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Decision Making Modelling with Logistic Regression Approach

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Abstract

Decision making is a process of making choices by identifying decision, gathering information, identifying alternatives, and also assesing alternative resolutions. The decision making which is discussed in this study is related to bid/ no bid. In an effort to uncover the main factors that characterize the one distinct of bidding decisions, namely bid/ no bid, this study identifies the key determining factors and their importance weights. Significant factors in the decision to bid process are identified and a pro-forma to elicit a numerical assessment of these factors is developed and validated using the bid/ no bid decision-makers from a construction company. Using the pro-forma, data were collected from the collaborating company for historical bid opportunities. The aim of this research paper is to analyse and present factors which has a positive and significant relationship the decision to bid/ no bid. Statistical techniques are used to get a better understanding of data characteristics and to have the model process. Factor analysis was used in this research to find a way to summarize the information contained in a number of a original variables into a smaller set of new, composite dimensions or factor with a minimum loss of information. Logistic regression models were developed with the factors as independent variable from previous factor analysis process to get the final model with predictive accuracy rate of 87 percent. The positive and significant factors contributing to the prediction were competition in the market, market share, and experience, demonstrate that the model functions effectively in predicting the bid/ no bid decision process.

Keywords: Bid/no bid decision, contractor, strategic decision, decision making, factor analysis, logistic regression

INTRODUCTION

The bidding process involves two crucial decisions: first, whether bid or not to bid for a project and second, the determination of the bid price. The bid/no bid decision is complex and dynamic, involving many factors also while the selection process of the most appropriate projects for which to bid or not to bid is fundamental decision to a successful commercial strategy (Shash, 1993)[16]. Bid/ no bid decision-making is a critical activity for a contractor. Limited by both the nature of and the competition for bid opportunities, bid/ no bid decision is associated with uncertainty and complexity (Lin and Chen, 2004)[11]. One of the most important decisions that have to be made by contractor firms is whether to bid or not to bid for a project, when an invitation has been received. Because of the importance of his decision making issue, the decision is not considering only about a probability to win the tender but also taking into account of the latter part, which is being able to finish the job as planned with the expected profit (Lin and Chen, 2004)[11]. Since contractors' bidding behaviors are affected by numerous factors related both to the specific features of the project and dynamically changed situations, bidding decision problems are highly unstructured. The usual practice is to make bid decisions on the basis of intuition derived from a mixture of gut feelings, experience and guesses (Drew, 2001)[6]. However, the development of successful bidding strategies is a key factor to the survival of a contracting company. The basis of a successful strategy is to filter out losing bid opportunities and concentrate proposal efforts on bid opportunities that, when successful, assist in satisfying the objectives of the organization. With regard to preventing an organization from dissipating its energies in preparing a losing proposal, Rosenau, (1998)[15] even asserted that the bid/no-bid decisionmust be made within the context of the organization's strategic framework. Numerous researchers have developed models for bid/no bid and mark-up size decisions.

Previous Decision to Bid/No Bid Decision Models

Ahmad (1990)[1] presents a deterministic worth evaluation model of the bid/no-bid decision problem. A suggested decision is made by comparing this score with a desired minimum (threshold) score. Although the model is illustrated using ahypothetical bidding decision-making scenario, the model is theoretical, based on a set of attributes obtained from a questionnaire survey of 400 US general contractors. Thirteen attributes (factors) lower-level criteria, representing major objectives of a construction firm, are divided into four hierarchical groups: job-related, market-related, firm-related and resource-related. A great volume of literature concerned with bidding strategies has resulted in many bidding models. However, Friedman's study was the first research aimed to develop a quantitative bidding optimization model. Sadly, the evidence suggests that practitioners have made relatively little use of those models (Rothkopf and Harstad, 1994)[18] and most of these models continued in academic circles and did

not apply into the practical world (Wanous et al., 2000)[19]. A small number of qualitative studies have looked at how actual bidding decisions have been made in practice (Wanous et al., 2000)[19]. Surprisingly, it has been found that most of these bidding models have concerned only the mark-up decision, which has received most of the concern. This school of research concerns models that focus upon maximizing the expected profit from a tender. In addition, the appropriate bidding strategy and the process of forming it have received similar concern.

Above phenomenon or all the symptoms mentioned above, this research is the analysis of the factors influencing the decision contractors offer bid/no bid. To determine the factors that influence the decision of contractors bid / no bid to set out in a cooperation / contract then the method is done by spreading the questionnaire randomly to the contractor in accordance qualification and classification of both the contractor who've not bid in a work package or contractor has bid on all packages given to the contractor.

