DE GRUYTER OPEN
DOI: 10.1515/ace-2015-0037
ARCHIVES OF CIVIL ENGINEERING
Vol. LXI ISSUE 4 2015

CLASSIFICATION OF THE BID/NO BID CRITERIA – FACTOR ANALYSIS

A. LEŚNIAK[1]

Abstract**:** For the construction company, tendering is the most popular way of acquiring contracts. The decision to participate in the tender needs to be made carefully, as it affects the condition of the company and is an important aspect in its quest for success. The bid/no bid decision making is a complex process involving a number of factors. The research carried out so far has mainly concerned the identification of the various kinds of influences on contractors' bidding decisions. The researchers, on the basis of contractors' opinions, created rank lists in an attempt to categorize the factors. In this paper the author employs factor analysis which belongs to basic methods of multi-dimensional data analysis. The paper's aim is first to depict an output set of observed variables, that is bid/no bid factors, in terms of a smaller set of latent variables which cannot be directly observed and then to interpret the dependencies between them.

Keywords: bid/no bid factors, contractor's bidding decision, factor analysis

1. INTRODUCTION

The choice of the tender to participate in is vital for the company in order to build its position on the market. The ability to select appropriate contracts may not only determine the overall condition and success of the company, but even its survival. Resignation from entering the tender means losing profits and possibly failing to establish new business relations or to develop the company. A bid/no bid decision depends on a number of factors related to both the company and the project under tender. The factors influencing bidding decisions, in turn, are determined by the environment and the market in which the company operates. Researchers around the world have repeatedly

[1] Assistant professor. Ph.D., Eng. Cracow University of Technology, Faculty of Civil Engineering, Institute of Construction and Transportation Engineering and Management, ul. Warszawska 24, 31-155 Kraków, e-mail: alesniak@izwbit.pk.edu.pl

attempted to identify them, thus contributing to the creation of models facilitating bid/no bid decisions. The factors identified were usually evaluation criteria of a particular tender and, at the same time, input data for the models created.

The present paper aims at establishing key criteria determining bidding decisions, the observable results of which are particular factors identified on the basis of literature and surveys. For this purpose a factor analysis was performed to present an output set of observable variables by means of a smaller number of hidden variables, which cannot be directly observed. The paper uses a set of factors identified by the Polish contractors.

2. TENDERING AS THE MOST COMMON TYPE OF PROCUREMENT

Methods of obtaining contractors in the construction market depend on the type of the market, type of contract and its value. In the case of the public sector in Poland, the contracting authority is obligated to observe the Public Procurement Law (The Act of 29 January 2004) [18]. The Act specifies seven types of public procurement procedures and the choice depends on the conditions and restrictions which were introduced: open tendering, restricted tendering, negotiated procedure with publication, negotiated procedure without publication, competitive dialogue, single-source procurement procedure and electronic bidding. Selection of the procedure depends solely on the prerequisites and limitations specified in the said Law, and these do not address the project delivery system [11].

Open tendering is a bidding process, where all parties interested and responding to a public contract notice are invited to submit a tender (art. 39 of the PPL). On the contrary, a restricted tendering is a mode in which, in response to a public notice, contractors submit applications to participate in bidding, whilst only those invited to tender may submit their tenders (in accordance with art. 47 of the PPL). The information included in [14] reveals that that the most common type of public procurement used is open tendering. This type of procurement is allowed by the Act in every case, similarly to the restricted tendering. However, the latter is selected by the contracting authorities much less frequently.

Use of the tender procedure has several advantages:

- no requirement to state reasons and no need of any evidence (art. 39 of the PPL),
- it is the most competitive type of procurement - bids may be submitted by all interested contractors,

- the procedure is not complicated. The contracting authority announces a tender, in response all the interested parties submit bids, and the most advantageous bid is selected,
- procedural time is the shortest when compared to other types of procurement (in 2013, the average duration of this procedure was 38 days, while in the use of restricted bidding the duration is 81 days, and in the case of competitive dialogue as long as 180 days [18].

