



AUDIT ASSESSMENT OF THE EFFECTIVENESS OF PUBLIC PROCUREMENT PROCEDURES

Iryna Drozd

Taras Shevchenko National University of Kyiv, Ukraine
E-mail: drozdirina@ukr.net

Mariia Pysmenna

Flying Academy of National Aviation University, Ukraine
E-mail: mari.pismennaya.83@ukr.net

Nataliia Pohribna

Taras Shevchenko National University of Kyiv, Ukraine
E-mail: nataliapohribna@knu.ua

Nataliya Zdyrko

Vinnitsia National Agrarian University, Ukraine
E-mail: Natashka26@i.ua

Anna Kulish

Kyiv National Economic University named after Vadim Hetman, Ukraine
E-mail: Kulish.anna@ukr.net

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ABSTRACT

The article seeks describing the benefits and challenges faced by auditors in assessing the effectiveness of public procurement procedures in terms of applying the methodology for calculating efficiency, economy and effectiveness, taking into account the risks of procurement in e-auctions. Quantitative risk parameters are calculated using data of probabilistic indicators of procurement risk assessment according to the ratio of the number of relevant procedures (sub-threshold and above-threshold) to the total number of procurement procedures. Statistical valuation methods are used for the cost risk assessments and calculation of the aggregate risk indicator of public procurement. The calculations are performed using the data of the open e-procurement system ProZorro for all announced procurements in 2018-2019. We analyzed the methods, indicators and the extent to which the study of the



public procurement effectiveness via bibliographic and case studies is performed. As a result, the majority of methods cover four components of assessing the public procurement efficiency - targeted efficiency, cost-effectiveness, organizational efficiency, efficiency of budget expenditures for public procurement. This does not provide an assessment of the automated systems' impact on the procurement procedures results and on possible savings due to the use of certain procurement procedures. To comprehensively assess the procurement efficiency in e-bidding, the authors propose considering four key risks: the risk of cancellation of the procurement procedure, the risk that the procurement procedure will not take place, the risk of appealing the procurement, the risk of disqualification. As a result of risks calculations under the sub-threshold and above-threshold procurement, individual values of risks and their aggregate indicator are determined. This will adjust the scope of audit procedures to verify individual procurements and identify weaknesses in the procurement management system. We believe that the methodology of auditing the procurement effectiveness, taking into account the quantitative and qualitative parameters of procurement risks, will be a useful audit tool to determine the effectiveness of the use of public funds under individual procurements and identify areas of cost-effectiveness for the state budget funds.

Keywords: Public Procurement; Risks; Audit; Audit Assessment; Efficiency; Finance; Enterprises

1. INTRODUCTION

National economies have recently been negatively affected by pandemics and quarantine measures. The negative dynamics of the revenue side of the budget and the forced reduction of expenditures necessitate a more careful approach to spending on procurement for the needs of the state. Taxpayers who face the threat of increasing taxes and fees and/or cutting services hope that the state budget expenditures on the purchase of goods, works and services will be accompanied by the effective management of taxpayers' funds. This is not always the case. Recent advances in the public procurement theory suggest that complex auctioning schemes create opportunities for collusion and corruption (Lambert-Mogiliansky & Sonin, 2006).

Audits aimed at assessing the value for money (VfM), which emerged in the late 70's of the twentieth century in response to the economic crisis and the budget deficit of the world (Pollitt et al., 1999) began determining the efficiency of use in addition to legality. Examining the types and forms of auditing (external, internal, public and private (Bowerman, Raby &



Humphrey, 2000), considered that auditing is only one aspect of a broader but a rapidly evolving “performance measurement society” that includes other important elements, which include increased inspection and self-assessment. (Mayne & Ontario, 2006) divide the purpose of audit and evaluation. Examining the essence of performance audits, these authors name the result of the methodologies used as one of the difficulties in fulfilling their roles to the public sector.

The main task of the performance audit, as one of the types of public audit is a constant and comprehensive audit of three “E” - economy, efficiency and effectiveness (McCrae & Vada, 1997) of public procurement is carried out by all higher institutions of public audit.