Factors to be a topic that will be examined as well as a cornerstone for the assessment questionnaire obtained through theoretical and previous studies, the Dean (1969)[5], Paranka (1971)[13], Ahmad (1990)[1], M.King & Phythian (1992), Shash (1998)[17], Wanous et al. (2000)[19], Lin and Chen (2004)[11], Egemen & Mohammed (2007), Choi & Linton (2011)[3] and Lemberg (2013)[10]. From the results of this study there are four aspects namely: 1. Contractor, 2. Project, 3. Market, 4. Company / Owner.

Bid/no bid decision making	Contractor	Availability of free manufacturing capacity	Paranka (1971), Ahmad (1990), M. King & Phythian (1992), Wanous et al. (2000), Egemen & Mohamed (2007), Lem- berg (2013)
		Experience	Ahmad (1990), Mustafa (1990), Shash (1998), Cova (2000), Wanous et al. (2000), Egemen & Mohammed (2007), Lemberg (2013)
	Contractor	Financial resources	M. King & Phythian (1992), Cova (2000), Wanous et al. (2000), Lowe (2004), Egemen & Mohamed (2007), Lemberg (2013)
		Internal resources	Ahmad (1990), Mustafa (1990), Cova (2000), Wanous et al. (2000), Lowe (2004), Egemen & Mohamed (2007), Lemberg (2013)
		Partners/ subcontractor	Cova (2000), Wanous et al. (2000), Lowe (2004), Egemen & Mohamed (2007), Lemberg (2013)
		Incumbency	Teece (1986), Tripsas (1997), A.A. King & Tucci (2002), Rubel (2013), Lemberg (2013)
	Project	Novelty of the products	Dean (1969), Wasson (1976), Kingsman & de Souza (1997), Bijmolt, Van Heerde & Pieters (2005), Lemberg (2013)
		Rigidity of cus- tomer specifications	Ward & Chapman (1988), Ahmad (1990), Shash (1998), Wanous et al. (2000), Egemen & Mohamed (2007), Lemberg (2013)
		Compatibility	Kelly & Coaker (1976), Katz & Shapiro (1994), Lemberg (2013)
	Market	Competition in the market	Paranka (1971), Ahmad (1990), M.king & Phythian (1992), Kingsman & de Souza (1997), Lin & Chen (2004), Lemberg (2013)
		Market area	Ward & Chapman (1988), Ah- mad (1990), Wanous et al. (2000), Egemen & Mohamed (2007), Lemberg (2013)

RESEARCH OBJECTIVE

The aim of this research paper is to present a checklist that allows the decision-maker in the bidding process to investigate and analyze the factors that influence the decision to bid/no bid. Majority of the research conducted on bid/ no bid decision making processes and the factors that influence the decision making concern construction industry and large project contracts (Bagies & Fortune, 2006)[2]. In order to answer the research question, first a literature review is conducted. The aim of the literature review is to describe individual and organizational decision making and in more detail the decision making of bid processes. Through the literature review the relevant factors that have been considered important and significant are indentified. After this the factors influencing the success of a bid are measured with a questionnaire. By analyzing the questionnaire results the aim is to identify those factors that influence the success of a bid and use this information to guide the bid/no bid decision making.

Factors Relating to Bid/No Bid Decision Making

In order to make justified decisions that are based on a broad perspective and valid data, several variables needs be taken into account in the evaluation of the enquiries. This will help in determining if it is profitable to bid on an enquiry and realize what the possibilities of winning the bid are. Lemberg (2013)[10] concentrated the study on the determination of the factors which influence the success of a manufacturing system

offers of telecommunication solutions, and perform the 17 different factors to influence the decision to bid or not to bid and divide these factors into 4 groups, namely (1) Contractor (2) Project, (3) Market, (4) Company / Owner. Of the 17 factors - these factors likely factor their business activities in the future with the company/owner, the suitability of the proposed project to the specifications requested company/owner, market competition and the availability of financial resources to be an important factor affecting the contractor. In the study of this paper and its breakdowns and related factors refer to the study of Lemberg (2013)[10] where in the study besides sourced from previous studies varied and current.

