ANALYSIS OF PUBLIC PROCUREMENT IN STRATEGY RESOURCE SOURCING: DOES RELATION OF MATTER IN LONG RUN CONTRACTS?

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Public procurement, strategy, supplier relations, strategy resource

Abstract

The proposed paper is conducting the analysis of public procurement of electricity in Slovak Republic between years 2014 and 2022. Based on 1,009 observations there is made an analysis of the rate of savings in public procurement with focus on features describing the repeated relation between the supplier and contracting authority, as well as evaluation of the savings rate according to the chosen type of procurement strategy, comparing the auction and contractual type. Results of CHAID algorithm suggests the predicted savings have tendency to be higher while using auction type, also supported by non-parametric test, when the median saving rate is higher by 3.73%

1. Introduction

There are various energy procurement strategies that organizations can use to acquire energy. Some of the commonly used strategies include fixed-price contracts, index-based pricing, and renewable energy procurement. Fixed-price contracts involve purchasing energy at a fixed price over a specific period. Index-based pricing involves purchasing energy at market rates based on a specified index, while renewable energy procurement involves sourcing energy from renewable sources such as wind, solar, and hydro. Procurement strategies are essential for organizations to effectively manage their costs and obtain goods and services of the desired quality. According to Shuler (2021) and KPMG (2009), the cost of procurement can be as high as 70% or more of the total cost of goods sold in some industries. Hence, procurement is a strategic priority for management, and organizations need to develop effective procurement strategies to reduce costs and improve quality. In order to achieve robust competition in the procurement process, the selection procedure must be impartial and fair. Unintentional or intentional biases can be avoided in a fair and objective process to help ensure that the best options are chosen. Third-party providers are encouraged to participate because of the integrity of the process, which gives them the assurance that their bids will be thoroughly evaluated on their merits. To accomplish this, procurements must contain the necessary safeguards to prevent giving any offers an unfair advantage, to ensure that they are carried out as intended, and to deal with unforeseen circumstances in a way that is fundamentally fair and consistent with the process's competitive intent. The procurement should be set up to support market players' competitive offerings that are strong and innovative ideas. Participants in the market must have the following conditions in order to be encouraged to respond competitively: (1) assurance that their offers will be treated fairly and objectively; (2) assurance that their confidential information will be adequately protected; and (3) access to sufficient information regarding bidder requirements, product specifications, model contract terms, evaluation procedures, and other factors that would affect the resources they choose to offer.

One approach to procurement strategy is to identify the most suitable suppliers who can provide high-quality goods and services at competitive prices. According to Duica et al. (2018), supplier selection is a critical component of procurement strategy, and organizations need to consider several factors when selecting suppliers, such as supplier capabilities, reliability, and performance. Identifying the need, making the choice to buy, finding sources, picking the best suppliers, contracting, and maintaining connections with potential contractors are all parts of the complicated notion of procurement management, which is a function of the B2B market. To find the correct supplier and keep a long-lasting and prosperous relationship with them, supplier selection is a difficult process throughout the supply chain. Another approach is to develop long-term relationships with suppliers to ensure a stable supply of goods and services. According to Naoui-Outini and El Hilali (2019), strategic partnerships with suppliers can help organizations reduce costs, improve quality, and foster innovation. However, developing such partnerships requires trust, mutual understanding, and commitment from both parties. Additionally, organizations can implement e-procurement systems to streamline their procurement processes and reduce costs. According to Alor-Hernandez et al. (2011), e-procurement systems can help organizations automate their procurement processes, improve supplier collaboration, and reduce transaction costs. Several studies have examined the effectiveness of different energy procurement strategies. A study by Ari et al. (2022) found that fixed-price contracts were effective in reducing energy costs, while index-based pricing resulted in higher costs due to market volatility. Renewable energy procurement was found to be effective in reducing greenhouse gas emissions and increasing energy security.