Increasing the analytical potential of the audit in the current situation is an important direction in the development of its methodology (Slobodyanik, Kondriuk & Haibura, 2019).

Mega-trends that will change the way we do business in the next decade will not only require a rethinking of the vision of procurement, make the necessary changes in their strategy, but also create the conditions for changing methods of assessing efficiency and effectiveness. Among the most important modernizing influences are the use of big data and the global network, the new role of procurement in decision-making based on this data (Spiller et al., 2013) and volatility as a new norm: transfer of supply risk to competitive advantage (Spiller et al., 2013).

Adi and Dutil (2018) note the presence of asymmetry in the selection of objects of performance evaluations, when many ministries are underestimated and others are systematically overestimated. Therefore, increasing the productivity of the audit organizations themselves is also in the application of more acceptable criteria for the selection of the object and the implementation of assessments according to modern adapted methods.

The audit results will help raising public awareness about the results of assessing the effectiveness of the public funds use in organized bidding.

2. LITERATURE REVIEW

In the modern economic literature, research on the category of “efficiency” and diverse methods and approaches to its evaluation are widely presented. Research on performance analysis can be divided into two main categories: (a) research related to the development of regulatory decision-making procedures; and (b) those that discuss the application of regulations to empirical data (Kroll & Levy, 1980). The main problems of analytical audit evaluation of

the results of procurement procedures in real life have received limited attention in the theoretical literature.

Our contribution offers an integrative nature of the audit evaluation methodology of the procurement procedures effectiveness, which links the evaluation indicators of the three “E” with the procurement risks. The effectiveness of public procurement depends on a combination of factors: regulatory framework for procurement, macroeconomic and political processes, the degree of saturation of commodity markets, professionalism of customers, the adequacy of the formulation of conditions and features of structural diversity of public procurement.

The study of literature sources showed a variety of approaches to assessing the effectiveness of procurement, as well as the lack of consensus on the methodology of its implementation. This diversity of approaches is explained by the fact that in Ukraine there is no single methodology for assessment, including those defined by regulations. Thus, some scientists in assessing the effectiveness of public procurement take into account the calculation of the absolute and relative effect of public procurement by comparing prices in a single competition (Methodological, 2008).

The method of Lapin, Kiseleva and Kumundzhieva (2016) is an example of such a technique, which is designed to evaluate the activities of customers in the field of public procurement. The researchers suggests calculating two indicators: cost-effectiveness and the validity of the initial contract price. Cost-effectiveness is calculated as the difference between the initial (maximum) contract price and the price at which the contract is concluded. The second indicator - the assessment of the validity of the initial (maximum) contract price is determined by the deviation of the initial (maximum) contract price, which is stated by the customer, from the average contract price offered by the bidders. The researchers proposes, in addition to savings, i.e. the difference between the initial (maximum) contract price and the price at which the contract is concluded, to evaluate the validity of the initial (maximum) contract price as a deviation of the initial (maximum) contract price from the average contract price, offered by the participants of the order.

In our opinion, this approach has a number of disadvantages. Thus, comparing the contract price with the average price of suppliers' bids, it is possible to determine the “effectiveness of the tender within its participants”, but with a small number of such participants, and even more so in case of conspiracy, the resulting performance evaluation will be ineffective.



Ivanova (2010) proposes estimating the savings in public procurement as the difference between the sum of the average bid prices of suppliers and the sum of the bid prices for which the contract is concluded and to determine such an indicator for each sector of public procurement separately.

In addition, the scientist's method involves assessing the feasibility of determining the initial price of contracts as a deviation from the average savings in the industry. We believe that the comparison of the final value of the contract and the market price for similar goods is a more acceptable indicator, in our opinion. However, in this case, determining such a market price can be quite problematic. We will explain why.