In the private sector, the client decides what form of search for a contractor is the most advantageous. The client can, of course, voluntarily use the types of procurement recommended by the Public Procurement Law, but it can also use other procedures. However, the leeway cannot result in a violation of law or serve to circumvent the law or violate the rules of social coexistence. No piece of legislation imposes on a private party the need to publish a contract notice in a particular place and a particular way (regardless of the value of the contract). The client may, for example, provide information about the tender to the public by posting the notice at its registered office, on its website or by using web portals. It can also inform only the selected contractors about the tender, by sending them an invitation to tender. Appropriately performed decision-making process can lower the risk of investing and execution of works [13], [16].

2. FACTORS DETERMINING THE BID DECISIONS

Once a tender is announced, construction companies must make a decision whether to participate in the tender procedure. If they are determined to do so, they start preparing their bid. This decision depends on a number of factors related to the contractors themselves, the project and the company's environment. Extensive research has been performed in order to establish the factors that determine the bid/no bid decision. The first studies were conducted among building contractors in 1988 in the United States [1], who identified 31 factors. In 1993 in Great Britain [17] 55 potential factors were found. In 2000 Wanous et al. [19] performed research in Syria, which resulted with a list of 38 factors ranked according to their importance to contractors. Research in Singapore [5] established a set of 51 factors. A more recent study in Saudi Arabia [2] revealed as many as 87 potential factors influencing bid/no bid decisions.

A detailed description and results of research conducted in Poland can be found in the study based on a survey implemented by [10] in which a large group of Polish contractors were invited to participate. 61 of them (out of 160, which accounts for 38%) responded to a questionnaire. Their task was to specify the degree of importance of 16 factors, marking them on a 1-7 scale. For each factor an average score was established. The questionnaire revealed that the three key factors affecting the

decision to participate in a tender for construction works were the following: the type of works, past experience with similar projects and contract conditions. On the other hand, the factors that had the least impact on the bidding decisions, in their opinion, were: possibility of subcontracting, the need for special equipment and the difficulty of the work. Among the responses, signed by 38% of companies from more than 75% of contracts resulting from bidding, and only 19% of respondents signed less than 25%.

Table 1 shows the most significant factors influencing the decision to participate in the tender for the implementation of construction works, based on various surveys among contractors in different countries.

Table 1. The most significant bid/no bid factors

COUNTRY / YEAR OF RESEARCH				
Great Britain [17] 1993	Syria [19] 2000	Singapore [5] 2000	Saudi Arabia [2] 2009	Poland [10] 2013
Need for work	Fulfilling the to-tender conditions imposed by the client	Type of project	The client financial capacity	Type of works
Number of competitors tendering	Financial capability of the client	Size of project	Project cash flow	Past experience with similar projects
Experience in such projects	Relation with and reputation of the client	Degree of technological difficulty	Ability of doing the project	Contract conditions

Source: based on [10]

3. CLASSIFICATION OF BIDDING CRITERIA

In the study selected experts evaluated 44 bidding procedures, with emphasis on the participation of the contractor. Each tender was described by means of 15 criteria (factors identified in Poland and presented in [10]) influencing the bid/no bid decision. Each factor was evaluated in accordance to a 1-7 scale, where 1 was the factor with no influence on the decision and 7 was the one with the greatest significance in decision making. The average evaluations of the criteria are presented in Table 2.

