a new project, he needs to make another difficult decision that is to determine a suitable mark up percentage for this project. Bidding for a new project commits the bidder to bid preparation costs. Thus, contractors have to be more selective in bidding to reduce these costs. The need for automated system to assist contractors in dealing with different bidding situations has resulted in research over a long period. The first half of the bidding process, i.e. the bid/ no bid decision, has received very little attention from researchers. On the other hand, many bidding models have been developed for the second half of the bidding problem, i.e. selecting the optimum mark up. These models are based on mathematical theory and attempt to simulate the real world situation. Most of the mathematical models are based on Freidman's model (1956).

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The main aim of these models is to compute the probability of winning the contract for a certain mark up. Although determining the probability of wining is an important part of the bidding decision-making process, it is not all. It should be complemented with considering the impact of many other factors. These models have not been popular amongst practitioners for various reasons, including the large amount of data-tracking and calculations required for implementing them. The usual practice is to make the decision on the basis of intuition derived from a mixture of gut feelings, experience and guesses. Numerous factors are involved in this process. Thus it necessary to have some type of structured approach to deal with it.

The main objective of this paper is to develop a qualitative bidding model to help contractors in systematically evaluating the bidding situation of a new project and recommend a bid/no-bid decision. If many new projects are available for bidding, the model can help in selecting the most suitable one. Also the model in useful to carry out a what-if analysis for a single project.

The development process of a qualitative bidding model is explained below. First, the most important factors that characterize the bidding process in Syria were identified and a parametric model was developed for each one. A bidding index was produced. Based on this index, the model will recommend either to bid or not to bid for the project. The proposed model was tested on 182 real bidding situations. It proved 93% accurate in simulating experienced contractors' decisions.

LITERATURE REVIEW

The literature contains a great number of theoretical bidding models based on the works of Friedman (1956) and Gates (1967). All these mathematical models proved to be suitable for academia but not for practitioners. Very few qualitative approaches, which study how the bidding decisions are made in practice, have been carried out.

Ahmad and Minkarah (1988) conducted a questionnaire survey to uncover the factors that characterized the bidding decision-making process in the United States. Subsequently, Ahmad (1990) proposed a bidding methodology based on the decision analysis technique for dealing with the bidding problem. In this model, the bidding problem is decomposed into four high-level criteria and thirteen lower-level criteria. This model demands many inputs some of which the bidder, especially those with limited experience, might not be able to provide. Also, it assumes that all factors contribute positively to the total worth, i.e. desirability, of the project under consideration. No distinction was made between some factors that count for the total worth, such as profitability, and others that count against the total worth, such as "degree of hazard". However, this approach is the most promising step on the road to modelling the bid/no-bid decision.

Ahuja and Arunachalam (1984) proposed a model to aid contractors in systematically evaluating the risk due to the uncertainty of availability of required resources before bidding on a new project. A CPM summary network, with resources allocation, was required for this model. In fact, this model could be viewed as a resource allocation model but not as a bid/no-bid model. It does not have clear criteria to give a bid or no bid recommendation. Resources, and risks related to them, are not the only criteria that affect the bid/no-bid decision-making process.

Abdelrazig (1995) carried out a literature review and identified 37 factors that affect the bid/no-bid decision. The analytic hierarchy process (AHP) was utilized and computer software named Expert Choice was developed to help contractors in Saudi Arabia in making their bid/no-bid decisions.

Wanous *et al.* (1998) conducted a questionnaire survey among Syrian contractors to uncover the parameters that characterize their bid/no-bid decision-making process. Thirty-eight parameters were ranked according to their relative importance in making the decision in Syria. It was concluded that fulfilling the "to-tender" conditions, financial capability of the client, and relation with/ reputation of the client are the most important factors.

THE MODELLING PROCESS

The bid/no-bid decision is a binary decision-making process, having only two possible outputs. However, the influences of various internal and external factors make it a very complex process.

A good point to start developing a structured model for this process is identifying the factors that affect it. Thirty-eight factors that influence the bid/ no bid decision in Syria were uncovered by Wanous (1998). Table 1 represents these factors in a descending order according to their importance indices (Ib).

It seemed, from a simple correlation analysis, that contractors did not differentiate between the "risk expected" factor and the "degree of hazard" factor and between the "availability of skilled labour" and "the availability of qualified staff". Also, the "project's geological study" factor is assumed to be included in the "risk expected" factor. Thus, three factors, degree of hazard, availability of qualified staff and the project's geological study, were omitted to eliminate double counting for the same factor.