The market price is calculated on the basis of information about the concluded identical agreements with homogeneous goods, works or services. Thus, in most cases, customers use the information posted on the websites of potential suppliers, and accordingly on the basis of such data and determine the average market price. In the case of impossibility to determine the market value of the order, and this is usually a common practice in the procurement of works or services, then customers use the cost method of determining the price.

In practice, there is another option for determining the comparative efficiency of the order, namely on the basis of contract prices for previous tenders. The task of the customer is to develop and implement effective processes for evaluating suppliers and determining the criteria for the winner (Sollish & Semanik, 2012), which determines the prerequisites for effective procurement. However, the disadvantage of this approach is that it does not take into account the transaction costs of customers and does not reflect changes in prices for such goods. In addition, it is clear that some groups of goods may become cheaper over time, while others may become more expensive.

In our opinion, the main disadvantage of methods for assessing the public procurement effectiveness is that they are based solely on price indicators. Therefore, the qualitative characteristics of goods, works and services purchased on a competitive basis are ignored, thus losing the meaning of such a competition. Moreover, the evaluation of the public procurement effectiveness is not taken into account at all. The latter comes down only to determining a monetary efficiency.

The authors evaluate cost models for materials, consumables, and equipment in order to examine the potential cost savings from specific procurement procedures. The results of the cost model show that the use of competitive tenders, procurement calendars, central

warehouses and lists of tenderers is associated with significant cost savings (Duncombe & Searcy, 2007).

We should agree with the thought of certain scientists on the need to take into account the assessment of the public procurement quality, in other words, the level of the consumer's satisfaction with the services, works, or the delivery of goods, if "efficiency depends on the value and productivity perceived by the consumer" (Karlöf, 1996).

Such interpretation can be considered to be true, taking into account that quality is an indicator of the sufficiency of the product and service's power, which is responsible for the assessment of the consumer's satisfaction quality, in accordance with the goal of that particular commodity. In this case, quality assessment is primarily a diagnosis of the properties of usefulness and reliability, outlined by the customer for the delivered goods or work and services performed. However, in our opinion, this approach has its drawbacks, as there are some difficulties with such an assessment.

So, according to the theory of benefits, it seems that all benefits are classified into the inspectorate, experimental and fiducial. A more detailed qualification allows the inspection goods to be featuring such characteristics that may be defined only after the delivery.

Specific features of experimental benefits provide additional characteristics, as it is possible to reconfigure it for less than an hour to get specific goods. In this case, fiducial goods are a type of goods, the evaluation of which is characterized by a subjective nature.

Therefore, given the above, it should be noted that the time gap can serve as an important point in the process of qualitative evaluation of efficiency.

A group of scientists - proponents of a slightly different position, propose using the criteria of economy, productivity of resources used, cost-effectiveness, taking into account the time factor, with a thorough analysis of the type, conditions and completeness of contracts (Nesterovich, 2008), evaluate the implementation of planned indicators (Karlöf, 1996), which allows determining the degree of goals' achievement.

3. DATA AND METHODOLOGY

The main input data parameters that were used to test the hypothesis of the possibility and feasibility of using risks in assessing the effectiveness of public procurement for audit purposes, are formed in the open e-procurement system Prozorro (2020).



The time range of the study consists of the interval 2018-2019 in terms of procurement data for each month. With regard to the choice of research methods, the key task is the development of such arrays of indicators that allow calculations of risks using both quantitative and qualitative parameters.

Quantitative risk parameters were calculated using calculations of probabilistic indicators of procurement risk assessment, such as the ratio of the number of relevant procedures to the total number of procurement procedures (Table 1). Statistical methods were used for cost assessments and calculation of the aggregate indicator of public procurement risk (Table 1).