Table 2. The average evaluations of the factors under analysis

FACTORS INFLUENCING BID/NO BID DECISION	FACTOR'S AVERAGE EVALUATIONS
K_1 - Type of works	6,02
K2 - Past experience with similar projects	5,84
K3 - Contract conditions	4,18
K4 - Owner's reputation	5,16
K5 - Value of the project	4,68
K6 - Need of work	6,00
K7 - Size of the project	4,64
K8 - Profits from similar past projects	4,00
K9 - Time of project duration	4,91
K10 - Criteria of bid selection	4,07
K11 - Location of the project	5,27
K12 - Time for the preparation of the bid	5,27
K13 - Possible subcontractors	5,82
K14 - Necessity for specialized equipment	5,82
K15 - Degree of complexity of works	5,66

3.1. FACTOR ANALYSIS – DESCRIPTION OF THE METHOD

Factor analysis is one of the basic multi-dimensional methods of data analysis, the purpose of which is to interpret the structure of dependencies between many variables. The method depicts an output set of observed variables in relation to a smaller set of latent variables which cannot be directly observed. In this approach the observed variables Ki can be represented by linear functions of latent common factors Fk and a set of unique factors Ui, which characterise each particular variable [12]. The algorithm of factor analysis consists of the following stages:

1) Determining whether the variables satisfy the assumptions of factor analysis.

For this purpose, Bartlett's test of sphericity [3] is used, since it allows checking the hypothesis of independent variables. Alternatively, the computation of the Kaiser-Mayer-Olkin measure can be applied to specify the closeness of the relationships between observable variables (on a scale from 0 to 1). In practice it is assumed that the factor model can be used when the KMO value is greater than 0,5 [12].

2) Selecting a factor method and evaluating factor loadings.

There exist a number of factor analysis methods [15], such as: the principal axis method, maximum likelihood method, generalized least squares method or alpha method. Here, factor analysis involved

the maximum likelihood method [6], in which factor loadings are specified in such a way that the probability of the model's interpretation of the correlation coefficients of observed variables was the greatest.

3) Determining the number of factors.

Since establishing the list of factors is rather subjective, it is advisable to find a means to facilitate the process. Numerous studies have provided criteria and techniques that aid decision making [15]. One of them is Cattell's scree test [4], based on the interpretation of a scree plot with eigenvalues as the Y-axis and the corresponding components as the X axis joined with a line. The task is to find a break point marking the boundary between the hypothetical steep slope and a levelling off. Another common criterion is the criterion of the minimum eigenvalue proposed by Kaiser [8] which assumes that the analysis should include only these factors whose eigenvalue is greater than 1.

4) Rotation of factors.

The next step in the research is typically factor rotation which facilitates the interpretation of the results obtained. A considerable number of rotation methods exist [9], yet regardless of the method chosen, the share of the factors in the explanation of the common variance of the variables in the model is unchanged [12]. This study employed Varimax rotation, which minimizes the number of variables having high factor loadings and aids the interpretation of particular latent factors [7].

5) Reporting the results of the factor analysis.

This final step of the analysis involves the interpretation of the results and the presentation of conclusions.

3.2. FACTOR ANALYSIS OF BID/NO BID CRITERIA – THE COURSE OF THE METHOD

The first step was designed to check whether the variables satisfy the assumptions of factor analysis. The Bartlett's test of sphericity disproved the zero hypothesis stating that the correlation matrix was an identity matrix. The conclusion was that the statistical correlations between the variables could undergo the next analysis. An additional proof was provided by the Kaiser-Mayer-Olkin criterion whose value equal to 0,544 confirmed that the empirical data are well suited to the factor analysis. Subsequently, the number of factors by means of the scree test (Fig. 1) and Kaiser's criterion were determined. With these criteria under consideration, a solution with five factors (F1, F2, F3, F4, F5), each with the value greater than 1, was adopted.

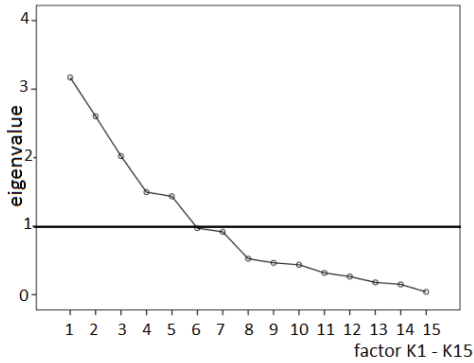


Fig. 1. The scree plot

This solution allowed to account for 71,5% of the variable variance in the factor model. The contribution of the other factors proved insignificant. To facilitate the interpretation of the results, the significant factors underwent orthogonal rotation in terms of the Varimax method with Kaiser normalization. Table 3 illustrates the correlations of individual factors with the original variables representing expert evaluations of the importance of the bid/no bid criteria.