Both the pandemic of COVID and the financial crisis of 2008 revealed the potentially catastrophic risks of just-in-time strategies and the need for one that would be better referred to as just-in-case that places a lot more of a focus on resilience. Given how much debt in private companies is now owned by the public sector, this is only going to become more crucial. So how can businesses make this transformation in the most efficient way? By approaching procurement in a way that emphasizes building robust multi-relational networks rather than linear supply chains. In fact, if one adopts this mentality, procurement may end up becoming a strategy. As stated by Ramírez et al. (2020) Procurement becomes a key component of strategy as businesses place less emphasis on efficiency and more on resilience. This is due to its exceptional capacity to coordinate long-term value-creating systems that can survive external shocks, accept incompatible value holders, share burdens, and evolve dynamically. This illustrates an essential lesson: When resilience is your top concern, smart procurement might be the best approach.

2. Methodology and data sample description

Presented paper is following two main objectives. First objective is to analyze if there is evidence of repeated deals between procurer (contracting authority) and supplier resulting in the different value of savings in public procurement of electricity. Second objective of the presented paper is to test the difference between the procurement strategy (process) and its influence on savings while procuring the electricity. Both objectives are tested on the sample of public procurements in Slovak Republic in the period from 2014 to 2022, which were directly related to the electricity. All the analyzed public procurements are publicly available data from Slovak national electronic contracting system (EKS). The analyzed data consist of 1,009 observations.

In order to achieve stated objectives, there was applied CRISP-DM methodology and decision tree approach, similar to Rocha et al. (2010) and Wiemer et al. (2019). CRISP-DM is a de-facto standard in data mining that provides a process model for applying data mining projects. It includes descriptions of the typical phases of a project, the tasks involved with each phase, and an explanation of the relationships between these tasks (Schröer et al., 2021). CRISP-DM is an industry-proven way to guide data mining efforts and support the iterative nature of data science (Huber et al., 2021). Decision trees are a popular machine learning algorithm used for both classification and regression tasks. They have many advantages over other algorithms, including being flexible, requiring fewer data cleaning, and being easy to interpret and visualize. Some commonly used decision tree algorithms include CART, C5.0, and CHAID. CHAID is particularly useful for market research and can build wider decision trees because it is not constrained to make binary splits (Almuallim et al., 2002). To prevent overfitting of decision tree, there will be used sample partition in conventional share of 0.7 training data and 0.3 testing data. Beside partitioning, there will be also used column sampling at 0.8. Beside machine-learning techniques there is used non-parametrical statistical method Mann-Whitney U test for testing the differences between examined groups. The dependent variable is savings of the observed procurement process, which is defined as a percentage of the savings when comparing the anticipated price of the procurement and the final price. Independent variables used in presented analysis were: *offers_count* representing the number of offers registered for the contract; *CO_all_contracts_count* defining the market share of the supplier (contractor), as the frequency of the contracts provided by supplier; *Price_incl.VAT* describing the final value of the approved and signed contract; *CO_all_contracts_mean* another variable describing the position of supplier on the market, as the average value of signed contracts; *number_of_bids* representing the count of bids made for contract in auction, in order to see the difference if the offers were changed during the auction; *applicants* stands for the number of applicants (suppliers) registered in the process of procurement; *bid_per_CO* as the number of bids made in relation to the number of suppliers in the competition; *Contract_length_days* equals to the number of the days the final contract was signed; *Number_of_CO_notified* as the number of suppliers, who were officially informed before the procurement procedure; *COCA_all_contracts_count* representing the number of contracts signed between the winning supplier and the contracting authority.

Table 1. Descriptive statistics of the sample

Variable	Min	Max	Mean	St. Dev.
saving_pct	0	0.96	0.1	0.114
offers_count	1	376	23.75	36.86
CO_all_contracts_count	1	1660	293.95	312.8
Price_incl.VAT	345.24	425219	65358	65488
CO_all_contracts_mean	13000	173500	55154	16024
number_of_bids	1	376	24.26	36.92
applicants	1	9	3	1.76
bid_per_CO	1	188	7	11.33
Contract_length_days	0	1460	500	248.88
Number_of_CO_notified	22	624	173	62.53
COCA_all_contracts_count	1	12	2	1.58

Table 1 illustrates descriptive statistics of an examined sample of public procurements of electricity. The variance of the dependent variable savings from procurement is moving from 0 to 96%, with the average value at 10%. Except the mentioned variables in Table 1, there is also categorical variable identifying the procurement strategy (process) – auction or contractual (Table 2).