Market	Market share	Lin & Chen (2004), Egemen & Mohamed (2007), Lemberg (2013)
	Total value of the bid	Paranka (1971), Ahmad (1990), M. King & Phythian (1992), Wanous et al. (2000), Ege- men & Mohamed (2007), Lem- berg (2013)
Contractor	Price sensitivity	Morris & Joyce (1988), Tellis (1988), Bijmolt, Van Heerde & Pieters (2005), Lemberg (2013)
	Sourcing strategy	Kortge & Okonkwo (1993), Choi & Linton (2011), Lemberg (2013)
	Current Relationship	Wanous et al.(2000), Lowe & Parvar (2004), Miller (2006), Smith (2012), Lemberg (2013)
	Future business possibilities with the customer	Paranka (1971), Shash (1988), M. King & Phythian (1992), Cova (2000), Egemen & Mo- hamed (2007), Lemberg (2013)

RESEARCH METHODOLOGY

In this chapter the research methodology of this paper is explained. First, the sampling of respondents is discussed followed by the data collection methods. The final part of this chapter concentrates on the data analysis procedures used in this research. To answer the research questions this study has one approach. The result of this study is to examine factors that influence the bid/no bid decision making by indentifying the critical factors through literature research. To answer the research question, altogether 100 contractors cooperating with a construction company to fill in a questionnaire. This research takes a historical look and examines how the factors indentified in previous studies in fluence the success of the bids placed earlier by the manufacturer

After the data collection a general analysis of the gathered data was conducted. First the data set was checked for possible errors, missing values and outliers. Second, the response rates were calculated and the characteristics of the respondents were analyzed. Third, correlation coefficients were calculated. Fourth, contingency tables of the different variables indentified from the literature concerning successful and unsuccessful bids were formulated and analyzed. This was followed by two-sample t-test for the difference between two means. Before further analyses, factor analysis was done to check how the variables load on different factors. Fifth, logistic regression analyses were conducted in order to find out which variables contribute to investigate and analyse the factors that influence the decision to bid/no bid decision making.

Logistic Regression Approach

Logistic regression is multiple regression but with an outcome variable that is a categorical variable and predictors variables that are continuous or categor- ical(usually dichotomous). Logistic regression is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not nicely distributed. Logistic regression has been especially popular with medical research in which the dependent variable is whether or not a patient has a disease (Wuensch, 2011)[20].

In logistic regression analysis, the independent variables do not need to be interval, normally distributed, linearly related or of equal variance within each group. However, a case can only be in one category, in this study either successful or unsuccessful bidding (Patry, 2008)[14].

Hair et al. (2010)[9] declare as follows:

"Logistic regression may be described as estimating the relationship between a single non-metric (binary) dependent variable and set of metric or non-metric independent variables, in this general form:

$$Y_1 = X_1 + X_2 + X_3 + \ldots + X_n$$

(binary non-metric) (non-metric and metric)"

In line with hair, field (2009)[7] states as follows:

"Logistic regression is multiple regression but with an outcome variable that is a categorical variable and predictors variables that are continuous or categorical"

Logistic regression analysis used in this study is used to find out the most dominant factor on 17 factors, with dependent variable and the same independent variables - the same non-metric (own category). Thus, multiple binary logistic regression equation for the 17 factors has the form

$$\ln\left(\frac{P(y=1)}{1-P(y=1)}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k,$$

Because in this study using 17 independent variables, then the value of *k* to 17.

Thus, multiple binary logistic regression equation can be written:

$$ln\left(\frac{P(y=1)}{1-P(y=1)}\right)=\alpha+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\beta_5x_5+\beta_6x_6+\beta_7x_7+\beta_8x_8+\beta_9x_9+\beta_{10}x_{10}+\beta_{11}x_{11}+\beta_{12}x_{12}+\beta_{13}x_{13}+\beta_{14}x_{14}+\beta_{15}x_{15}+\beta_{16}x_{16}+\beta_{17}x_{17}$$

Information:

Y = sucessful bid

a = constant

$\beta_1, \beta_2, \ldots, \beta_{18}$ = regression coefficient variable of $x_1, x_2, \ldots, x_{18}$

x_1 = Availability of free manufacturing capacity
x_2 = Experience
x_3 = Financial resources
x_4 = Internal resources
x_5 = Partners
x_6 = Incumbency
x_7 = Novelty of the products
x_8 = Rigidity of customer specifications
x_9 = Compatibility
x_{10} = Competition in the market
x_{11} = Market area
x_{12} = Market share
x_{13} = Total value of the bid
x_{14} = Price sensitivity
x_{15} = Sourcing strategy
x_{16} = Current relationship
x_{17} = Future business possibilities with the customer

Instead of adding all independent variables into the model at once, in the first analysis the variables that load on the same factors are added into the analysis separately as combined factors. In the second logistic regression analysis groups of variables are added into the analysis in order to investigate if the model is better when a group of variables is included or left out of the model. This hierarchical entry of variable groups is based on the above mentioned factor analysis.