Table 3. A matrix for the rotated bid/no bid factors*

Factors influencing bid/no bid decision	F1	F2	F3	F4	F5
K_1 - Type of works	0,277	-0,038	**0,871**	0,063	0,039
K2 - Past experience with similar projects	0,024	0,048	**0,882**	0,044	-0,177
K3 - Contract conditions	-0,466	**0,724**	0,055	-0,023	-0,098
K4 - Owner's reputation	-0,041	**0,817**	-0,161	0,126	0,109
K5 - Value of the project	**0,939**	-0,160	0,061	-0,101	0,032
K6 - Need of work	0,211	-0,150	-0,114	0,047	**0,568**
K7 - Size of the project	**0,933**	-0,081	0,236	-0,103	0,086
K8 - Profits from similar past projects	0,329	**0,557**	0,438	-0,021	-0,277
K9 - Time of project duration	0,121	**0,513**	-0,319	0,395	-0,086
K10 - Criteria of bid selection	-0,251	0,308	0,055	-0,196	**0,672**
K11 - Location of the project	-0,152	-0,057	0,418	0,428	**0,545**
K12 - Time for the preparation of the bid	-0,272	**0,653**	0,264	-0,118	0,215
K13 - Possible subcontractors	0,249	0,123	-0,310	-0,332	**0,642**
K14 - Necessity for specialized equipment	0,008	0,007	-0,072	**0,784**	-0,057
K15 - Degree of complexity of works	-0,206	0,096	0,240	**0,832**	-0,072

*Method of establishing factors – the maximum likelihood method. Rotation method – Varimax with Kaiser normalisation (rotation reached convergence in 7 iterations). The correlation coefficients greater than 0,5 are in bold. Source: own study using SPSS 20 software

The F1 factor is positively correlated to a large degree with two sub-factors: the value and size of the project. It is assumed that the F1 factor depicts the scale (or size) of the project under consideration. The F2 factor is positively correlated with contract conditions, owner's reputation, profits from similar past projects, time of project duration and time for the preparation of the bid. Thus the factors mentioned here are related to the financial aspect of the project: profitability and the financial risk. The next factor, F3, is strongly and positively correlated with the type of works and contractor's past experience with similar project. In this case it is clear that these subfactors are related to the experience and competences of the contractor. For the F4 factor, high correlation coefficients were observed in the case of subfactors related to the necessity for specialized equipment and the degree of works complexity. Here the factors are clearly linked to the technical conditions of the planned works. The F5 factor is associated with the need of work, the possibility of hiring subcontractors, the localization of the project and the criteria of bid selection. The factor can be described as the organizational one, connected with the company's activity.

Summarizing the results of the factor analysis based on the experts' evaluations of individual criteria influencing bidding decisions, 5 basic groups of bid/ no bid factors were established:

1) The size of the project
2) Financial conditions of the project
3) Contractor's experience
4) Technical conditions of the project
5) Organizational aspects.

4. SUMMARY

The selection and analysis of factors constitute the basis of the construction of a model facilitating bidding decisions. Previous research has suggested a long list (from 16 to 55) of factors which potentially may have an impact on the decision-making process. Considering the fact that they frequently become input data for the models proposed, it seems justifiable to reduce the set and, subsequently, to simplify the existing models. The paper includes an evaluation of 15 factors influencing bidding decisions for a selected group of tenders. The factors were evaluated according to a 1-7 scale (1 – no influence of a given factor; 7 – highly significant influence). To reduce the set of input data (i.e. the 15 factors), a factor analysis was proposed. The results of the analysis proved satisfactory.