Table 1: The main indicators that characterize the effectiveness of public procurement

No	Name of the indicator	Method of calculating the indicator
<i>Probabilistic indicators of public procurement risk assessment</i>		
1.	Probability of cancellation of the procurement procedure	Number of canceled procedures / Total number of procedures
2.	Probability that the procurement procedure will not take place	Number of procedures that did not take place / Total number of procedures
3.	Probability of appealing the procurement procedure	Number of complaints satisfied / Total number of procedures
4.	Probability of disqualification of the participant	Number of price offers of the disqualified participants / Total number of price offers
<i>Cost indicators of public procurement risk assessment</i>		
5.	Cost at risk of cancellation of the procurement procedure	Quantile of the function of distribution of the expected value of purchases that have been canceled, with the selected level of confidence of 95%: $k = x_i + \frac{x_{i+1} - x_i}{y_{i+1} - y_i} (k\% - y_i)$ where: k is the absolute value of the quantile of the distribution of a random discrete quantity, including k% - the relative value; x_i - i-th value in ascending order of the random variable; y_i - estimation of the relative location of the i-th value of a random variable in a set of its values; n - is the number of values of the random variable under consideration.
6.	Cost at risk that the procurement procedure will not take place	Quantile of the function of distribution of the expected value of purchases that did not take place
7.	Cost at risk of appealing the procurement procedure	Quantile function of the distribution of the expected value of the procured purchases
8.	Cost at risk of disqualification of the participant	Quantile of function of distribution of the price offers sum for the purchases which have been disqualified
9.	Aggregate value at risk	The amount of value at risk analyzed
10.	Cumulative public procurement risk indicator	Cumulative value at risk / Expected value of procurement

Source: Pysmenna (2017)

We used the unique content for analytical research in terms of sub-threshold and above-threshold procurement, which is largely due to the availability of the necessary information (Prozorro, 2020). At the same time, we did not differentiate according to the sectoral distribution of procurement customers.



All empirical data on individual public procurement, reflected on ProZorro, were used.

We agree that at the organizational stage of their implementation, public and private sector customers have differences (Beuve, Moszoro & Saussier, 2018). However, audit evaluation according to our methodology can be used to determine the effectiveness of public or private procurement. The reasoning in favor of this conclusion is the common rules for conducting such procurement in the electronic system, on the basis of which we conducted analytical research.

We have disregarded the detection by analytical methods of conspiracy and/or corruption of procurement during performance evaluation, although we agree with Lambert-Mogiliansky and Sonin (2006) on the significance of such effects on procurement results. However, methods of detecting fraud and its implications for procurement efficiency, the risks of collusion and corruption have not been the subject of this article.

The purpose of the study was to propose a method of auditing the effectiveness of procurement procedures, which links the indicators of efficiency, productivity, economy with the risks of public procurement. To this end, the existing methods of assessing the use of funds for public procurement and indicators that determine the factors influencing the category of efficiency are analyzed. It was determined that a comprehensive performance assessment is possible provided that a procurement risk assessment is used.

4. RESULTS

Scientific analysis proves that in a broad sense, efficiency is an indicator that characterizes the relationship between the result of the process and the cost of its implementation. In addition, given the variety of targets and outlined results, it is possible to qualify economic, social, production and other types of efficiency.

In view of the above, the efficiency of the public procurement system should be understood as a complex concept consisting of the following components:

first, the target efficiency as the degree of achievement of the system results;

second, economic efficiency as the ratio of the economic effect and the cost of resources needed to achieve such an effect;

third, organizational efficiency, which characterizes the infrastructural and competitive environment of order placement, the level of development, implementation and use of



regulatory, methodological, informational, analytical support of the public procurement system;

fourth, the efficiency of budget expenditures for public procurement (Figure 1).

Emphasizing the application of the method of comparing the costs and benefits of public procurement, it should be noted that expert assessment of all costs play an important role. The latter can be divided into direct, such as the contract price and insurance costs, and indirect, arising from the occurrence of any adverse events.

