Universal Journal of Management 3(5): 179-186, 2015
DOI: 10.13189/ujm.2015.030502
http://www.hrpub.org

A Methodology to Detect the Deviations of the Project's Budget Compared to Market Prices

José Luis Fuentes-Bargues[1,2,*], Mª Carmen González-Cruz[1], Cristina González-Gaya[3], Mª del Prado Díaz de Mera-Sánchez[4]

[1]Department of Engineering, Polytechnic University of Valencia, 46022 Valencia, Spain
[2]Department of Chemical Engineering, University of Valencia, 46100 Burjassot, Valencia, Spain
[3]Department of Construction Engineering and Manufacturing, National University of Distance Education, 28040 Madrid, Spain
[4]Department of Chemical Technology and Energy, King Juan Carlos University, 28933 Móstoles, Spain

Abstract The budget of a project reflects the cost of the investment needed to build an infrastructure, install a system or acquire new materials or supplies. A well-formulated budget in accordance with market prices, allows contractors to prepare offers according to their technical, economic and financial characteristics. On the other hand, it avoids current philosophies that aim to get the contract at any price. Philosophies subsequently used to point out problems and claims during the execution of the project (contradictory prices, delays, etc.) in order to recover some or the entire economic bid carried out during the tendering. In this paper a simple and fast methodology is developed to check if the tendering price is in accordance with market prices, so that the economic viability of the project is not at risk. The application of the methodology on a sample of projects allows us to check the influence of the type of project (civil or building) on the characteristics of the budget. It also allows us to point out the insufficient economic endowment of the projects as the start of the subsequent problems during the execution of the work.

Keywords Budget, Tendering, Public Procurement, Building, Civil Works, Market Prices

1. Introduction

Public procurement in first world countries makes up between 10 to 15% of their gross domestic product (GDP) [1-2], and sometimes these values are even greater, so competitive bidding is one of the fundamental pillars of the construction sector [3-6].

Public procurement of construction works has a number of characteristics that distinguish it from the private sector [3,7] and at the same time give it a greater complexity [8-10].

The award of a contract by an administration depends on a number of endpoints. In the European Union, Directive 2004/18/EC [11] regulates public procurement and describes the tendering criteria (such as price, quality technical merit, aesthetics and functional characteristics, environmental characteristics, running costs, profitability, customer service, technical assistance, delivery date, execution time, etc.) that allow the contracting authority to select the economically most advantageous tender (EMAT).

The EMAT, based on several criteria, is traditionally called the procedure contest, while the bid which is based solely on a single criterion, which must inevitably be the price, is the procedure traditionally known as auction. These rules are common practice in most of the public procurement sector and are also used in many procedures in the private sector [12-13].

The evaluation criteria used can be divided into two groups: the criteria evaluated by formulae and those evaluated by value judgments. For the former, various predetermined formulae can be employed, including aspects such as price, delivery time, the necessary labor for the project, etc. However, the scores for the criteria assessed by value judgments will always contain some subjective bias by the individual who performs the evaluation.

Research on tendering criteria has traditionally focused on developing optimal bidding price prediction models or bidding strategies [14-17]. The decision about whether to participate in a tender is complex, and the decision factors and their relative importance vary between businesses [9,18-23]. Models have been developed that assist decision making based on: neural networks [24-27], AHP-ANP techniques [28-29], game theory [30], DEA techniques [31-32], graphical models [33-34] or a combination of several techniques [35].

Regarding the scoring formulae used (Economic Scoring Formulae, ESF), there are studies that analyze their behavior and establish guidelines or recommendations for use [36-40].

Once the bids have been submitted, the contracting

authority considers the bidders' proposals. The bidders may occasionally deviate from rational behavior and make anomalous offers (also known as outliers), at prices much lower or higher than the other bidders.

Impossibly high offers, which do not expect to win the auction, are known as courtesy bids [41-42] and may be made for any number of reasons; the buyer may have little interest in the contract, or lack the resources and skills to properly submit a suitable bid, or may simply make an offer to ensure being considered in future procedures [43].

Impossibly low offers (known as Abnormally Low Tenders (ALT)) [44], are those considered as disproportionate if too low to provide a normal level of profit, and cannot be explained on the basis of construction methods, the technical solution chosen, the originality of the work or the favorable conditions of the bidder.

There are many reasons to explain this behavior: the bidder may be in desperate need of the contract, even though it may turn into a financial loss. He may lack experience in auctions or may have miscalculated the costs and the return needed to recoup its funding [45-46]. There have also been cases in which a low bid was deliberately submitted to oust a competitor, protect a company's position in the market or gain access to a new market [47-48], a phenomenon known as predatory pricing [49].