For the assumed set of data, five basic factors influencing bidding decision were established: size of the project, financial conditions of the project, contractor's experience, technical conditions of the project and organization. Further study will employ these findings to create a model facilitating bidding decisions.

REFERENCES

1. Ahmad, I. Minkarah, "Questionnaire survey on bidding in construction", Journal of Management in Engineering Division, vol. 4, no. 3, pp. 229-243, 1988.
2. S. Bageis, C. Fortune, "Factors affecting the bid/no bid decision in the Saudi Arabian construction contractors", Construction Management and Economics, vol. 27, pp. 53-71, 2009.
3. M. S. Barlett, "A note on the Multiplying Factors for Various Chi Square Approximations", Journal of the Royal Statistical Society, vol. 16 (2), pp. 169-173, 1954.
4. R. B. Cattell, "The scree test for the number of factors", Multivariate Behavioral Research, vol. 1 pp. 245-276, 1966.
5. D. K. H. Chua, D. Li. "Key factors in bid reasoning model", Journal of Construction Engineering and Management vol. 126, no. 5, pp. 349-57, 2000.
6. K. G. Joreskog, "Some Contribution to Maximum Likelihood Factor Analysis", Psychometrica, vol. 32, pp. 443-482, 1967.
7. H. F. Kaiser, "The Varimax Criterion for Analytic Rotation in Factor Analysis", Psychometrica, vol. 23, 187-200, 1958.
8. H. F. Kaiser, "An Index of Factorial Simplicity", Psychometrica, vol. 39, pp. 31-36 1974. [11]
9. J. O. Kim, W. Mueller, Factor Analysis, Statistical Methods and Practical Issues, Beverly Hills, CA: Sage Publications, 1978. Sage University Paper, 1978.
10. Leśniak, E. Plebankiewicz, "Modeling the Decision-Making Process Concerning Participation in Construction Bidding." Journal of Management in Engineering, vol. 31(2), pp. 04014032, 2015.
11. Leśniak, E. Plebankiewicz, K. Zima, "Design and build procurement system - contractor selection", Archives of Civil Engineering, LVIII, 4, pp. 463-476, 2012.
12. T. Panek, J. Zwierzchowski, Statystyczne metody wielowymiarowej analizy porównawczej, Teoria i zastosowania, Oficyna Wydawnicza SGH, 2013.
13. M. Połoński, K. Pruszyński, " Impact of Baseline Terms on the Course of Critical Paths and Time Buffers in the Modified Goldratt's Method", Archives of Civil Engineering, vol. 59 (3), pp. 313–320, 2013.
14. Report of the President of the Procurement Office on the Functioning of the Public Procurement System in 2013. Public Procurement Office, Warszawa 2014.
15. Sagan, Badania marketingowe w praktyce. Podstawowe kierunki, Wydawnictwo Akademii Ekonomicznej w Krakowie, Kraków, 2004.
16. D. Skorupka, "The method of identification and quantification of construction projects risk" Archives of Civil Engineering, vol. 51 (4), pp. 647-662, 2005.
17. A.A. Shash, "Factors considered in tendering decisions by top UK contractors", Construction Management and Economics, vol. 11, pp. 111-118, 1993.
18. The Act of 29 January 2004 - Public Procurement Law, 2004, Journal of Laws of 2010, No. 113, item. 759, No. 161, item. 1078 and No. 182, item 1228 and of 2011, No. 5, item 13, No. 28, item 143 and No. 87 item 484.
19. M. Wanous, A.H. Boussabaine, J. Lewis, "To bid or not to bid: a parametric solution", Construction Management and Economics, vol. 18, pp. 457-466, 2000.