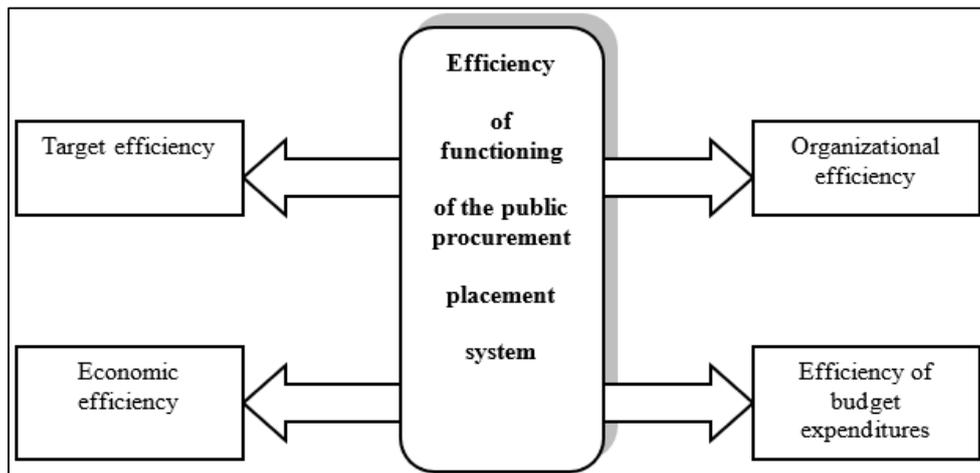


Figure 1: Decomposition of the definition “efficiency of the public procurement system”
 Source: developed by the authors

If the benefits to the public or, in other words, the benefits of meeting needs are higher than the cost of purchasing and placing an order, then such a project is considered potentially effective (Arrowsmith, Linarelli & Don Wallace, 2000). In this case, the cumulative effect of public procurement can be expressed through various effects (Table 2).

Table 2: Features of the set of effects

No	Types of effects	The essence of the concept
1.	Direct savings	are lower prices compared to the planned amount of funding
2.	Indirect or implicit savings	are characterized by the purchase of goods, works and services of higher quality and on more favorable terms than usual. For example, no advance payment, reduction of delivery time, longer warranty period, availability of additional services, etc.
3.	The side effects	are manifested, for example, in reducing the level of corruption, increasing the degree of openness of public procurement procedures, increasing the business reputation of the customer and the investment attractiveness of the region

Source: compiled by the authors using Lapin, Kiseleva and Kumundzhieva (2016)

The costs of achieving the economic effect of public procurement are usually expressed in the amount of:

- labor costs for the implementation of organizational measures for procurement;

- material costs of public procurement, such as the cost of consulting services, consumables, postal and courier services, the cost of equipping workplaces and renting additional premises, to ensure the functioning of the infrastructure of the public procurement system (including official websites and publications), training staff.

Waters (2015) considers it necessary to take into account the degree of customer satisfaction when assessing the effectiveness of procurement, i.e. compliance with consumer demands, ensuring the best conditions for public procurement, reliability and qualification of the supplier. In this case, we often use the method of comparison of suppliers, which analyzes the proposals of all suppliers in order to identify those, who are able to qualitatively fulfill the government order with the lowest contract price.

However, in our opinion, there is an important problem of information asymmetry, because only suppliers know their true so-called “cost curves”. It is clear that under such conditions, customers can analyze the history of relationships with suppliers, which is the most effective tool for obtaining information on their costs for the amount of losses due to the supply of substandard products, the number of erroneous deliveries, reliability of delivery, etc.

It is possible to eliminate these shortcomings in the case of using another assessment method of procurement efficiency - the method of analysis of the main provisions of the contract. This method involves analyzing the presence and essence of certain provisions that govern the relationship between supplier and customer. In this case, the evaluation is based on certain criteria that must be taken into account in the contract, namely: the presence of possible risks during procurement, achieving a certain result given the identified planned costs, delineation of rights and obligations of the parties, establishing a monitoring procedure for orders, features of the dispute resolution process, opportunities for communication between the parties, etc. Thus, the contract is evaluated in terms of its completeness: the more detailed are all the necessary provisions, the more efficient is the procurement.

Of course, the analysis of the contract implementation can be carried out both during the whole cycle of public procurement and after its completion. The analyzed method uses a number of qualitative indicators, such as staff qualifications, the process of interaction and communication, the degree of satisfaction of all parties involved in the public procurement process, compliance with the deadlines for placing orders and work.

