SIMULATION MODEL FOR CRITICAL FACTORS IN BIDING PUBLIC PROJECT ACTIVITIES FROM ROMANIA

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ABSTRACT
Improving tendering activity is a key concern for bidders, because the tendering activity underlies the competitiveness and the profitability of the contractors and it involves considerable risks. In this paper we proposed to look for links between the winning percentage, the degree of their admissibility and the number of received bids, in public tenders that take place in Romania. Accordingly, we identified an econometric model for modeling the phenomenon of public contracting, that may be applied for certain percentages of the estimated value, also depending on the number of received offers. The model can be implemented by the bidders to obtain practical results in predicting the value of the lowest offer and to decide if "to offer" remain the best decision.
The article evaluates one of the most important determinants of procurement process, the competitiveness, and brings in new elements of management in the bidding process by using of the econometric model.

KEYWORDS: *biding strategy, cost estimation, tender management*

JEL CLASSIFICATION: *M21, C51, H57, D41*

1. INTRODUCTION

Estimating the project's costs in the bidding process is a complex activity that must take into account the internal and external factors of the bidder company. Improving tendering activity is a key concern for bidders because it underlies the competitiveness and the profitability of contractors, involving significant risks. A good estimate assumes a low variation of estimated costs around actually incurred costs.
Estimating the value of a contract should be done mainly based on actual costs and potential risks, but in order to win the contract to the lowest price, the tendering department staff must realize how much they have to lower the price of the offer to have a winning offer and also get a bigger profit, after completion of the awarded contract.
This paper evaluates one of the determinants of the procurement process in terms of bidders and help to optimize their activity by proposing an econometric model designed to increase the number of awarded contracts.

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2. LITERATURE REVIEW

According to Hwang, S. (2009), "Any building project begins with an initial estimate of its cost". Budgeting is one of the most important tasks in the project management and in the bidding procces, as well.
According to Hicks, J. (1992), "without a good budgeting, only a miracle can avoid seriously negative outcomes, despite the competence for planning and the financial capacity of the contractor". Akintoye, A. (2000) states that "a proposal is the sum of all the dry prices with a margin of contribution, where this margin of contribution comprehends the non industrial charges and a net margin".
The challenge is to prepare tenders bidders offers that include all the costs and the risks of the future project, the winning bids and generating a larger profit as possible, because, after all, the profit is the primary motivation for the contractor to win and execute a contract (Dikmen, I., Birgonul, MT, and Gur, AK, 2007).
When preparing an offer, the economic operator must take into account the estimated contract value. According to the Guvern (2006), a tender may be rejected because it is too small and can not be justified or exceed the approved budget of the contract and there is no possibility increases of these amounts. Therefore it is up to the bidder to ensure the initial real situation of the future work and to notify a possible underestimation of the value of the initial contract.

3. FACTORS INFLUENCING CONTRACTORS MARK-UP DECISIONS

Ahmad and Minkarah (1988), Shash and Abdul-Hadi (1992) and Shash (1993) suggested that a investigation of the factors affecting the bid decisions is essential before attempting to develop a bidding strategy.
Mohammed Fadhil Dulaimi and Hong Guo Shan (2002) identified the 40 common factors that the different researchers have argued influence local contractors' bid mark-up decisions (see table 1).

Table 1. Factors influencing the contractor's bid mark-up decision

Category	Factors	Category	Factors
Project characteristics	Size of contract	Economic enviroment	Overall economy
	Duration of project		Risk involved in investment
	Project cash flow		Anticipated rate of return
	Location		Availability of labour/equipment
	Type of owner		Government division requirement
	Degree of difficulty		Tax liability
	Degree of safety		
Company's characteristics	Availability of required cash	Project documentation	Type of contract
	Uncertainty in cost estimate		Type of procurement

	Need for work	Completeness of document
	Past profit	Owner's requirement
	Current workload	Use of nominated sub-contractors
	General overhead	Value of liquidated damages
	Portion subcontracted to others	Risk of fluctuation in material price
	Experience in similar project	Insurance premium
	Need for public exposure	
	Availability of qualified staff	
	Establishing long relationship with client	
	Tendering method	
	Tendering duration	
	Pre-qualification requirement	
Biding situation	Bidding document price	
	Availability of other projects	
	Numer of competitors	
	Identity of competitors	
	Requirement of bond capacity	

Source: http://www.researchgate.net/publication/24077604_The_factors_influencing_bid_mark-up_decisions_of_large -_and_medium-size_contractors_in_Singapore, retrieved in February, 2015.