Received 22. 06. 2015

Revised 17. 07. 2015

LIST OF FIGURES AND TABLES:

KLASYFIKACJA CZYNNIKÓW PRZETARGOWYCH – ANALIZA CZYNNIKOWA

Słowa kluczowe: czynniki przetargowe, decyzje przetargowe wykonawcy budowlanego, analiza czynnikowa

STRESZCZENIE:

Wybór przetargu, do którego startuje przedsiębiorstwo jest bardzo ważny w aspekcie budowania jego pozycji na rynku. Umiejętność wyboru odpowiednich zleceń decyduje o ogólnej kondycji i sukcesie firmy, a nawet o jej przetrwaniu na rynku. Podjęcie decyzji o przystąpieniu do przetargu uwarunkowane jest wieloma czynnikami związanymi zarówno z przedsiębiorstwem, jak i przedsięwzięciem, którego dotyczy przetarg. Na świecie podjęto dotychczas szereg prób identyfikacji czynników mających wpływ na decyzje o uczestniczeniu w przetargu, a te z kolei przyczyniły się do budowy modeli wspomagających podjęcie tych decyzji. W artykule podjęto próbę wykrycia kluczowych kryteriów determinujących podejmowane decyzje przetargowe, których obserwowalnym efektem są konkretne czynniki zidentyfikowane na podstawie literatury przedmiotu i badań ankietowych. W tym celu zastosowano analizę czynnikową. Sposoby pozyskiwania wykonawców na rynku budowlanym zależą od rodzaju rynku, rodzaju zamówienia i jego wartości. W przypadku sektora prywatnego to inwestor sam decyduje jaka forma poszukiwania wykonawcy jest dla niego najkorzystniejsza. W przypadku sektora publicznego zamawiający zobowiązany jest do przestrzegania ustawy Prawo Zamówień Publicznych z dnia 29 stycznia 2004 r. z późn.zm. Najczęściej stosowanym trybem udzielania z zamówień publicznych na roboty budowlane jest przetarg nieograniczony. Jest to podstawowy tryb, dopuszczany przez ustawę w każdym przypadku i posiadający istotne zalety: brak przesłanek do stosowania, wysoki stopień konkurencyjności, nieskomplikowana procedura i krótki czas postępowania.

Po uzyskaniu informacji o ogłoszonym przetargu potencjalny wykonawca musi podjąć decyzje o przystąpieniu do przetargu i rozpocząć zazwyczaj pracochłonny proces przygotowania oferty. Dotychczas przeprowadzono szereg badań na całym świecie w celu identyfikacji czynników wpływających na decyzje przetargowe wykonawców robót. Pierwsze przeprowadzono w 1988 roku w USA [1] a w ostatnich latach w Syrii [5] i Arabii Saudyjskiej [2]. Wyniki badan przeprowadzonych w Polsce przedstawiono w pracy [3]. Prowadzone w różnych krajach badania są zbieżne i podobne czynniki znajdują się w czołówce listy ale również, w każdym kraju pojawiała się grupa takich czynników, która jest charakterystyczna dla tego rynku. W tabeli 1 przedstawiono trzy najistotniejsze czynniki przetargowe wytypowane w wyniku badań prowadzonych w różnych krajach.

Tabela 1. Najistotniejsze czynniki przetargowe

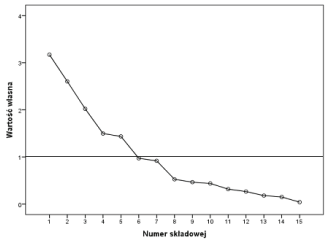
Syria [5] / 2000	**Saudi Arabia [2] / 2009**	**Poland [3] / 2013**
Spełnienie wymagań przetargowych	Zasoby finansowe inwestora	Rodzaj robót
Zasoby finansowe inwestora	Przepływy pieniężne przedsięwzięcia	Doświadczenie w realizacji podobnych przedsięwzięć
Relacje i reputacja inwestora	Możliwości wykonawcy	Warunki umowne