In an industry as important as construction, with poor profitability and insufficient company resources, ALTs have consequences for national economies and international competitiveness. The final cost of the work is in many cases above the price at which the project was awarded [50-54].

Some authors have analyzed the mathematical formulae or tools to determine which bids are 'abnormal' or 'risky' [43, 55-56]. Some methods detect ALTs by assessing the deviation of the offer from the average bid [57-58], while others use graphical methods [59].

The reduction in the number of investments in public procurement and the rules which govern it, have lead bidders to create business policies that could be summarized as "get the contract and run" [60] or "sign the contract and claim" [61]. These policies are based on getting the contract at all costs (with abnormally low bids or very significant improvements for the administration) and transferring the economic problems to the execution of the work with substantial claims on erroneous measurements, inconsistent prices, modified projects, etc. In the first place, these actions involve a delay in the execution of the projects and at times threaten the viability of the project [62-63].

Many of these situations could be avoided if the projects were financially sustained, i.e. if the tendering price estimated was in accordance with the market price, as indicated by the regulations.

In this paper a methodology from the point of view of the administration is developed. The objective of the methodology is to check if the tendering price is in accordance with the market prices, to avoid that the economic viability of the project is at risk. This methodology will be applied previously to the tendering of the project. If the budget of the project is not according to the market prices the project will not tendered and will be re-studied.

The paper is structured by five sections. First section is the introduction on the topic. Section two of this paper, "Definitions" describes a series of basic concepts for the development of the methodology. In section three, the methodology is developed and an application example is given. In section four, "Results", the results of applying the methodology on a list of thirty-nine projects are presented, and finally, section five shows the conclusions from the article.

2. Definitions

According to the European directives, the economic value of the tender is defined as the contract execution budget (CEB) plus value added tax (VAT). CEB reflects the investment required to implement a project and is composed of the material execution budget (MEB), overheads (OH) and profit (P).

MEB reflects the cost of implementing the various units that make up the project, while OH reflects a percentage of between 13% and 17% of the MEB that covers the structural, financial, tax, and other costs that fall on the contractor. The contractor's profit is seen as a percentage of MEB – and is usually 6%.

The cost or price of each of the project work units consists of direct costs (DC) and indirect costs (IC). DC includes the labor (LAB) directly involved in the execution of the work unit, materials on site (MAT), as well as the staff costs, fuel and energy used operating machinery and equipment, and depreciation and maintenance of equipment and facilities (MACH). These costs are reflected formally in the budget document known as the simple pricing table (labor, materials and equipment). Additionally, all units of work usually include a small percentage called supplementary direct costs (SDC) that includes small items of equipment or tools that are difficult to quantify.

Some work units may include other simple work units called ancillary prices: such as mortar and concrete. These are defined in the simple pricing tables of the budget document, and they are termed as AP in the present study.

IC includes installation costs for on-site offices, communications, construction of warehouses, workshops, temporary building for staff, laboratories, costs of technical and administrative staff assigned exclusively to the work, and contingencies. IC is usually computed as a constant percentage of DC for all project work units – depending on the nature of the work, the total budget, and the expected project completion time.

In short, we can calculate that the material execution budget (MEB) is equal to:

$$MEB = MACH + LAB + MAT + AP + SDC + IC \quad (1)$$

3. Materials and Methods

The proposed methodology is developed to check if the tendering price is in accordance with the market prices, in order to avoid that the economic viability of the projects is at risk. This methodology has some phases (Figure 1).