Such an assessment is usually conducted by questioning all participants, from senior management of the authorized body for the coordination of procurement of goods, works and

services at public expense, suppliers, and ending with employed officials who directly place orders or submit proposals for public procurement (Perov, Dashkov & Abdrakhimov, 2006). The methodology for assessment the public procurement systems MAPS (2018) of the World Bank and the Organization for Economic Cooperation and Development (OECD) is scientifically meaningful.

The MAPS methodology was developed in 2003-2004 and is constantly being improved, taking into account the Recommendations of the OECD Public Procurement Council (RPP, 2015) and reflecting the leading international framework for such procurement, in particular the Model Law of the United Nations Commission on International Trade (Uncitral, 2011), EU Public Procurement Directives (Public Procurement in the EU, 2016).

The MAPS analytical structure consists of a basic evaluation methodology and various additional modules, focuses on specific aspects of public procurement policy and can be used by countries depending on their needs. Thus, the analysis of the country's conditions Moncrieffe, Luttrell (2005) should be based on a limited number of factors potentially important for procurement reforms, namely:

- 1) political, economic and geostrategic situation in the country;
- 2) links between the procurement system and public administration and public finance management systems,
- 3) national policy objectives that affect the strategy, quantity and quality of public procurement (White, Parfitt, Lee & Mason-Jones, 2016);
- 4) the environment for the implementation of reforms in the field of public procurement.

The originality of the MAPS methodology is that the system of indicators is based on four panels:

- a) the existing legal and political structures that regulate the procurement process in the country;
- b) institutional framework and management efficiency;
- c) the system functioning and the competitiveness of the internal market;
- d) accountability, integrity and transparency of the procurement system.

Each panel, in turn, includes several indicators and sub-indicators to be evaluated. In total, such a system has 14 indicators and 55 sub-indicators, which correspond to the relevant



criteria for “instant” comparison of the current system with these principles. The studied indicators are expressed in qualitative and/or quantitative terms.

What are the advantages of the method of evaluating the effectiveness of public procurement by MAPS? The analysis carried out in the process of scientific research made it possible to identify the following advantages of this technique:

- first, the formulation of the concept of “sustainable public procurement” in line with the integration of the three components of sustainable development, i.e. economic, social development and environmental protection (Spiller et al., 2013);
- secondly, public procurement objectives are usually aimed at reducing the demand for resources, minimizing the negative impact of goods, works or services throughout their life cycle, ensuring fair contract conditions, including ethical rights, human rights and employment standards;

third, the possibility of using public procurement and other innovative methods in evaluation.

In practice, the audit evaluation of public procurement uses evaluation criteria that do not take into account public requests for information about their effectiveness (Figure 2). Under the procurement audit by the Accounting Chamber (Accounting Chamber of Ukraine, 2019), the conclusions on the criteria of transparency, timeliness and completeness of management decisions were not evaluated in terms of their impact on the effectiveness of procurement procedures.

In our opinion, the assessment of the public procurement effectiveness mainly in terms of budget savings (in absolute terms and as an average percentage reduction in the price of goods, works, services purchased) is insufficient for audit purposes. This conclusion is made by the auditors of the Accounting Chamber of Ukraine, assessing the report of the Ministry of Economy, Trade and Agriculture of Ukraine (Accounting Chamber, 2020), in which the Ministry informs about “savings” of 1.02 billion UAH in public procurement in 2019, but does not indicate the causes of this process. The auditors of the Accounting Chamber do not confirm the amount of public savings announced by the Ministry of Economy, as there is no analysis and reliable indicators of efficient and transparent public procurement, the report does not analyze the factors, including those affecting the expected value of tenders.

In our opinion, the use of public savings as the main criterion for the effectiveness of the public procurement system is insufficient for an objective and comprehensive assessment,



as the calculation of budget savings does not take into account a reasonable determination of the initial (maximum) contract price and pricing, resulting in the problems in calculating the savings rate.