First the constant model is calculated, after which the variable groups are added in to the model one by one. In the final model all variables are included in the model. In the following chapter the results of these analyses are explained in more detail.

RESULTS

The results are presented. First overall response rates and characteristics of the respondents are summarized. After this the answers of respondents for each individual variable for successful and unsuccessful bids are considered and the results of an independent two-sample t-test for the difference between two means are analyzed. The t-tests is used to show if there is a statistically significant difference between the means of successful and unsuccessful bids when considering the different variables indentified. After analysing the answers for each variable and the t-test results for the difference between two means, the results chapter continues with the logistic regression analyses. The results are summarised from a step by step procedure where the independent variables from different groups indentified with factor analysis were added into the regression analysis (Lowe dan Parvar, 2004)[12].

Relationships between the Factor Scores and the Decision Outcome

The factor scores were correlated to evaluate it's relationships between the decision to bid outcome and the three underlying dimensions of the pro-forma.

The logistic regression analysis begins with the constant model after which the control variables are added into the model creating the first model (table 3). After this the three groups of variables are added into the analysis in separate steps,

	Model		
	B	SE	Exp(B)
Variable			
Experience	-1.306*	0.568	1.952
Financial resources	0.035	0.245	0.385
Internal resources	0.786	0.569	1.876
Partners	0.486	0.423	1.502
Incumbency	-0.685	0.298	0.809
Compatibility	0.667	0.415	1.456
Market Share	1.347*	0.814	3.065
Free manufacturing	0.145	0.562	1.745
Degree of novelty	-0.356	0.423	0.399
Rigidity	-0.034	0.543	0.788
Market area	0.645	0.323	0.478
Price sensitivity	0.268	0.765	0.865
Sourcing strategy	0.768	0.245	1.264
Competition	-1.267*	0.645	2.289
Total value	0.497	0.295	0.679
Relationship	-0.552	0.325	1.578
Future projects	2.152**	0.625	4.672

In last step, the group of 3 variables are added into the fourth model. The model chi square has 30 degrees of freedom, a value of 73.787 and a probability of $p < 0.001$. We can reject null hypothesis and can conclude that the predictors have a significant effect and create a different model. The -2 Log Likelihood value has to 76.423 indicating an improvement in the model when compared to the previous models. Cox and Snell's R-Square value is 0.499 indicating that 49.9 percent of the variation in the dependent variable is explained by the logistic model. The Nagelkerke's R-Square value of 0.757 indicates a moderately strong relationship of 75.7 percent between the predictors and the prediction. In the final model that contains all the variables, experience (B = -1.306, $Exp(B)$ = 1.952, p = 0.021, market share (B = 1.347, $Exp(B)$ = 3.065, p = 0.014), competition (B = -1.267, and $Exp(B)$ = 2.289, p = 0.038) contribute significantly to the prediction, but the other independent variables do not contribute as they are non-significant.

Bid/no bid decision modelling with logistic regression approach is :

$$ln\left(\frac{P(y=1)}{1-P(y=1)}\right) = \alpha + \beta_2 x_2 + \beta_{10} x_{10} + \beta_{12} x_{12}$$

	Factor 1	Factor 2	Factor 3	Cronbach's Alpha	Name of the factor
Experience	0.746				
Financial resources	0.722				
Internal resources	0.691				
Partners	0.652			0.845	company
Incumbency	0.617				
Compatibility	0.584				
Market share	0.545				
Free manufacturing		0.728			
Degree of novelty		0.652			
Rigidity		0.649		0.756	product specifications
Market area		0.563			
Price sensitivity		0.496			
Sourcing strategy		0.450			
Competition			0.679		
Total value of the bid			0.587		
Relationship			0.516	0.624	customer relationship
Future projects			0.467		

CONCLUSION

The two-sample t-tests, factor analysis, and logistic regression analysis were conducted to find and analyze 17 factors that had positive and significant influence on decision to bid/ no to bid. The findings of this research paper suggest that only three out of the seventeen different variables identified from the literature contribute significantly to the prediction of a bid being a successful bid. Those variables are experience, market share, and competition in the market made a significant contribution to the prediction, with market share as a factor which had the highest predictive value. A logistic regression model demonstrated a high prediction capability of 87%. The results are very encouraging; a reliable model. Further, the reliable model has a higher predictive accuracy than previous attempts to model this process.

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