The importance indices for the remaining 35 factors are illustrated in Figure 1. For simplicity, it was decided to discount the factors whose importance indices are less than the cut-off point (A). The remaining 22 factors were grouped into two sets. The factors that count for the "bid" decision, i.e. encouraging factors, and the factors that count against the "bid" decision, i.e. discouraging factors. To structure the decision process, a parametric model was developed for each factor (Figures 2a and 2b), where:

Ib*i* : is the importance index for an encouraging factor F*i*;

NB*i*: is the minimum acceptable level of F*i*, i.e. below this parameter the factor F*i* will be enough to cause a "no bid" decision;

B*i*: is a neutral score below which the factor F*i* will have a negative contribution to the "bid" decision and above it this factor will have a positive contribution;

Ib*j* : is the importance index for a discouraging factor F*j*;

NB*j*: is the maximum acceptable level of F*j*, i.e. above this parameter the factor F*j* will be enough to cause a "no bid" decision; and,

B*j*: is a neutral score above which the factor F*j* will have a negative contribution to the "bid" decision and below it this factor will have a positive contribution.

Table 1: Bid/no-bid criteria

Bid/no-bid criteria	**Importance index (Ib) (%)**
1. Fulfilling the to-tender conditions imposed by the client	90
2. Financial capability of the client	78
3. Relations with and reputation of the client	77
4. Project size	73
5. Availability of time for tendering	71
6. Availability of capital required	68
7. Site clearance of obstructions	68
8. Public objection	68
9. Availability of materials required	66
10. Current work load	66
11. Experience in similar projects	64
12. Availability of equipment required	64
13. Method of construction (manually, mechanically)	64
14. Availability of skilled labour	58
15. Availability of qualified staff	56
16. Original project duration	56
17. Site accessibility	54
18. Risks expected	52
19. Degree of hazard	52
20. Rigidity of specifications	50
21. Expected project cash flow	47
22. Degree of buildability	47
23. Availability of other projects	46
24. Confidence in the cost estimate	45
25. The project's geological study	40
26. Project location	32
27. Original price estimated by the client	29
28. Past profit in similar projects	27
29. Expected date of commencing	25
30. Availability of equipment owned by the contractor	22
31. Expected number of competitors (Degree of competition)	18
32. Local climate	18
33. Specific features that provide competitive advantage	16
34. Fluctuation in labour/ materials price	15
35. Competence of the expected competitors	13
36. Relations with other contractors and suppliers	10
37. Proportions to be sub-contracted	6
38. Local customs	4

Ib_j / Ib_j ; B_i / B_j; NB_i / NB_j were identified through a questionnaire survey and semi-structured interviews conducted among Syrian contractors. A contribution index for each bidding factor is produced and, then, a bidding index (BI) is computed for the new bidding situation under consideration.

The contribution of an encouraging factor F_i is computed by the following formula:

$$C_i = Ib_i * (CA_i - B_i) \qquad (1)$$

Where:

CA_i: is the contractor's assessment of the Factor F_i to reflect the bidding situation under consideration.