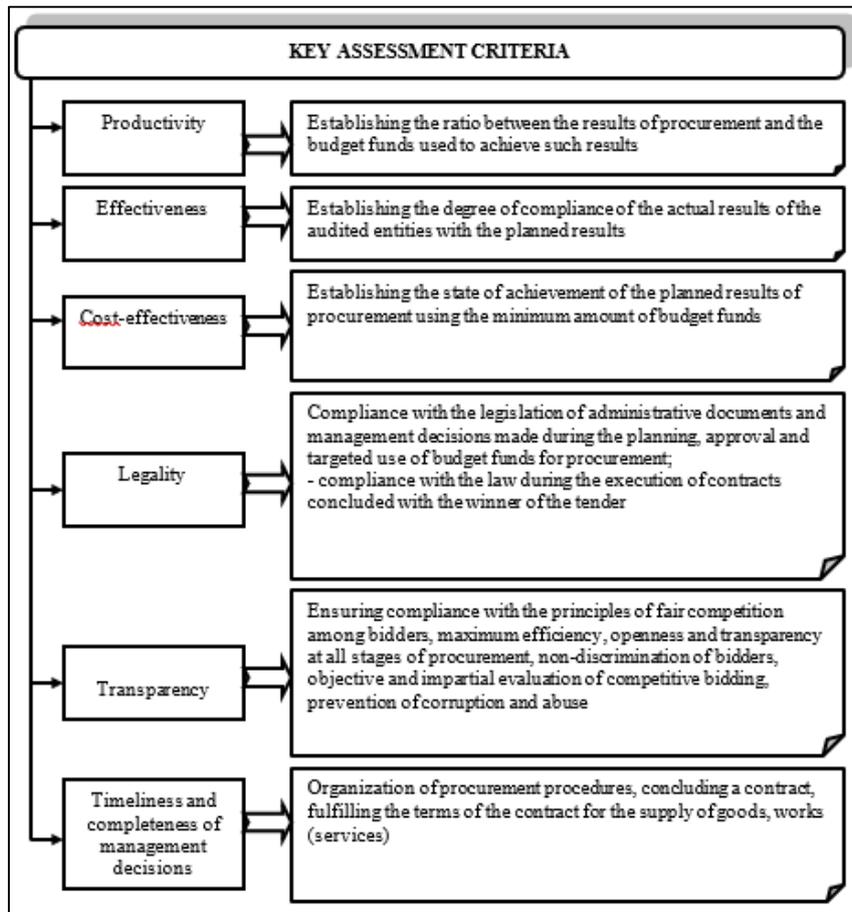


Figure 2: Criteria for assessing the effectiveness of the use of public funds allocated for the purchase of goods, works and services

Source: compiled by the authors

It should be added that the analyzed approach to assessing the effectiveness of public procurement by the only criterion of saving budget resources, in our opinion, is not entirely correct. This conclusion is substantiated by:

- first, insufficient development of methodological support in terms of calculating the initial contract price;
- secondly, the leveling of attention to the specifics of non-price factors that affect both the choice of supplier and terms of supply, and the level of qualification and reliability of public procurement executors;
- third, not taking into account the costs of ensuring the functioning of the public procurement system.

One cannot but agree that the calculation of savings depends on the initial contract price.

At the same time, in case of substantiation of the latter, it is necessary to have special knowledge of market research in order to conduct an in-depth market research by public customers. Therefore, in most cases, the initial (maximum) price of contracts is fixed at the level of financial resources allocated for the purchase of a particular type of product, which, in turn, does not reflect the real market situation. But, under such conditions, when achieving the effect of saving budget resources, there is usually a problem of incomplete use of allocated budget funds for certain items. For the customer, this means a reduction in funding for the costs in subsequent periods.

In addition, it should be noted that significant savings can be achieved either as a result of unreasonable overestimation of the initial contract price, or as a result of non-fulfillment of public procurement plans and the presence of tenders, which did not lead to the conclusion of such contracts.