Mohammed Fadhil Dulaimi and Hong Guo Shan (2002) have shown that contractor size have a significant bearing on the factors that would influence the bid mark-up decision. The large contractors tend to be more concerned with the nature of the construction work of the tendered project when they make the decision on the mark-up size. By contrast, the medium size contractors are more concerned about their own company's finance, and how bidding for a particular project would enable the company to maintain a viable business.

Winning a contract, it is not enough for bidders to master the estimation techniques to offer closer to the real price and to apply company-specific coefficients.

According to Samuel Laryeia (2008), the biding process is not just a technical exercise, it is intuitive, unsystematic, and a skill that they gain from experience. Above intuition and talent to feel correct prices, we think that, before taking decisions in the bidding process, it is very important to know the size and the capacities of the opponents.

In this paper we proposed to identify how much the bidders must take into account these factors when making decisions in the bidding process.

4. METODOLOGY

In preparing this article, we conducted a quantitative analysis of extracted data from Electronic Procurement System Platform (SEAP), relating to works contracts awarded in 2014. This research work verify the existence of the links between the number of competitors for each tender, the ratio of admissibility and rejection of bids, the value of the offers and the ratio of the winning bid and the estimated value of the contract.

4.1 Analysis of public works contracts awarded in 2014 in Romania

We selected data from the SEAP for 1168 contracts awarded in 2014 in Romania. There weren't taken into consideration a number of 534 contracts, which were awarded by negotiation without notice, also 11 procedures, which were not found all the information needed for analysis.
From the 623 awarded contracts, 80% were awarded on the criteria of having the lowest price, 20% were awarded on the criteria based on the most advantageous offer.
Of the 623 contracts reviewed in detail, 543 were awarded through opened tender procedure, 12 contracts were awarded by restricted tender procedure, two procedures were tendered by accelerated restricted and 66 contracts were awarded by negotiated procedure.
It can be seen that Beneficiaries have the interest directed to lowest costs for the executed works at the expense of quality of works, execution terms or maintenance costs.
We can also notice the preponderance of open procedures, also considered most transparent ones.
We were interested in the value of the contract awarded to the estimated value of the contract and we noticed the following:

- 13% of the winning bids were below 60% of the estimated value of the contract. It is necessary to deepen the study of these contracts, because it can not be determined at present the main causes of these very low bids (if designers have overestimated the value of the contract, or entrepreneurs have taken the risk of small profit for the contract).

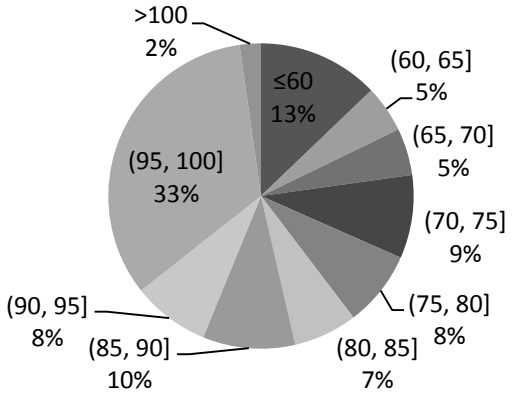


Figure 1. The ratio between the value of the winning bid and the estimated value of the contract

Source: Own study based on the research results

The percentage award or winning percentage will understand the ratio between the value of the winning bid and the estimated value of the contract.

- For 36% of contracts had a single admissible offer (see figure 1). As in the above case, it is very interesting to monitor in the future the causes of rejection of tenders and how they can be improved.
- 33% of winning bids represented more than 95% of the estimated value of the contract. For won contracts with a percentage of 95% of the initially estimated value, only for 42% of them there were presented more than a single admissible bid (see figure 1).