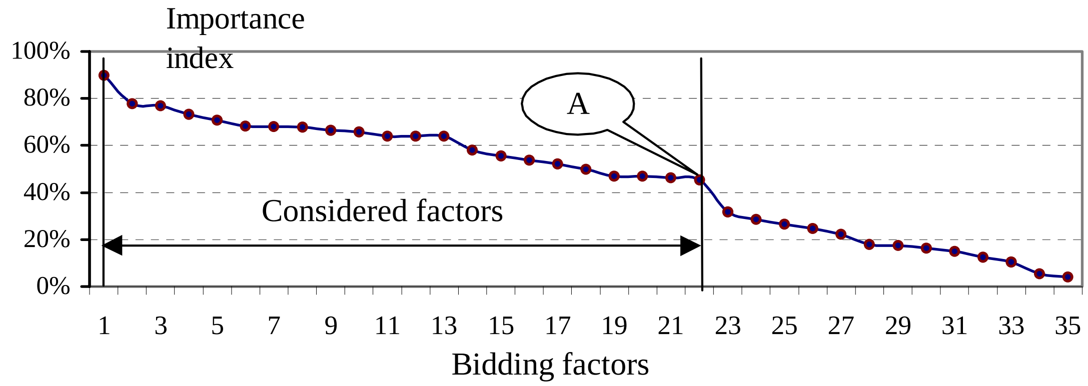

Figure 1: selecting the most important bidding factors

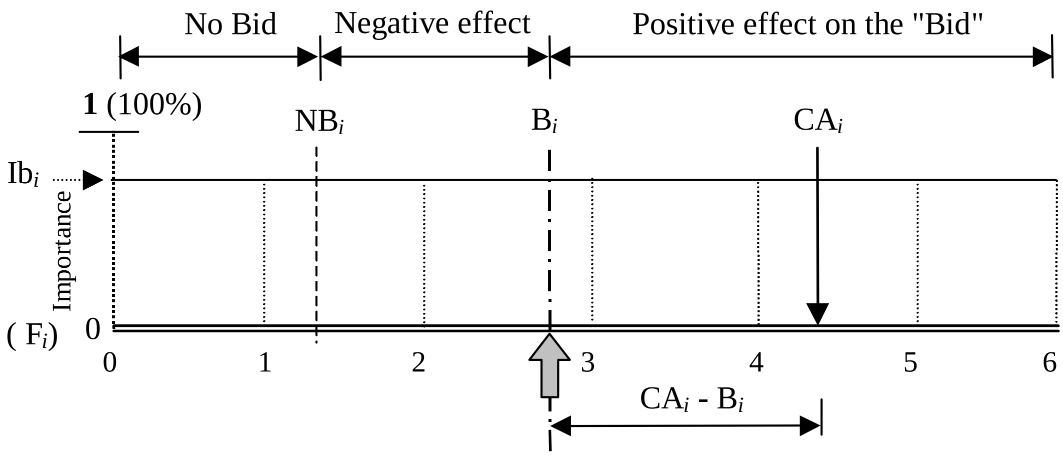

Figure 2a: A parametric model for an encouraging factor

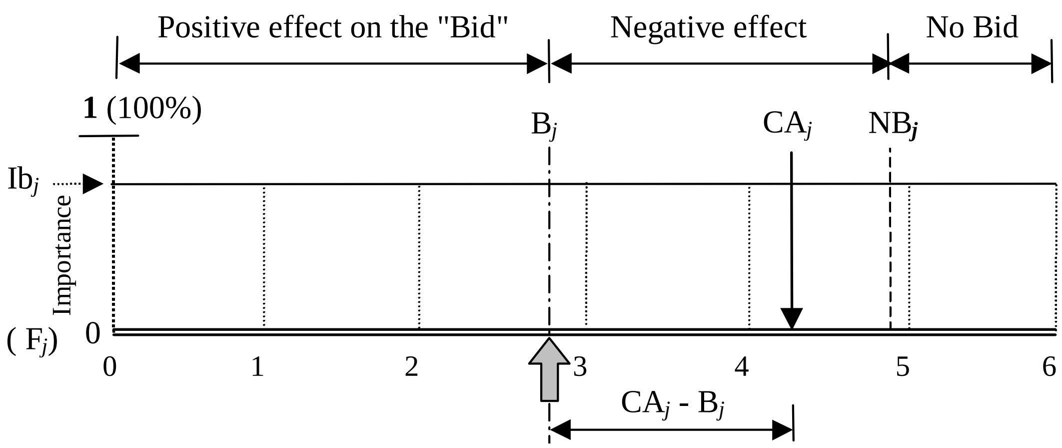

Figure 2b: A parametric model for a discouraging factor

Table 2a: Encouraging bidding factors in descending order of importance

i	**Encouraging Factors**	**Standard Deviation**	**Bi Score**	**Importance Index Ib*i***	**Nb*i***
1.	Fulfilling the to-tender conditions	0.37	5.84	0.90	5
2.	Financial capability of the client	0.88	3.48	0.78	2
3.	Relation with/ reputation of the client	0.78	3.84	0.77	2
4.	Availability of time for tendering	1.09	2.54	0.71	0
5.	Availability of capital required	0.73	3.41	0.68	2
6.	Site clearance of obstructions	0.9	3.64	0.68	0
7.	Availability of materials required	0.9	3.56	0.66	2
8.	Experience in similar projects	0.74	3.61	0.64	2
9.	Availability of equipment required	0.84	3.40	0.64	0
10.	Proportion that could be constructed mechanically	0.72	3.05	0.64	0
11.	Availability of Skilled labour	0.83	3.25	0.58	0
12.	Sufficiency of the project duration	0.79	3.02	0.56	0
13.	Site accessibility	1.03	3.00	0.54	0
14.	Favourability of the expected cash flow	1.08	2.80	0.47	0
15.	Degree of buildability	1.11	2.28	0.47	0
16.	Confidence in the cost estimate	0.73	3.85	0.45	0