3. Results

When dividing observations in the sample according to the procurement type, 439 observations were classified as an auction type of procurement process, while 570 were a contractual type of procurement process. The contractual process of procurement showed mean percentual savings at 9.06%, and in the auction type of procurement process, the mean value of savings was at the level of 11.09%, as illustrated in Table 2. Except for the mean value of savings, the auction process of the public procurement showed a higher mean value of every examined variable as offers received (*offers_count*), number of bids (*num_of_bids*), applicants and price of the final contract.

Table 2. Average values of observed variables according to the procurement process

Proc. process	n	saving_pct	offers_count	num_of_bids	applicants	Price	days_contract
Auction	439	0.1109	40	40	4	68500	500
Contractual	570	0.0906	11	12	2	63000	498

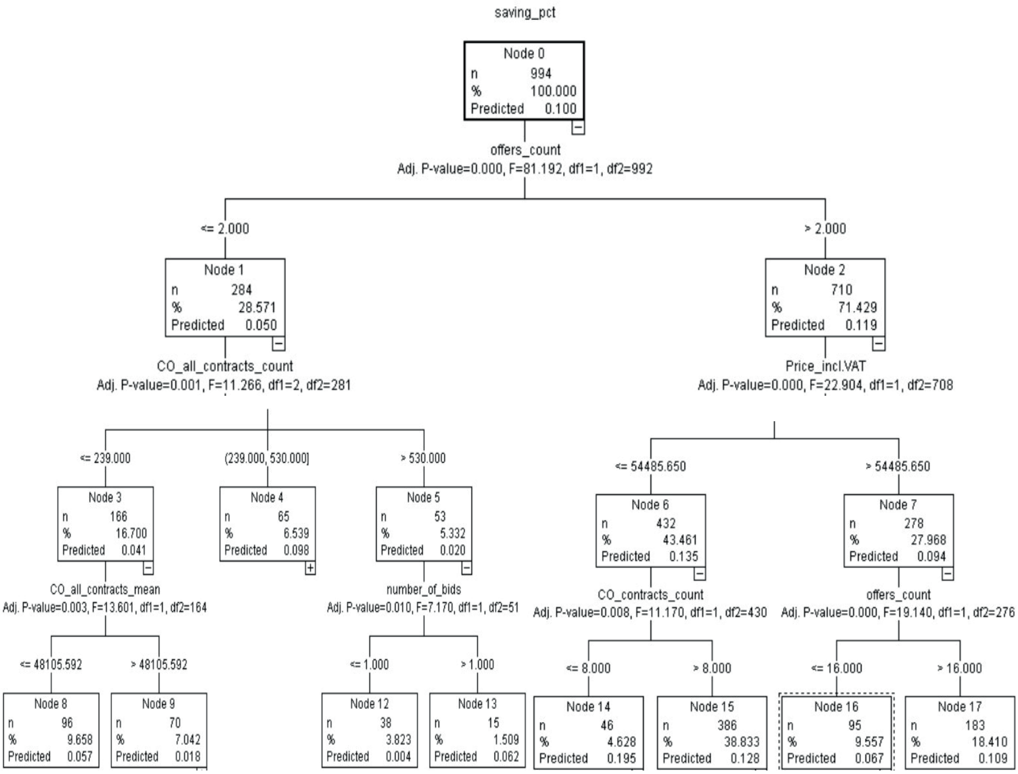

Figure 1. CHAID algorithm: Decision Tree – aggregated strategies results, model 1