4.2 Results

We assumed that there is a close relationship between the number received of bids, the number of admissible bids, the estimated value of the contract and the winning percentage. To verify the assumptions, it is necessary to measure its intensity by a simple correlation or a synthetic indicator. It can be determinated to what extents the factorial parameter x (total value of projects submitted) contributes to the formation of the dependent parameter y (total value of projects approved) connection from nature, direction and form point of view between the two variables.
After verifying the existence of the correlations, the method yelded the following graphics:

- The admisibility report and the winning percentage (r = -0.91, see graphic 1). There is a strong and inverse correlation between the admissibility of tenders and the winning percentage (the ratio of the winning bid and the estimated value).

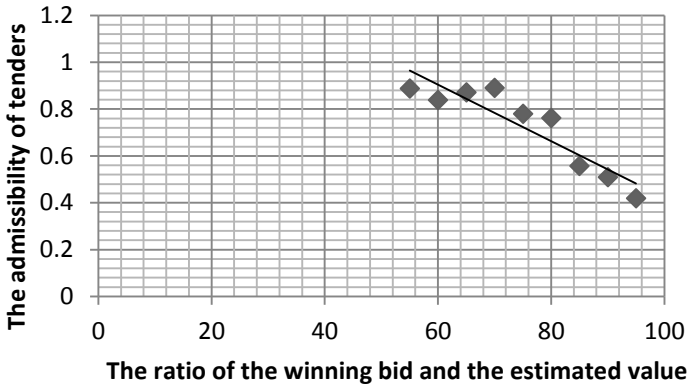
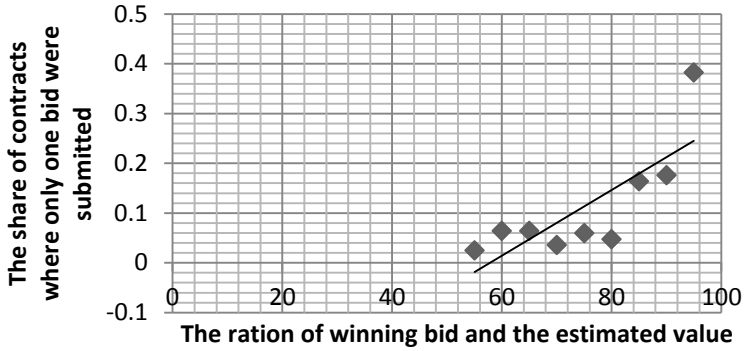


Figure 2. Correlation between the admissibility of tenders and the ration of winning bid and the estimated value

Source: Own study based on the research results

- The share of contracts where only one bid was submitted and the winning percentage (r=0.78, see graphic 2). There is a strong and direct relation between the share of contracts where only one bid were submitted and the winning percentage (the ratio of the winning bid and the estimated value).



- **Figure 3. The correlation between the share of contracts where only one bid were submitted and the ratio of the winning bid and the estimated value**

Source: Own study based on the research results

- The share of rejected offers and the winning percentage (r = -0.55, see graphic 3). There is a moderate and inverse relationship between the share of rejected offers and the winning percentage (ratio between the winning bid and the estimated value).

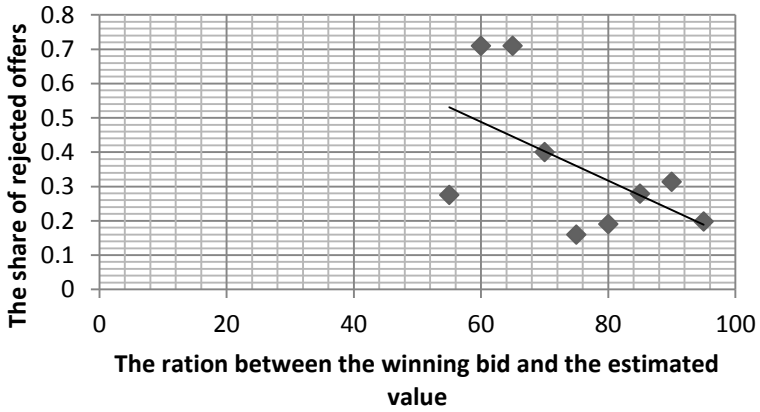


Figure 4. Correlation between dintre raportul de respingere si ratio between the winning bid and the estimated value

Source: Own study based on the research results

We can say that bidders bid high values, close to the initial estimated value of the contract, when they have the information that they are the only bidders, or as little competition will be eligible. Of course, eligibility is a sensitive issue, given the perception of entrepreneurs to the proper conduct of public procurement procedures.