Table 2b: Discouraging bidding factors in descending order of importance

i	**Discouraging Factors**	**Standard Deviation**	**Bi Score**	**Importance Index Ib*i***	**Nb*i***
1.	Project size	0.65	3.69	0.73	5
2.	Public objection	0.75	2.15	0.68	2
3.	Current work load	0.75	2.90	0.66	6
4.	Risks expected	0.73	3.12	0.52	6
5.	Rigidity of specifications	0.75	3.66	0.50	6
6.	Availability of other projects	0.76	5.21	0.46	6

Similarly, the contribution of a discouraging factor F_j is computed by the following formula:

$$C_j = Ib_j * (CA_j - B_j) \qquad (2)$$

Where:

CA_j: is the contractor's assessment of the Factor F_j to reflect the bidding situation under consideration.

Then, the bidding index (BI) for the project under consideration is computed using the following formula:

$$BI = \sum(Ib_i * (CA_i - B_i)) - \sum(Ib_j * (CA_j - B_j)) \qquad (3)$$

For $CA_i = B_i$ and $CA_j = B_j$, the bidding index will be BI = 0. That represents the mid-point case scenario where there are neither positive nor negative contributions to the "Bid" decision, i.e. the strengths of both "Bid" and "No Bid" decisions are equal.

If BI > 0, that indicates a more positive contribution to the "bid" decision and if BI < 0 that indicates a more negative contribution to this decision. In this model, the bid decision will be recommend when BI ≥ 0 and the no-bid decision will be recommended when BI < 0. Figure 3 illustrates the hierarchical structure of the proposed model and how a bidding index is produced for a new bidding situation.