Źródło: opracowanie na podstawie [3]

Celem analizy czynnikowej jest przedstawienie wyjściowego zbioru obserwowalnych zmiennych za pomocą mniejszej ilości zmiennych ukrytych, których nie można bezpośrednio obserwować. W tym ujęciu obserwowalne zmienne Y_i można przedstawić za pomocą funkcji liniowej ukrytych, wspólnych czynników F_k oraz zbioru czynników swoistych U_i, charakteryzujących poszczególne zmienne [4]. W modelu czynnikowym przyjmuje się założenie o braku korelacji między czynnikami wspólnymi (F_k) a czynnikami swoistymi (e_i). Algorytm analizy czynnikowej składa się z kilku etapów :Ustalenie czy zmienne spełniają założenia analizy czynnikowej, wybór modelu czynnikowego i oszacowanie ładunków czynnikowych , ustalenie liczby czynników, rotacja czynników, interpretacja wyników analizy czynnikowej.

Bazując na zidentyfikowanych w [3] czynnikach, eksperci dokonali oceny 44 postepowań przetargowych, w których rozważano udział wykonawcy. Każdy przetarg został oceniony za pomocą 15 kryteriów (czynników) wpływających na podjęcie decyzji przetargowej. W wyniku analizy czynnikowej można wyodrębnić 5 kluczowych czynników decydujących o udziale w przetargu (Rys. 1):

F1 - rozmiar przedsięwzięcia
F2 - warunki finansowe przedsięwzięcia
F3 - doświadczenie wykonawcy
F4 - techniczne uwarunkowania przedsięwzięcia
F5 - względy organizacyjne.



Rys. 1. Wykres osypiska dla analizy czynnikowej

Wyselekcjonowanie i badania czynników są podstawą budowy modeli wspomagających decyzje przetargowe. Dotychczasowe badania wskazują długą listę (od 16 do 55 czynników), które mają znaczący wpływ na proces podejmowania decyzji.. Biorąc pod uwagę, ze najczęściej czynniki te stanowią dane wejściowe proponowanych modeli można rozważyć redukcję wymiaru zbioru co w dalszym kroku umożliwiłoby uproszczenie samych modeli. W pracy dokonano oceny 15 czynników wpływających na decyzje przetargowe dla wybranej grupy przetargów. Czynniki oceniano w skali punktowej od 1-7 (1- brak wpływu czynnika, 7 znaczący wpływ). W celu klasyfikacji i redukcji danych wejściowych (liczby 15 czynników) zaproponowano analizę czynnikową. Wynik przeprowadzonej analizy czynnikowej jest zadowalający. Dla przyjętego zbioru danych wyodrębniono pięć zasadniczych czynników wpływających na decyzje przetargowe: rozmiar przedsięwzięcia, warunki finansowe przedsięwzięcia, doświadczenie wykonawcy, techniczne uwarunkowania przedsięwzięcia, względy organizacyjne.

LITERATURA:

1. I. Ahmad, I. Minkarah, “Questionnaire survey on bidding in construction”, Journal of Management in Engineering Division, vol. 4, no. 3, pp. 229-243, 1988.
2. A. S. Bageis, C. Fortune, “Factors affecting the bid/no bid decision in the Saudi Arabian construction contractors”, Construction Management and Economics, vol. 27, pp. 53-71, 2009
3. A. Leśniak, E. Plebankiewicz, ”Modeling the Decision-Making Process Concerning Participation in Construction Bidding.” Journal of Management in Engineering, vol. 31(2), pp. 04014032, 2015.
4. T. Panek, J. Zwierzchowski, Statystyczne metody wielowymiarowej analizy porównawczej, Teoria i zastosowania, Oficyna Wydawnicza SGH, 2013
5. M. Wanous, A.H. Boussabaine, J. Lewis, “To bid or not to bid: a parametric solution”, Construction Management and Economics, vol. 18, pp. 457-466, 2000.