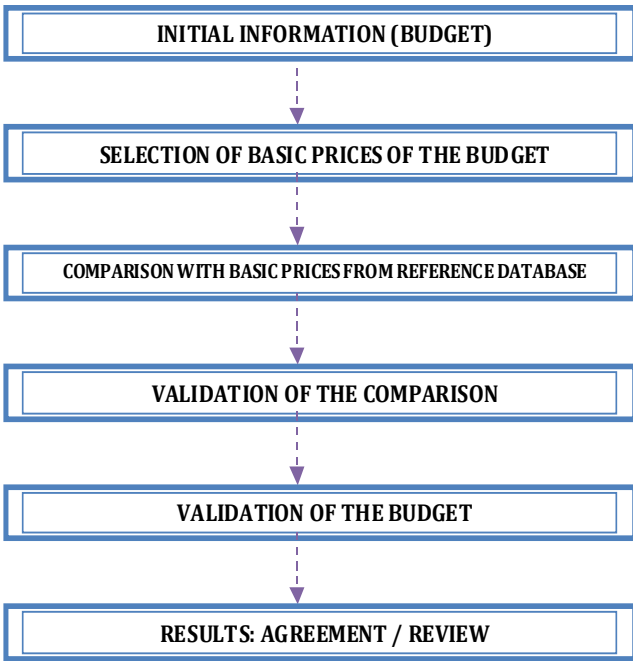

Figure 1. Methodology. Source: Prepared by authors

The first step of the methodology is to collect the information of the Project, in particular of the Budget and the Annex of Prices.

The second phase consists in the selection of basic prices of the materials, labor and machinery with the greatest economic weight in the project. Prices are selected from basic price tables using a total of ten units from each category (labor, machinery and materials).

In the third phase a check between the selected basic prices and the basic prices on the reference database is carried out. In this case, the construction prices database used by the project team (if the information is available) will be chosen as a baseline database. Otherwise, the database of construction prices of the regional or national body where the project is located will be used.

The sample of selected prices is considered valid when at least 20 basic prices (of the 30 selected) from the project are compared with 20 basic prices from the reference database. The acceptance criterion for basic prices is that there is no more than a 15% difference above or below database prices.

Finally, a project is considered valid from the price point of view when at least 70% of basic prices (namely, 14 items) have been accepted after comparison with the reference prices.

If a project is deemed valid, then the contracting authority will consider that the cost of the project matches market prices and so the tendering file will be processed. If a project is considered invalid, the project will be returned to the project team for an analysis of the proposed solution with respect to market prices (including materials used and construction processes).

Projects involving implementation processes, organizational processes, technologies, materials, or locations that are unusual may be regarded as special projects and the contracting authority, having submitted the project to the corresponding economic analysis described above, must decide on the viability of the project. If the project is declared economically invalid but the contracting authority decides to make it viable because of its special characteristics, then this decision must be appropriately justified with an explanatory document placed in the project file.

The methodology described has been applied over a sample of thirty nine projects tendered by public administrations. The projects included in the sample have been tendered between 2008 and 2011 and the required collected information has been the economic data, the sheets of administrative clauses and the results of the tender.

In Tables 1, 2 and 3 an example of the procedure for each of the projects studied is shown, indicating the selected basic prices corresponding to Labor, Machinery and Materials and the comparison with those prices from the reference database. The data presented are for the project No. 6 tendered by the *Consell Valencia de l'Esport*, corresponding to the "Enabling Works in the Building for the Socio Cultural and Sports Center in Mislata (Valencia, Spain)".

Table 1. Comparison of Materials Basic Prices. Source: Prepared by authors

Materials	Project Price (euros)	Database Price (euros)	Project Price / Database Price (%)	Comparison	Project Amount (Measurement x Project Price) (euros)
Vitomodul Viessmann heating unit 575 KW	31,565.71	---	---	---	31,565.71
Biomass Boiler 300 KW	50,486.97	---	---	---	50,486.97
Astral Heat Pump BDP30F	14,954.06	---	---	---	74,770.30
Team BC Ciatesa Roof Top Model IPF-120-U MC11	10,008.92	---	---	---	30,026.76
Ribbed panel of 30 mm thickness	123.43	19.81	623.07%	OUT OF RANGE	35,987.50
Platform consisting of galvanized structural steel	123.14	---	---	---	28,691.62
Acoustic panel	117.29	---	---	---	169,263.78
Black Marquina marble tile 40x40x2 cm	41.05	---	---	---	55,180.27
HA 25 / B / 20 / IIa	64.6	73.58	87.80%	IN RANGE	52,571.67
Fiberglass Panel	16.46	---	---	---	30,590.91

Table 2. Comparison of Labor Basic Prices. Source: Prepared by authors

Labor	Project Price (euros)	Database Price (euros)	Project Price / Database Price (%)	Comparison	Project Amount (Measurement x Project Price) (euros)
First Officer in construction	16.97	20.3	83.60%	OUT OF RANGE	248,261.24
Specialized Workman in construction	15.92	19.05	83.57%	OUT OF RANGE	95,029.11
Pawn ordinary construction	15.81	18.94	83.47%	OUT OF RANGE	251,754.14
First Officer in Metal	15.25	16.41	92.93%	IN RANGE	38,244.83
Expert in Metal	14.77	15.9	92.89%	IN RANGE	23,754.96
First Officer in Plumbing	15.25	16.41	92.93%	IN RANGE	23,924.83
Second Officer in Metal	14.81	15.95	92.85%	IN RANGE	26,167.60
First Officer in Painting	15.96	19.82	80.52%	OUT OF RANGE	30,714.54
First Officer in Electricity	11.87	16.41	72.33%	OUT OF RANGE	26,719.62
Second Officer in Plumbing	14.81	15.95	92.85%	IN RANGE	19,011.85