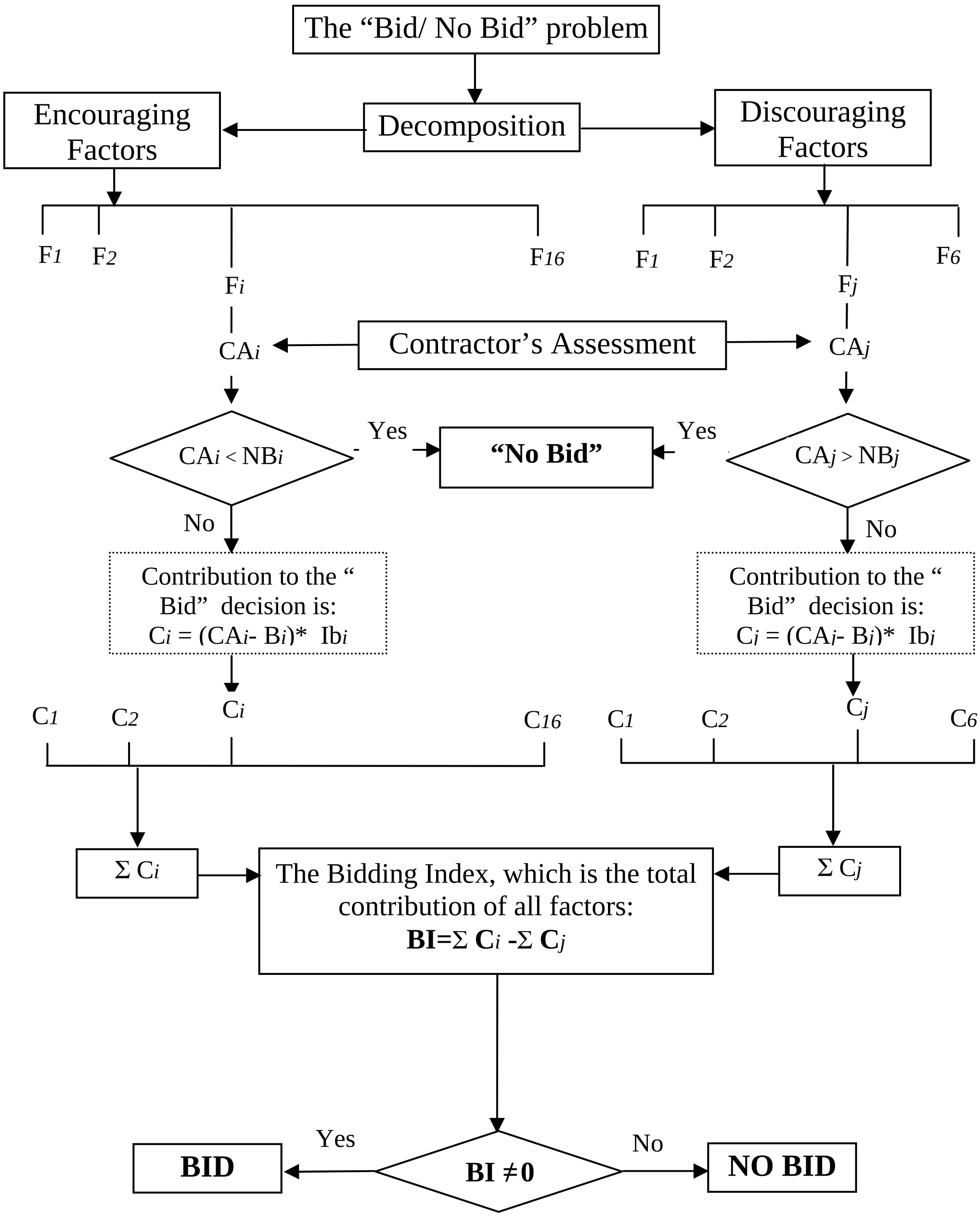

Figure 3: The hierarchical structure of the bid/no-bid model

MODEL VALIDATION

This model was tested against real bidding situations. The required data were elicited using a simple form of three parts. The first part was devoted to the general characteristics of the project under consideration such as the project size, type and duration. Part two listed the most important criteria that affect the bid/no-bid decision.

The final part of the form was concerned with the final decision taken by the contractor. Three hundred copies of this form were sent to thirty general contractors operating in Syria (ten copies each). The participating contractors were requested to describe, i.e. assess each new bidding opportunity they deal with in terms of the aforementioned bidding criteria and to provide their actual bid or no bid decision.

182 forms were filled in and returned. Repetitive personal contact with the respondents was very useful to get this high response rate (61%).