- The number of the received tenders and the ratio between the winning bid and the estimated value (r = -0.74, see graphic 4). Also showed an inverse and strong relation between these two variables.

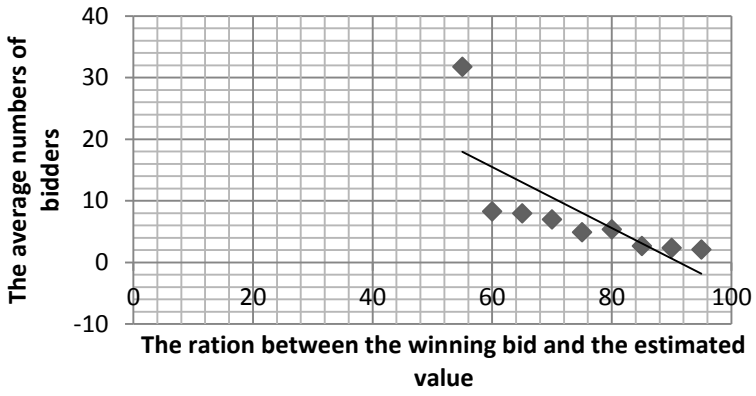


Figure 5. Correlation between the number of bidders and the ration between the winning bid and the estimated value

Source: Own study based on the research results

- The estimated value of the contracts and the winning percentage (-0.07). There is an insignificant relationship between the estimated value of contracts and the winning percentage (The ratio between the winning bid and the estimated value).

Table 2 centralized the variables we studied the existence of correlations.
To calculate the Pearson correlation coefficient we used the following formula:

$$r = \frac{\sum (X - \overline{X})(Y - \overline{Y})}{\sqrt{\sum (X - \overline{X})^2 \sum (Y - \overline{Y})^2}} \quad (1)$$

Table 2. Calculations to verify the correlation between the studied variables

y	x_1	x_2	x_3	x_4	X_5
55	0.28	0.03	0.89	31.76	157,338,968.8
60	0.71	0.06	0.84	8.32	24,340,504.41
65	0.71	0.06	0.87	8.00	19,977,319.86
70	0.40	0.04	0.89	6.98	37,540,541.30
75	0.16	0.06	0.78	4.90	33,245,605.95
80	0.19	0.05	0.76	5.40	460,775,166.82
85	0.28	0.16	0.56	2.70	8,663,517.92
90	0.31	0.18	0.51	2.37	5,385,936.66
95	0.20	0.38	0.42	2.11	15,804,030.86
R	-0.77	0.79	-0.93	-0.97	0.04

Source: Own study based on the research results

The variable values:

$$Y = \{(yi, yi+1] \mid yi+1=yi+5\%;\ y1=60\%,\ y8=300\%,\ i=1,8\},$$

x1= The percentage of the contracts where only one bid was submitted, though more competitors tenders presented their offers

x2= The percentage of the contracts where only one bid were submitted
x3= The admisibility report
x4= The average number of bidders or received tenders
x5= The average initial estimated value of contract
y=f(x)+u

Next, we wanted to identify an econometric model, which describes the phenomenon award of contracts depending on variables known to potential bidders. From the set of awarded contracts by tender procedure, to achieve the econometric model we have not taken into account the awarded contracts for values representing less than 60% of the initially estimated value, We considered that these contracts require specific analysis, by identifying the causes of the very low offers.
From the Graphic 4, it can be seen that the empirical distribution points (x, y) can be approximated by a straight line. We propose the following mathematical function that could expresse the connection form:
y=f(x)+u=a+bx+u
y= the field in which you can find the winning percentage
x= the numbers of bidders
u= the residual variable
a,b= the model parameters, b≥0
Using the method of least squares we estimated the parameter values. Using this method is based on the following equations:

$$y_t = a + bx_t + u_t;\ \ t = \overline{1,n}$$
$$\hat{y}_t = \hat{a} + \hat{b}x_t \qquad (2)$$

MinimType equation here.um units of this function results in the following relations:

$$F'(\hat{a}) = 0 \Rightarrow n\hat{a} + \hat{b}\sum x_t = \sum y_t$$
$$F'(\hat{b}) = 0 \Rightarrow \hat{a}\sum x_t + \hat{b}\sum x_t^2 = \sum y_t x_t \qquad (3)$$