Table 3. Comparison of Machinery Basic Prices. Source: Prepared by authors

Machinery	Project Price (euros)	Database Price (euros)	Project Price / Database Price (%)	Comparison	Project Amount (Measurement x Project Price) (euros)
Mobile crane without platform (50 T)	123.07	216.17	56.93%	OUT OF RANGE	13,523.42
Exec team. Concrete screens	52.69	---	---	---	28,586.17
Retro tires. 70 cv 0.34 m3	29.73	50.44	58.94%	OUT OF RANGE	9,127.32
Transport Truck 15 tons	27.65	49.05	56.37%	OUT OF RANGE	26,061.73
Mechanical trowel	14.37	4.12	348.79%	OUT OF RANGE	23,541.93
Proportion of transport-screen machine	5.25	9.22	56.94%	OUT OF RANGE	8,138.03
Use of Steel lattice girder reticular formwork	4.23	7.43	56.93%	OUT OF RANGE	6,637.16
Loader tires102 cv 1.7 m3	11.89	44.61	26.65%	OUT OF RANGE	3,982.73
Use of Black Pine Wood Basin	19.69	34.6	56.91%	OUT OF RANGE	3,641.29
Use of Plastic bucket 80x76x25 enc. reticular	1.09	1.93	56.48%	OUT OF RANGE	4,234.99

Table 4. Summary Table of the comparison between Project Basic Prices and Basic Prices Database

Group of Basic Prices	Nº of Compared Basic Prices	Out of Range	In Range
Labor	10	5	5
Machinery	9	0	9
Materials	2	1	1
Prices in Range (%)		28.57	

Group of Basic Prices	Compared Amount (euros)	Amount in range (euros)	Amount out of range (euros)	Amount in range (%)	Amount out of Range (%)
Labor	783,582.72	131,104.07	652,478.65	16.73	83.27
Machinery	98,888.60	0.00	98,888.60	0.00	100.00
Materials	88,559.17	52,571.67	35,987.50	59.36	40.64
Total	971,030.49	183,675.74	787,354.75		
Total Amount in range (%)		18.92			

Finally, Table 4 summarizes the number of compared basic prices and the total economic value of each group studied. In this case the sample of basic prices is considered valid because it is possible to compare a total of 21 prices. However, the project is not considered valid from an economic point of view because only six prices have been considered within the range (28.57 % of price) and the amount of these six basic prices represents only 18.92% of the amount compared. This work should be re-examined by the editorial team or by the administration.

4. Results

The study sample consists of thirty-nine projects, twenty for the Civil Works subsector and nineteen for the Building subsector. These projects were tendered between 2008 and 2011, 11% in 2008 and 2009, 37% in 2010 and 52% in 2011. The geographical scope of the contracting authorities is divided into Local, Provincial, Regional and National (42%, 5%, 37% and 16% respectively). Depending on the number of criteria, thirty-six of the projects are tendering by the EMAT and three by the best economic offer (auction).

The first phase includes an analysis of the available information. Only twenty of the thirty-nine projects from the initial sample could be compared due to important factors. First of all, there is not enough information in the project (budget and annex of prices). Secondly, the economic documentation is not accessible in electronic format (FIEDBC3 format[1]). Of the nineteen projects which we cannot work with, fourteen belong to the Civil Works subsector and five of them to the Building subsector. In the structure of civil works projects, basic prices are included in the Annex of Prices, but only the unit prices, not the total amount of each basic price that exists in the project.

The sample that starts working in phase 2 is composed of twenty projects, twelve from the Civil Works subsector and eight from the Building subsector. Regarding the geographical scope of the contracting authority: three are National, nine are Regional and eight Local. Depending on the type of award procedure, eighteen are awarded by the EMAT and two by auction.

The ten highest basic prices of each group (Labor, Equipment and Materials) are selected and compared (phase 3) to the basic prices from the reference databases. As a result of phase 4, fifteen of the twenty projects of the sample are considered valid.