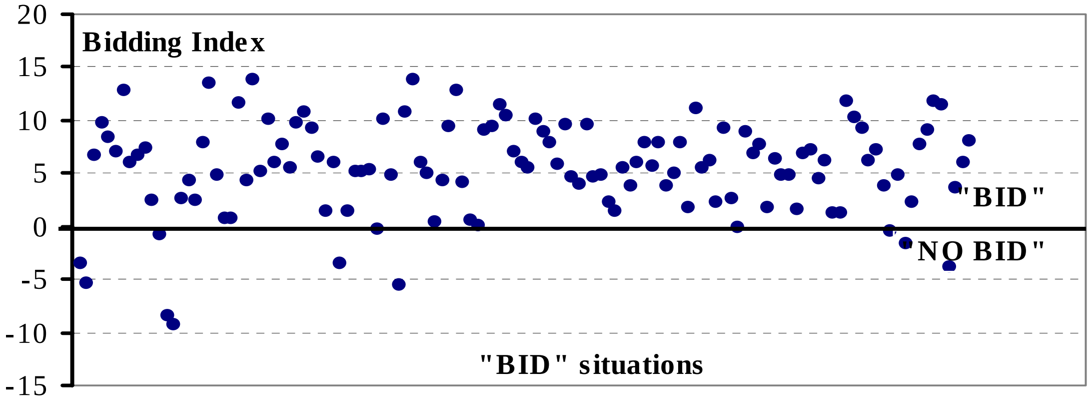

Figure 4: The bidding indices of real "bid" situations

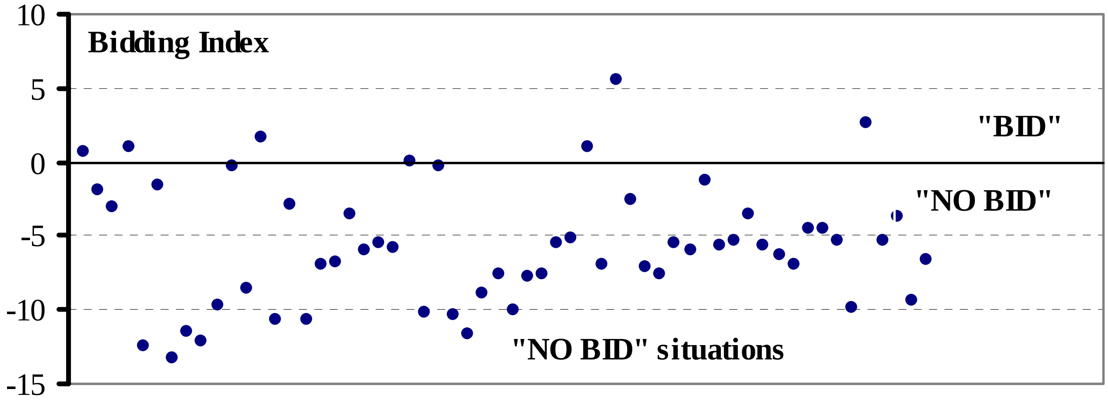

Figure 5: The bidding indices of real "No Bid" situations

These forms were divided into two sets; "bid" situations set which contains 124 projects and "no bid" situations set which contains 58 projects. By inputting the contractors' assessments of the first set, the model recommended to bid for 112 out of the 124 projects contained in it. Figure 4 shows the scatter diagram of the bidding indices of these "bid" situations. On the other hand, the model recommended not to bid for 51 out of the 58 projects contained in the second set as illustrated in Figure 5.

The validity of the proposed model is indicated by the following index:

$$VI = \frac{n}{N} \qquad (4)$$

Where VI is the validity index of the proposed model; n is the number of the successful simulation of the real decisions; and N is the total number of the tested cases. The model simulated successfully the contractors' decisions in (n =163) cases out of the total cases (N = 182) which implies a validity index of (VI = 90%).

In six bidding situations the model recommended not to bid while the actual decisions were to bid, however the client subsequently rejected these bids. Taking this into account improves the validity index to 93%.

A CASE STUDY

To demonstrate the application of this model a real bidding situation was used as a case study. Table 3 presents some of the general information about the project, the contractor's assessments of the bidding situation in terms of the aforementioned criteria and the final decision to bid or not to bid on this project. A factor is assessed by a score from 0 to 6 where 0 is extremely low and 6 is extremely high.

Table 5: A real bidding situation

Encouraging Factors			Discouraging Factors
CA_1=6	CA_7=6	CA_{13}=4	CA_1=4
CA_2=4	CA_8=3	CA_{14}=4	CA_2=2
CA_3=4	CA_9=3	CA_{15}=4	CA_3=4
CA_4=4	CA_{10}=5	CA_{16}=4	CA_4=2
CA_5=2	CA_{11}=4		CA_5=5
CA_6=4	CA_{12}=5		CA_6=3

The model starts by examining the individual bidding factors. The "to-tender conditions" factor is fully met as indicated by $AC_1 = 6$. The "no bid" is not recommended in this stage because this factor does not violates its "kill" value, i.e. $AC_1 = 6 > NB_1 = 4$.

The same process is repeated for all the encouraging factors and if any one of them is scored less than its kill value NB_i, the model recommends a "no bid" decision but the contractor can reject the recommendation and proceed in such cases. In this bidding situation, all the encouraging factors were scored higher than their NB_is.

Therefore, the model starts examining the discouraging factors. The fist one (project size) was scored $AC_1 = 4$ that means the size of this project is high compared to the average size the contractor deals with usually. However, this score is not higher than its "kill" value ($NB_1 = 5$). The other discouraging factors are examined in the same process. None exceeded its NB_j. Finally, the model produces a bidding index (BI) for the project under consideration: BI = +4.78 >0. Therefore, the model suggests bidding for this project. In real life, the contractor submitted a bid for this project and won the contract.

CONCLUSION

The model presented is a new method of making the bid/no-bid decision by quantifying the subjective evaluations of the bidder. The model is very flexible in the sense that attributes can be changed; some may be added and others could be deleted.

No bidding model can guarantee perfect outcomes. Nevertheless, this model is a useful tool in helping the bidder to understand the situation better and attain a reasonable degree of consistency. An overview of the past, similar models is also provided as a foundation for the proposed new model. The proposed bidding model is based on the findings of a formal questionnaire survey supported by six semi-structured interviews and validated against one hundred and eighty two real bidding situations. The model proved 93% accurate in simulating the contractors' decisions. The proposed model will be extended to enable the recommendation of a mark-up percentage, in the event of a decision to bid for a new project.

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