Table 3.1 Econometric model calculation

x_t	y_t	x_t^2	$x_t y_t$	$\hat{y}_t$	$(x_t-\bar{x})^2$	$u_t=y_t-\hat{y}_t$	u_t^2
1	2	3	4	5	6	7	8
8.32	60.00	69.27	499.35	62.37	10.39	-2.37	5.62
8.00	65.00	64.00	520.00	63.88	8.41	1.12	1.24
6.98	70.00	48.75	488.73	68.66	3.54	1.34	1.79
4.90	75.00	24.01	367.50	78.43	0.04	-3.43	11.78
5.40	80.00	29.21	432.38	76.06	0.09	3.94	15.49
2.70	85.00	7.32	229.92	88.73	5.73	-3.73	13.95
2.37	90.00	5.63	213.53	90.29	7.44	-0.29	0.09
2.11	95.00	4.44	200.27	91.54	8.95	3.46	12.00

Source: Own study based on the research results

Table 3.2 Econometric model calculation

$y_t-\bar{y}$	$(y_t-\bar{y})^2$	$x_t-\bar{x}$	$\hat{u}_t$	$\hat{u}_t(x_t-\bar{x})$	u_{t-1}	$(u_t-u_{t-1})^2$	u_tu_{t-1}	$(x_t-\bar{x})(y_t-\bar{y})$
9	10	11	12	13	14	15	16	17
-17.50	306.25	3.22	-2.37	-7.64				-56.41
-12.5	156.25	2.90	1.12	3.24	0.00	12.15	-2.64	-36.26
-7.5	56.25	1.88	1.34	2.52	0.00	0.05	1.49	-14.12
-2.5	6.25	-0.20	-3.43	0.68	0.00	22.75	-4.59	0.50
2.5	6.25	0.31	3.94	1.20	0.00	54.30	-13.51	0.76
7.5	56.25	-2.39	-3.73	8.94	0.00	58.84	-14.70	-17.96
12.5	156.25	-2.73	-0.29	0.80	0.00	11.83	1.10	-34.08
17.5	306.25	-2.99	3.46	-10.36	0.00	14.13	-1.02	-52.35

Source: Own study based on the research results

Using data from the columns 1,2,3,4 of the table 3 and the group of formula no. 3, results the estimated values of the parameters:

$\hat{b}$ = -4.693057111

$\hat{a}$ = 101.4287249

The theoretical values of the endogenous variable can be calculated using the relationship:

$$\hat{y}_t=-4.69306x_t+101.4287$$

To calculate the standard deviation of the residual variable and the parameters, we used the following formula 4, 5, 6, and the data from columns 6 and 8 of Table 2.1:

$$s_{\hat{u}}^2=\frac{\sum(y_t-\hat{y}_t)^2}{n-k} \quad (4)$$

$$s_{\hat{a}}^2=s_{\hat{u}}^2\left[\frac{1}{n}+\frac{\bar{x}^2}{\sum(x_t-\bar{x})^2}\right] \quad (5)$$

$$s_{\hat{b}}^2=s_{\hat{u}}^2\frac{1}{\sum(x_t-\bar{x})^2} \quad (6)$$

Where n=8, k=2

$s_{\hat{u}}^2$= 10.33 $s_{\hat{a}}^2$= 7.31 $s_{\hat{b}}^2$= 0.23

$s_{\hat{u}}$= 3.21 $s_{\hat{a}}$= 2.70 $s_{\hat{b}}$= 0.48

The econometric model can be written as:

$$\hat{y}_t=-4.69306x_t+101.4287,\ s_{\hat{u}}=3.21$$
$$(2.70)\qquad(0.48)$$

Estimators obtained by the least squares method are the maximum likelihood if following conditions are accepted:

- Observed variables are not affected by measurement errors. This condition is checked with three sigma rule:

$$x_t \in (\bar{x} \pm 3\sigma_x) \qquad \sigma_x = \sqrt{\frac{\sum (x_t - \bar{x})^2}{n}} \qquad \sigma_y = \sqrt{\frac{\sum (y_t - \bar{y})^2}{n}}$$
$$y_t \in (\bar{y} \pm 3\sigma_y) \qquad (8)$$

σ_x= 2.361037 $\bar{x}+3\sigma_x$= 12.18 $\bar{x}-3\sigma_x$= -1.98

σ_y= 11.45644 $\bar{y}+3\sigma_y$= 111.87 $\bar{y}-3\sigma_y$= 43.13

-1.98<5.10<12.18, 43.13<77.5<111.87

Because these conditions are met, the above assumption can be made without reservation.