If the projects considered valid are analyzed in more detail, an average of 23.47 compared basic prices is obtained, with an average distribution of 9.47 prices for labor, 8.80 basic prices for machinery and 5.20 basic prices for materials. In economic terms, this means an average compared amount of 887,584.48 euros (47.20% corresponding to labor, 20.54% to machinery and 32.25% to materials). At a global level, the compared basic prices represent an average of 42.60% of the MEB of the different projects.

Of the fifteen projects with a validated sample, eight belong to the Civil Works subsector and seven to the Building subsector. If the results are analyzed in terms of subsectors, the average number of compared prices in both subsectors is similar, 23.38 in Civil Works and 23.57 in Building, and their distribution is similar too (9.25 and 9.71 respectively in Labor, 8.88 and 8.71 in Machinery, 5.25 and 5.14 in Materials). However, there is a significant difference in the budget's average amount in relation to the MEB, 50.19% in Building and only 33.92% in Civil Works. If the compared amount is analyzed by groups, (Labor, Machinery and Materials), the results are 30.90%, 31.39% and 37.70% correspondingly for Civil Works, and 67.32%, 7.14% and 25.53% respectively for Building.

These data allow us to conclude that by comparing the same number of prices in Building and Civil Works, a bigger amount of the budget is validated in Civil Work projects, primarily because there are fewer units of work and the influence on the overall project is greater. The low percentage of basic prices of Machinery compared to basic prices of Labor in the Building Projects is a faithful reflection of the characteristics of this type of project, where the influence of labor in the whole process is crucial.

If the analysis is performed by geographical scope, it is

1 Standard exchange format of construction database

determined that six of the projects from the validated sample are local, seven regional and two national. At local scope, 22.67 prices are compared versus 23.86 prices at regional level, but the amount of budget represents 47.39% regarding the MEB at local scope versus 37.1% at regional level. This difference is mainly due to the fact that the sample of projects at regional scope is primarily composed by works of the Building subsector.

Once the samples are validated the next step is phase 5 (validation of the project budget), considering it validated if at least fourteen of the selected basic prices are within the range of ± 15% from the basic prices of the reference database. Of the fifteen projects available, only two projects have been validated. One belongs to the Civil Works subsector and was tendered by the Traffic Division Headquarters, consisting in the "Construction of a driving track for 4-wheel vehicles in the Traffic School of the Spanish Civil Guard in *Mérida* (*Badajoz*)" with 20 basic prices validated and 38.50% of MEB validated (65.45% on the amount compared).

The other project belongs to the Building subsector and was tendered by an entity of the government of the Community of Valencia called "*Construcciones e Infraestructuras Educativas de la Generalitat Valenciana (CIEGSA)*". The project consisted on the "Educational Center *José Pedrós* in the town of *Piles* (Valencia, Spain)" with 16 basic prices validated and 9.43% of the MEB validated (25.17 % from the amount compared).

The remaining Projects should be returned to the project team, or if appropriate, to the offices of Project Supervision of the contracting authority, for an analysis of the proposed solution and a re-study (including materials used and construction processes) in order to make the project economically viable in accordance with market prices.

Even though only two works have been validated from an economic point of view, if the sample is analyzed globally, the average amount of budget validated corresponds only to 8.83% of MEB (25.84% of the amount compared). Analyzing the results by type of prices, one finds that the greatest validation of basic prices, both in number and amount, occurs in the prices of Labor, followed by Materials and finally by Machinery.

This analysis is similarly performed with respect to the Civil Works and Building subsectors, and it may be concluded that the average amount of budget validated regarding the MEB is 10.71% in Civil Work projects and 6.69% in Building projects. In Civil Works, the most validated basic prices correspond to the Materials (46.64% in relation to the MEB and 34.75% in relation to the amount compared) whereas in Building, the most validated basic prices are Labor (50.06% with respect to the MEB) and Machinery (32.36% with respect to the amount compared).

If this analysis is based on the geographical scope, the average amount of the budget validated only reaches a value of 7.40% for local projects and 6.46% for projects of regional scope. At local scope the group with the most validated prices is Labor, with 62.05% of the MEB and at regional scope, Materials with 33.45% of the MEB.

5. Conclusions

The methodology developed allows a simple and fast comparison of a considerable amount of the Project Budget. In the study sample, an average budget of 42.60% of the MEB is compared with an average of 23.47 compared basic prices.

The application of the methodology endorses inherent characteristics of the projects for each of the subsectors, such as the large amount of Labor used in projects of Building subsector or the importance of Machinery in Civil Work projects. The characteristics of these projects allow us to conclude that by comparing the same number of prices in Building and Civil Works, a bigger amount of the budget is validated in Civil Work projects, primarily because there are fewer units of work and the influence on the overall project is greater.