Figure 1 illustrates Node 0 of the CHAID decision tree, with R2 score = 0.71, MAE = 0.075 which illustrates the variable with the highest importance on the dependent variable – savings from observed procurement processes. The model presented in Figure 1 metrics have reached mean absolute error (MAE) = 0.067, and standard deviation (SD) = 0.102. As the predictor of the savings with the highest importance was chosen parameter offers received for the public procurement contract,where the treshold resulted in to 2 offers. While the number offers was equal or less than 2, the predicted savings were 5%, otherwise it moved to 11.9%. The CHAID algorithm has not chosen the categorical parameter of procurement type (auction or contractual) as important feature, while making the predictions. Therefore, there was created another subsample for further modelling, where one subsamples consisted only of one procurement strategy, auction, or contractual respectively, see figures 2 and 3. Model 2 presented in Figure 2 shows the results of model, where predictions of public procurements savings are made only on the subsample consisting of auction strategy procurements. In this case the most impactful feature, which divide decision tree at first level to nodes 1 and 2 is feature number of bids, equaling how many times the offer for contract had changed. The threshold for the number of bids shows, that if the number of bids was more than thirteen, the predicted value of saving has mean value of 12.4%, while in cases, where the number of bids was thirteen or less (representing more than 71% of the subsample), the predicted saving is reaching 7.9% of mean value of expected contract value. The node 1 is following the division by the number of contractors (suppliers) notified. In this case, the highest savings are predicted in case, when there are less than 110 contractors notified about the auction (13.7%), while when there is notification for more than 259 contractors, the average predicted saving of the procurement is at the value 4.3%. Metrics of the model 2 have reached of R2 score = 0.75, MAE = 0.065. What represents slightly better evaluation metrics than in the case of the model 1.

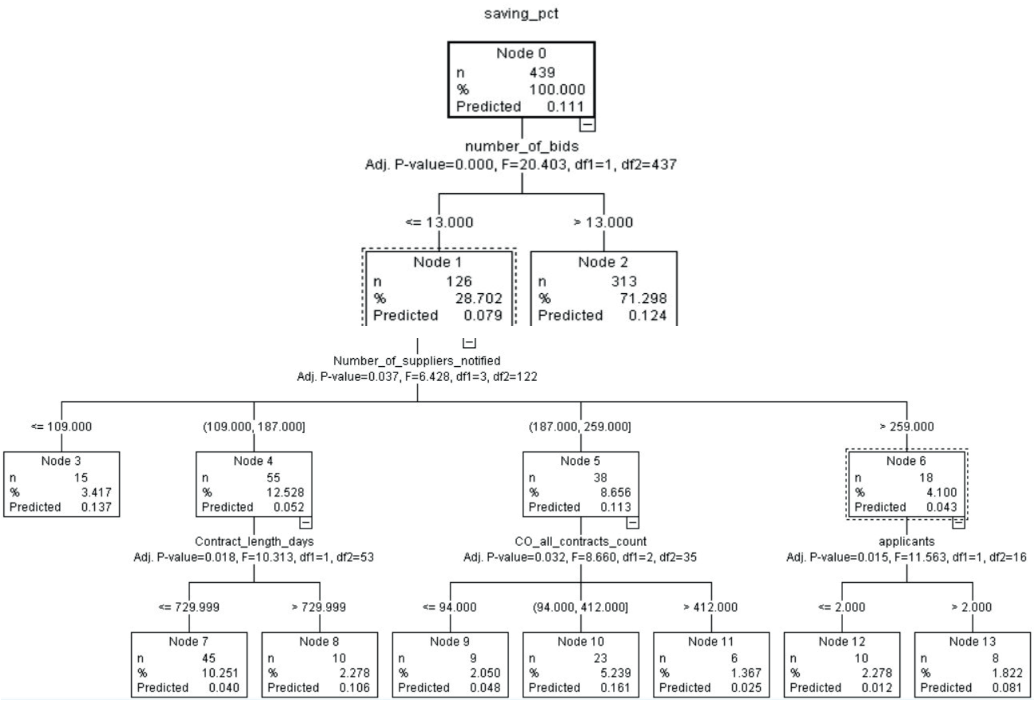

Figure 2. CHAID algorithm: Decision Tree – auction procurement results, model 2

In case of the subsample dealing only with contractual strategies of public procurement (Figure 3) the very first division of the decision tree is on the feature applicants, describing the number of the applicants in the competition.

The average value of saving is raising with the number of applicants in the procurement process. The lowest predicted value of savings is observed, when there is only one applicant, at the 4.6%, what was the case in 39% of studied subsample. The predicted value of savings in case of two applicants have raised to 8.6%. The highest mean value of predicted savings is observed in case of more than two applicants (Node 3, Figure 3). If there are more than two applicants, the prediction of the offered contract in procurement is based on the number of supplier count of contracts in observed period (*CO_all_contracts_count*).