- Average random variable is null. Its dispersion is constant and independent of x.

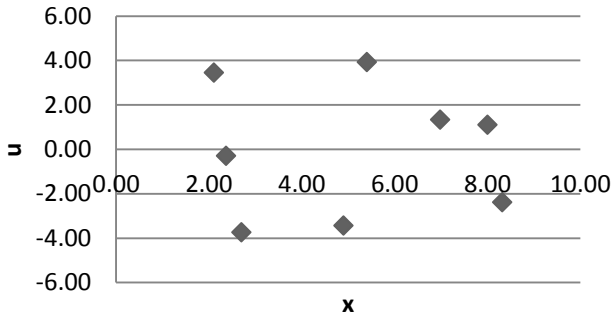


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Figure 6. Correlogram of the factor variable - x and residual value - u

Source: Own study based on the research results

The graph of empirical points shows an oscillating distribution, therefore can accept the hypothesis that the two variables are independent (see graphic 5).

- Residuals values are independent, there is the phenomenon of autocorrelation

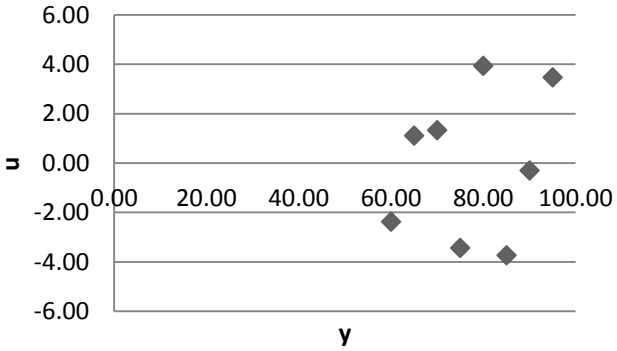

Figure 7. Correlogram of factor variable - y and residual value - u

Source: Own study based on the research results

As the graph points is oscillating, we can accept the idea that the two variables are independent and correlated, being carried hypothesis of independence of errors (see graphic 6)
Applying the Durbin-Watson test for independent verification of the variables y and u, we calculated empirically period d, which we compared with d1 and d2, values taken from Table Durbin-Watson, significance threshold α = 0.05, the number of variables (k = 1) and observed values (n = 8):

$$d = \frac{\sum_{t=2}^{n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{n}\hat{u}_t^2} \quad (9)$$

D= 2.81

D_1= 0.76 4-d_1= 3.24

D_2= 1.33 4-d_2= 2.67

2.67<2.81<3.24 → indecision, tending towards a low negative autocorrelation. Autocorrelation of errors can be neglected due to indecision.

- The verify the hypothesis of normality of the residual variable values. We verified the relationship:

$$P(|\hat{u}_t| \le t_\alpha s_{\hat{u}}) = 1 - \alpha \quad (10)$$

From the student distribution table, for the significance threshold α=0.05, n-2=6, we took the values $t_{0.05,6}$=1.943, $t_{0.01,6}$=3.143. We checked the relation (10) on the graphic 6. Note that the empirical values of the residual variables enroll in the built with a significance threshold α=0.05. The assumption of normality of the residual variable can be accepted with this materiality.

$t_{0.05}s_{\hat{u}}$= 25.70

- Checking the significance estimators

Estimators are significantly different from zero, with a significance threshold α, if you check the following relations:

$$t_{\hat{a}} = \frac{|\hat{a}|}{s_{\hat{a}}} > t_{\alpha;v}; t_{\hat{b}} = \frac{|\hat{b}|}{s_{\hat{b}}} > t_{\alpha;v} \quad (11)$$

Knowing the values of â, $\hat{b}$, $s_{\hat{a}}$, $s_{\hat{b}}$ and working with a significane threshold alfa=0.05 from Student distribution, $t_{0.05,6}$=1.943. Estimators are significantly different from zero with a threshold of significance alpha because it was checked the group of relations (11)