There is no influence of the geographical scope in the characteristics of the budget; it is marked by the type of subsector in which it is framed.

The pricing of the works remains one of the most conflicting issues. The administration wants to carry out more actions or more complete actions than what the funding permits and it tends to perform more complex projects or projects with insufficient budgets, causing problems during the execution of the works.

This fact is reflected in the application of the methodology where only two of the thirty-nine projects analyzed have similar basic prices (± 15%) to basic prices of the reference database. This means that only two of the projects in the sample have a budget in line with market prices, a necessary condition according to the European directives.

The number of projects that are tendered economically poor along with the reduction in the number of investments in public procurement have lead bidders to create business policies that could be summarized as "get the contract and run" or "sign the contract and claim".

These policies are based on getting the contract at all costs (with abnormally low bids or very significant improvements for the administration) and transferring the economic problems to the execution of the work with substantial claims on erroneous measurements, inconsistent prices, modified projects, etc. These actions involve a delay in the execution of the projects and at times threaten the viability of the project, so the government policies must not permit the tendering of projects without a budget according to the market prices.

REFERENCES

[1] Global Trade Negotations. Online available from: <http://www.progressivestates.org>.

[2] Organization for Economic Co-operation and Development

(OECD Observer). Bribery in Procurement, Methods, Actors and Counter-Measures, 2007.

[3] J.M.W. Wong, Y.H. Chiang, T.S. Ng. Construction and economic development: the case of Hong Kong, Construction Management and Economics, Vol.26, No.8, 813-824, 2008.

[4] P. De la Cruz-López, A. Del Caño-Gochi, E. De la Cruz-López. Downside Risks in Construction Projects Developed by the Civil Service: The Case of Spain, Journal of Construction Engineering and Management, Vol.132, No.8, 844-852, 2006.

[5] J.L. Fuentes-Bargues, C. González-Gaya. ¿Como distinguir ofertas con valores desproporcionados?, Dyna: Ingeniería e Industria, Vol.88, No.2, 132-135, 2013.

[6] J.L. Fuentes-Bargues, C. González-Gaya, M.C. González-Cruz. La contratación pública de obras: situación actual y puntos de mejora. Informes de la Construcción, Vol.67, No.537, doi://dx.doi.org/10.3989/ ic.12.130, 2015.

[7] P. Ballesteros-Pérez, M.C. González-Cruz, A. Cañavate-Grimal. Mathematical relationships between scoring parameters in capped tendering, International Journal of Project Management, Vol.30, No.7, 850-862, 2012.

[8] J.R. Splitter, C.J. McCracken. Effective project management in bureaucracies, Proceedings., AACE. International Trans. Annual Meeting, Vancouver, Canada. PM.6.1-PM.6.10., 1996.

[9] D. Drew, M. Skitmore. The effect of contract type and size on competitiveness in bidding, Construction Management and Economics, Vol.15, 469-489, 1997.

[10] Project Management Institute (PMI). Government extension to a guide to the project management body of knowledge. PmBok Guide, Ed. Project Management Institute, Newton Square, Pa, 2000.

[11] European Union. Directive 2004/18/CE of the European Parliament and of the Council of 31th March 2004, on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts. Official Journal of the European Union, 30th April 2004, L 134, 114-240.

[12] P. Bajari, G. Summers. Detecting collusion in procurement auctions, Antitrust Law Journal, Vol.70, No.1, 143-170, 2002.

[13] W.R Gayle, J. Richard. Numerical solutions of asymmetric, first-price, independent private values auctions, Computational Economics, Vol.32, No.3, 245-278, 2008.

[14] M.H. Rothkopf. A model of rational competitive bidding, Management Science, Vol.15, No.7, 362-373, 1969.

[15] P. Näykki. On optimal bidding strategies, Management Science, Vol.23, No.2, 687-705, 1976.

[16] S.G. Naoum. Critical analysis of time and cost of management and traditional contracts, Journal of Construction Engineering and Management, Vol.120, No.4, 687-705, 1994.

[17] M.H. Rothkopf, R.M. Harstad. Modeling competitive bidding: a critical essay, Management Science, Vol.40, No.3, 364-384, 1994.

[18] I. Ahmad, I. Minkarah. Questionnaire survey on bidding in construction, Journal of Construction Engineering and Management, Vol.4, No.3, 229-243, 1988.