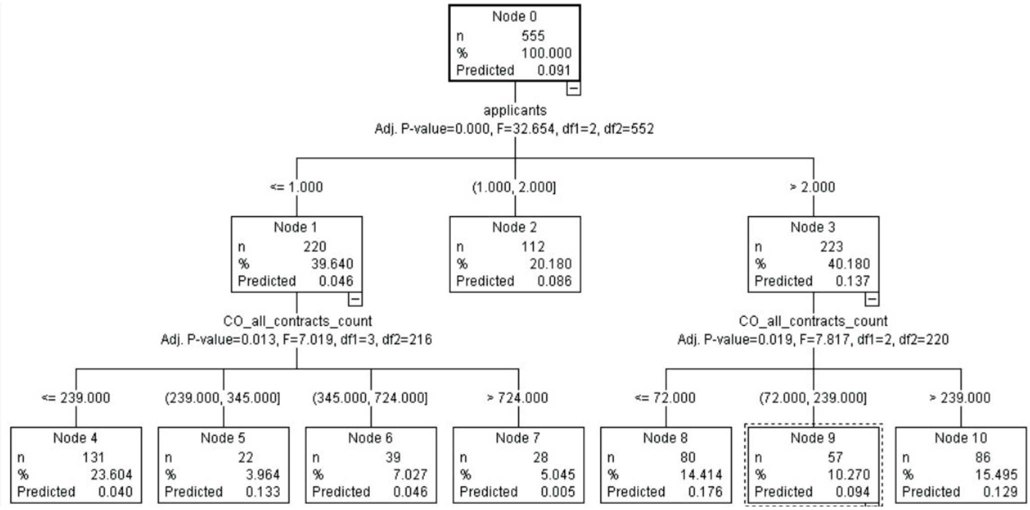

Figure 3. CHAID algorithm: Decision Tree – contractual procurement results, model 3

The predicted values do not follow any specific trend with the number of contracts the supplier offered. Higher values of predicted savings are observed in the threshold values of upper and lower interval. The middle interval signaling number of supplier contracts between 72 and 239 is predicting the average savings on contractual procurement process at 9.4% against the expected value of the contract. Model 3 presented in Figure 3 metrics have reached MAE = 0.071, R2 = 0.74, signaling slightly worse accuracy as in the case of baseline model 1.

Table 3. Testing the relation between chosen procurement features and procurement strategy

H	Null Hypothesis	Test	Sig.	Decision
1	The distribution of saving_pct is the same across categories of Procurement_strategy.		0.000	Reject the null hypothesis.
2	The distribution of Number_of_suppliers_notified is the same across categories of Procurement_strategy.	t-Samples Mann-Whitney U	0.486	Retain the null hypothesis.
3	The distribution of number_of_bids is the same across categories of Procurement_strategy.		0.000	Reject the null hypothesis.

H	Null Hypothesis	Test	Sig.	Decision
4	The distribution of offers_count is the same across categories of Procurement_strategy.		0.000	Reject the null hypothesis.
5	The distribution of CO_all_contracts_count is the same across categories of Procurement_strategy.		0.014	Reject the null hypothesis.
6	The distribution of COCA_all_contracts_count is the same across categories of Procurement_strategy.		0.315	Retain the null hypothesis.
7	The distribution of bid_per_CO is the same across categories of Procurement_strategy.		0.000	Reject the null hypothesis.