$t_{\hat{a}}$= 37.5075 > 1.943

$t_{\hat{b}}$= 9.752228 > 1.943

- Checking the plausibility of the model

To accept the hypothesis of linearity we calculated the correlation coefficient using the formula:

$$r_{y/x} = \frac{\operatorname{cov}(y,x)}{\sigma_x\ \sigma_y} = \frac{\sum (y_t - \bar{y})(x_t - \bar{x})}{n\ \sigma_x \sigma_y} \quad (12)$$

r_{yx} -0.97004

Linear correlation coefficient is defined in the interval [-1, 1], it follows that the value obtained -0.970 indicates a strong and inverse linear correlation between the two variables.
To calculate the correlation we used the following set of formulas:

$$R_{y/x} = \sqrt{\frac{V_x^2}{V_0^2}} = \sqrt{1 - \frac{V_u^2}{V_0^2}} \quad (13), \text{ unde:}$$

$$V_x^2 = \sum_{t=1}^{n} (\hat{y}_t - \bar{y})^2 \quad V_u^2 = \sum_{t=1}^{n} (y_t - \hat{y}_t)^2 \quad V_0^2 = \sum_{t=1}^{n} (y_t - \bar{y})^2 \quad (14)$$

$$F_c = \frac{s^2_{Y/X}}{s^2_{\hat{u}}} \quad s^2_{\hat{u}} = \frac{V_u^2}{n-k} \quad s^2_{Y/X} = \frac{V_x^2}{k-1} \quad (15)$$

V_0^2=	1,050.00
V_x^2=	982.22
V_u^2=	61.97
R_{yx}=	0.970044
$s_{\hat{u}}^2$=	10.32760351
$s_{y/x}^2$=	982.22
F_c=	95.11

Fisher Snedecor test indicates that the results are significant for a threshold of significance of 5%. Checking the significance correlation ratio and hence the coefficient of linear correlation test is performed using Fisher-Snedecor:

$F_c=(n-2)\frac{R^2}{1-R^2}$, R is significant if $F_c \geq F_{\alpha;v1;v2}$ (16)

F_c= 95.11 > 5.99 = $F_{0.05,1,6}$

Since the correlation ratio estimators and model parameters are significantly different from zero, with a 5% significance threshold, result that the econometric model is significant for the same materiality:

$\hat{y}_t$=-4.69306x_t+101.4287, $s_{\hat{u}}$ =3.21, R=0.970, d=2.81
(2.70) (0.48)

In estimating the tender, bidders must take into account both the accuracy and the correctness of which was estimated the value of the contract and the competition, since winning score depends to a moderate extent by the number of the received offers.

5. LIMITATIONS OF THE RESEARCH

In this paper, we didn't analyze the offers demands. Identified econometric model was not tested for these procedures for awarding contracts. It is necessary to deepen the study on contracts awarded for values representing more than 60% of the estimated value of the contract. At this moment, we can not determine the main causes of these very low offers (if designers have overestimated the value of the contract, or entrepreneurs have taken the risks of small profit for getting the job).
By applying the econometric model can be identified only the field where will reach the ratio of the winner of the contract and the amount initially estimated.

6. CONCLUSIONS

In this paper we verified the existence of strong links between the winning percentage of public procurement contracts in Romania, the degree of their admissibility and the number of bids received.
We identified an econometric model for modeling the phenomenon of procurement for a certain percentage of the estimated function, depending on the number of received offers.
This paper evaluates one of the most important determinants of procurement process, competition and proposes improving the management in the bidding process by using the econometric model.
The model can be implemented by the bidders to obtain practical results in predicting the field of 5% where the ration between the value of the winning offer and the estimated value of the contract will be, if the bidders know the number and capacity of the other potential bidders.
To succesful use the model for the determination, the biders must have a good knowledge of the competition. Using this econometric model to predict the value of the lowest offer, the bidders may decide to offer or not to. The final decision depends on the minimum limit of the expected profit.
Given that, for the contracts awarded with very large percentage of the initial estimated value of the contract, the number of the rejected offers is large, in the future is necessary to identify the reasons for rejection of the tenders and finding solutions to improve their activity to avoid rejection.

7. REFERENCES

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