[19] O.O. Odusote, R.F. Fellows. An examination of the importance of resource considerations when contractors make project selection decisions, Construction Management and Economics, Vol.10, No.2, 137-151, 1992.

[20] A.A. Shash. Factors considered in tendering decision by top UK contractors, Construction Management and Economics, Vol.11, No.2, 111-118, 1993.

[21] A. Fayek, I. Ghoshal, S. AbouRizk. A survey of the bidding practices of Canadian civil engineering construction contractors, Canada Journal of Civil Engineering, Vol.26, 13-25, 1999.

[22] M. González-Díaz, B. Arrunada, A. Fernández. Causes of subcontracting: evidence from panel data on construction firms, Journal of Economic Behavior and Organization, Vol.42, No.2, 167-187, 2000.

[23] X. Cui, V.S. Lai. Bidding strategies in online single-unit auctions: Their impact and satisfaction, Information and Management, Vol.50, No.6, 314-321, 2013.

[24] K.C. Lam, S.T. Ng, H. Tiesong, M. Skitmore, S.O. Cheung. Decision support system for contractor pre-qualification-artificial neural network model, Engineering Construction and Architectural Management, Vol.7, No.3, 251-266, 2000.

[25] R. Bendaña-Jácome, A. Del Caño-Gochi, P. De la Cruz-López, A. Castro-Rascado. Selección multicriterio de contratistas de obras. Enfoque basado en redes neuronales, Dyna Ingeniería e Industria, Vol.85, No.1, 71-84, 2010.

[26] E. Plebankiewicz. Contractor prequalification model using fuzzy sets, Journal of Civil Engineering and Management, Vol.15, No.4, 377-385, 2009.

[27] A. Nieto-Morote, F. Ruz-Vila. A fuzzy multi-criteria decision-making model for construction contractor prequalification, Automation in Construction, Vol.25, 8-19, 2012.

[28] J.P. Pastor-Ferrando, P. Aragonés-Beltrán, A. Hospitaler-Pérez, M. García-Melón. An ANP and AHP based approach for weighting criteria in public works bidding, Journal of the Operational Research Society, Vol.61, 905-916, 2010.

[29] W. Wei-Chih, Y. Wen-der, Y. I-Tung, L. Chun-Chang, C. Ming-Tsung, C. Yuan-Yuan. Applying the AHP to support the best-value contractor selection-lessons learned from two case studies in Taiwan, Journal of Civil Engineering and Management, Vol.19, No.1, 24-36, 2013.

[30] S. Mitkus. Public Procurement of Construction Work: A Bimatrix Game Model, Journal of Civil Engineering and Management, Vol.7, No.4, 334-338, 2001.

[31] K. Tone. A slacks-based measure of super-efficency in data envelopment analysis, European Journal of Operational Research, Vol.143, No.1, 32-41, 2002.

[32] M. Falagario, F. Sciancalepore, N. Costantino, R. Pietroforte. Using a DEA-cross efficiency approach in public procurement tenders, European Journal of Operational Research, Vol.218, No.2, 523-530, 2012.

[33] P. Ballesteros-Pérez, M.C. González-Cruz, J.P.

Pastor-Ferrando, M. Fernández-Diego. The iso-Score Curve Graph. A new tool for competitive bidding, Automation in Construction, Vol.22, 481-490, 2012.

[34] P. Ballesteros-Pérez, M.C. González-Cruz, A. Cañavate-Grimal. On competitive bidding: Scoring and position probability graphs, International Journal of Project Management, Vol.31, No.3, 434-448, 2013.

[35] C. Min-Yuan, H. Chia-Chi, T. Hsing-Chich, D. Hoang-Linh. Bidding Decision Making for Construction Company using a Multi-criteria Prospect Model, Journal of Civil Engineering and Management, Vol.17, No.3, 424-436, 2011.

[36] P.G. Ioannou, S.S. Leu. Average-bid method -competitive bidding strategy-, Journal of Construction Engineering and Management, Vol.119, No.1, 131-147, 1993.

[37] M. Rocha de Gouveia. The price factor in EC public tenders, Public Contract Law Journal, Vol.31, No.4, 679-693, 2002.

[38] F. Waara, J. Bröchner. Price and Nonprice Criteria for Contractor Selection, Journal of Construction Engineering and Management, Vol.132, No.8, 797-804, 2006.

[39] L.A. Ballesteros-Moffa. La selección del contratista en el Sector Público: Criterios reglados y discrecionales en la valoración de las ofertas, Revista de Administración Pública, Vol.180, 21-57, 2009.