To justify the creation of the subsamples, and results presented in model 2 and model 3, there was conducted nonparametric Mann-Whitney U Test (Table 3). According to the Mann-Whitney test results it was possible to state there are statistically significant differences in savings according to the type of procurement strategy. As presented in Tab. 3, according to the Mann-Whitney Test it was possible to reject the null hypothesis of the same distribution in the category of the procurement strategy, except the features number of suppliers notified, and the feature describing the repeating relationship between supplier and procurer – contracting authority (*COCA_all_contracts_count*). Feature describing the number of suppliers notified is observed only in model 2 (Figure2, Node 1). On the other hand, it was not possible to observe the feature describing the relationship between supplier and procurer in any of previously presented models as a predictor with significant impact on the savings from the public procurement. Box plot in Figure 4 illustrates the results from Mann-Whitney test from Table 3. It is possible to observe the statistically significant differences between auction and contractual type of public procurement of electricity. The auction type strategy median value of savings is at the level of 8.68%, while the contractual procurements yielded median value at the level of 4.95%. In the contractual type of procurement, it is also possible to higher variability of the savings, with the first quartile closer to the zero, than in the case of the procurements made as auctions. The contractual type of procurement also showed higher frequency of the outliers and extreme value occurrences.

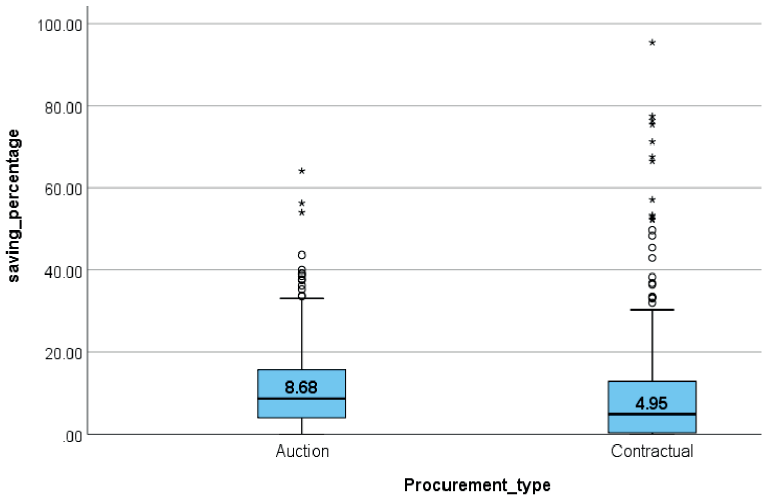

Figure 4. Box plot analysis of the relation between savings from procurement and procurement strategy

4. Conclusions

Presented paper analyzed public procurements related to the electricity in the Slovak Republic between the years 2014 and 2022. According to the 1,009 observations there is no evidence of the relation between the repeated occurrence of contracts between supplier and contracting authority and savings rate. The observed relation between supplier of electricity and the procurer expressed as the count of signed and approved contracts in the past did not show any significant importance, when analyzing mentioned relationship by algorithm CHAID in three models with modified sample. While analyzing the importance of the supplier, in the results there could have been observed, that the "power" of supplier (market share/the amount of contracts) is playing important role in the public procurement. The observable trend presented in Figure1, Figure 2, and Figure 3 could be explained that the lowest rate of savings is usually obtained when the electricity was procured from the biggest players on the energy market. In Figure 3, we could also observe that almost 40% of applicants were = 1, indicating possible monopoly or oligopoly structure presence, while in the Figure 2 describing the auction type, the smallest value observed for factor of applicants was 2, and only in 2.3% of the sample. Second objective of the paper was to focus on the public procurement strategy. In this case, it is possible to state, there are significant differences in savings rate accordingly to the procurement strategy. Contractual type of public procurement of electricity showed the median saving rate at the level of 4.95% from the value of the contract, what is significantly lower, than 8.68% observed in the auction type of public procurement. The results presented in the Figure1, Figure 2, and Figure 3 allows to argue, that auction type of procurement yields higher savings rate in electricity public procurement. While investigating the relationship between savings rate and procurement type there were identified similarities and differences in observed features of the procurement strategies. Speaking about the similarities, the length of contract, there were not observed significant differences, in case of both types of procurements the median value of the contract length was observed at the value 500 days, and the mean value is differentiated only by 2 days. On the other hand, in both cases the factor of the competition played the significant role. In auction strategy is the most important feature number of bids in auction, while in the contractual strategy it is number of applicants. In auction type of public procurement is observable higher average number of variables representing the competition of suppliers for given contract, such as number of offers, number of bids or applicants. In conclusion it might be stated that auction type of procurement strategy yields higher probability of savings rate in electricity procurement in Slovak Republic.

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