[40] J.L. Fuentes-Bargues, C. González-Gaya. Analysis of the Scoring Formula of Economic Criteria in Public Procurement, International Journal of Economic Behavior and Organization, Vol.1. No.1, 1-12, 2013.

[41] J. Whitakker. A study of competitive bidding with particular reference to the construction industry, Ph.D. thesis, City University, London, 1970.

[42] R. McCaffer. Contractor´s bidding behaviour and tender price prediction, Ph.D. thesis, Loughborough University of Technology, 1976.

[43] M. Skitmore. Identifying non-competitive bids in construction contract auctions, OMEGA: International Journal of Management Science, Vol.30, 443-449, 2002.

[44] European Union. DG III Group on Abnormally Tenders. Prevention, Detection and Elimination of Abnormally Low Tenders in the European Construction Industry. Report as agreed by the WG on 19th May 1999. Online available from: <http://www.ceetb.eu/docs/Reports/DG3ALT-final.pdf>.

[45] A. Calveras, J.J. Ganuza, E. Hauk. Gambling for resurrection in procurement contracts, Journal of Regulatory Economics, Vol.26, 41-68, 2004.

[46] M. Gunduz, V. Karakan. Damage to treasury: abnormally low tenders in public construction Works, Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, Vol.1, 130-136, 2009.

[47] G. Alexandersson, S. Hulten. Predatory bidding in competitive tenders: a Swedish case study, European Journal of Law Economics, Vol.22, 73-94, 2006.

[48] G. Alexandersson, S. Hulten. High and low bids in tenders: strategic pricing and other bidding behaviour in public tenders of passenger railway services, Annals of Public and Cooperative Economics, Vol.78, 161-194, 2007.

[49] B. Kobayashi. The law and economics of predatory pricing, George Mason University Law and Economics Research Paper Series, Paper 08-41, 2008.

[50] B. Flyvbjerg, M.S. Holm, S. Buhl. Underestimating costs in public work projects. Error or lie?, Journal of the American Planning Association, Vol.68, 279-295, 2002.

[51] B. Flyvbjerg, M.S. Holm, S. Buhl. How common and how large are costs overruns in transport infrastructure projects?, Transport Reviews, Vol.23, 71-88, 2003.

[52] J.J. Ganuza. Competition and cost overruns in procurement, The Journal of Industrial Economics, Vol.55, 633-660, 2007.

[53] J. Odeck. Cost overruns in road construction – what are their sizes and determinants?, Transport Policy, Vol.11, 43-53, 2004.

[54] A. Bucciol, O. Chillemi, G. Palazzi. Cost overrun and auction format in small size public works, European Journal of Political Economy, Vol.30, 35-42, 2013.

[55] R. McCaffer, A. Pettitt. Distribution of bids for buildings and roads contracts, Operations Research Quartely, Vol.27, No.4, 835-883, 1976.

[56] J.L. Fuentes-Bargues, C. González-Gaya. Determination of Disproportionate Tenders in Public Procurement, Journal of Investment and Management, Vol.2, No.1, 1-9, 2013.

[57] P.L. Conti, M. Naldi. Detection of anomalous bids in procurement auctions, Decisions Support Systems, Vol.46, 420-428, 2008.

[58] P.L. Conti, L. De Giovanni, M. Naldi. A rank-and-compare algorithm to detect abnormally low bids in procurement auctions, Electronic Commerce Research and Applications, Vol.11, 192-203, 2012.

[59] P. Ballesteros-Pérez, M.C. González-Cruz, A. Cañavate-Grimal, E. Pellicer. Detecting abnormal and collusive bids in capped tendering, Automation in Construction, Vol.31, 215-229, 2013.

[60] A. Ruiz-Ojeda. Derecho de la contratación pública y regulada, Ed. Civitas, Madrid, 2004.

[61] A. Mohamed-Khaled, S. Khoury-Shafik, M. Hafez-Sherif. Contractor´s decision for bid profit reduction within opportunistic bidding behaviour of claims recovery, International Journal of Project Management, Vol.29, No.1, 93-107, 2011.

[62] J.F. Martín-Seco. El Precio como criterio de adjudicación en los concursos, Cuenta con el IGAE, Vol.7, 11-26, 2003.

[63] C. Padrós-Reig. La regulación de la baja temeraria en los procedimientos de contratación. Fundamentación actual e historia normativa, Revista de Administración Pública, Vol.181, 267-300, 2010.