Thus, the traditional assessment of procurement efficiency based on the definition of budget savings does not fully reflect the degree of procurement efficiency and can be used only for operational analysis. Achieving savings of budget resources in public procurement is, although the main, but still only a part of the holistic process of efficient spending of budget funds, so it can be used only as an additional criterion of efficiency. Such an assessment levels out a set of important indicators, in particular - the quality of the customer's planning work, discipline in the execution of contracts, compliance with the principle of competitive procurement, the customer's compliance with the requirements of public procurement legislation, etc.

Thus, the efficiency of public procurement is replaced by the saving of budgetary resources, while the efficiency of their spending includes their saving. Hence, it is clear that such an assessment will determine only one aspect of the effectiveness of public procurement.

We believe that the lack of assessment of the risks faced by bidders and procurement customers is a significant disadvantage of this approach, because determining the level of such risks makes it possible to form additional characteristics of the effectiveness of the public procurement system. In our opinion, the key risks of public procurement that need to be evaluated and monitored are:

- risk of cancellation of the procurement procedure;



- risk that the procurement procedure will not take place;
- risk of procurement appeal;
- risk of disqualification of the participant.

Risk assessment, or in other words, determining the quantitative and qualitative consequences of its implementation, is possible using various statistical methods.

In our opinion, by using one or another method of risk assessment, the following information about the risk can be obtained: first, its probabilistic characteristics; secondly, its quantitative assessment (Shevchuk, 1998):

$$R = f(x) = f(P, I), \tag{1}$$

where, - the value of the assessment of the consequences of the occurrence of a risky event;

$f(x)$ - function of parameter (x);

P - the probability of a risky event;

I - the potential consequences of risk.

Risk assessment methods, which are traditional and well-tested (Goncharenko & Filin, 2016) to evaluate the risks of public procurement should be supplemented by the method of cost-effectiveness assessment (Zaiets, 2017). It involves comparing the benefits and costs of participation in the competitive public procurement procedures. In the field of public procurement, risk assessments can be obtained using the methods presented in Figure 3.

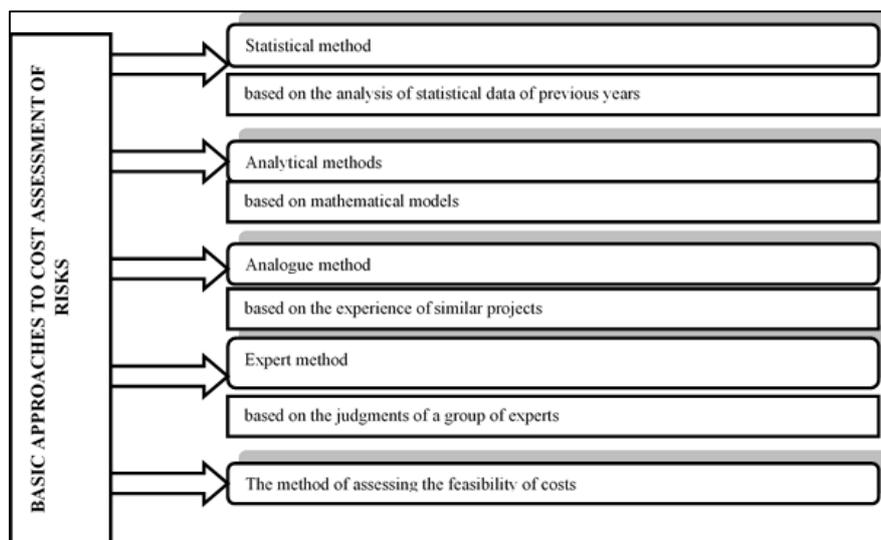


Figure 3: Methods for assessing the risks of public procurement
 Source: authors' development

The results of the assessment of the probabilities of risks realization are summarized and illustrated in Figure 4. Based on the performed calculations, it can be concluded that the risk that the procurement procedure will not take place is the highest risk of public procurement.

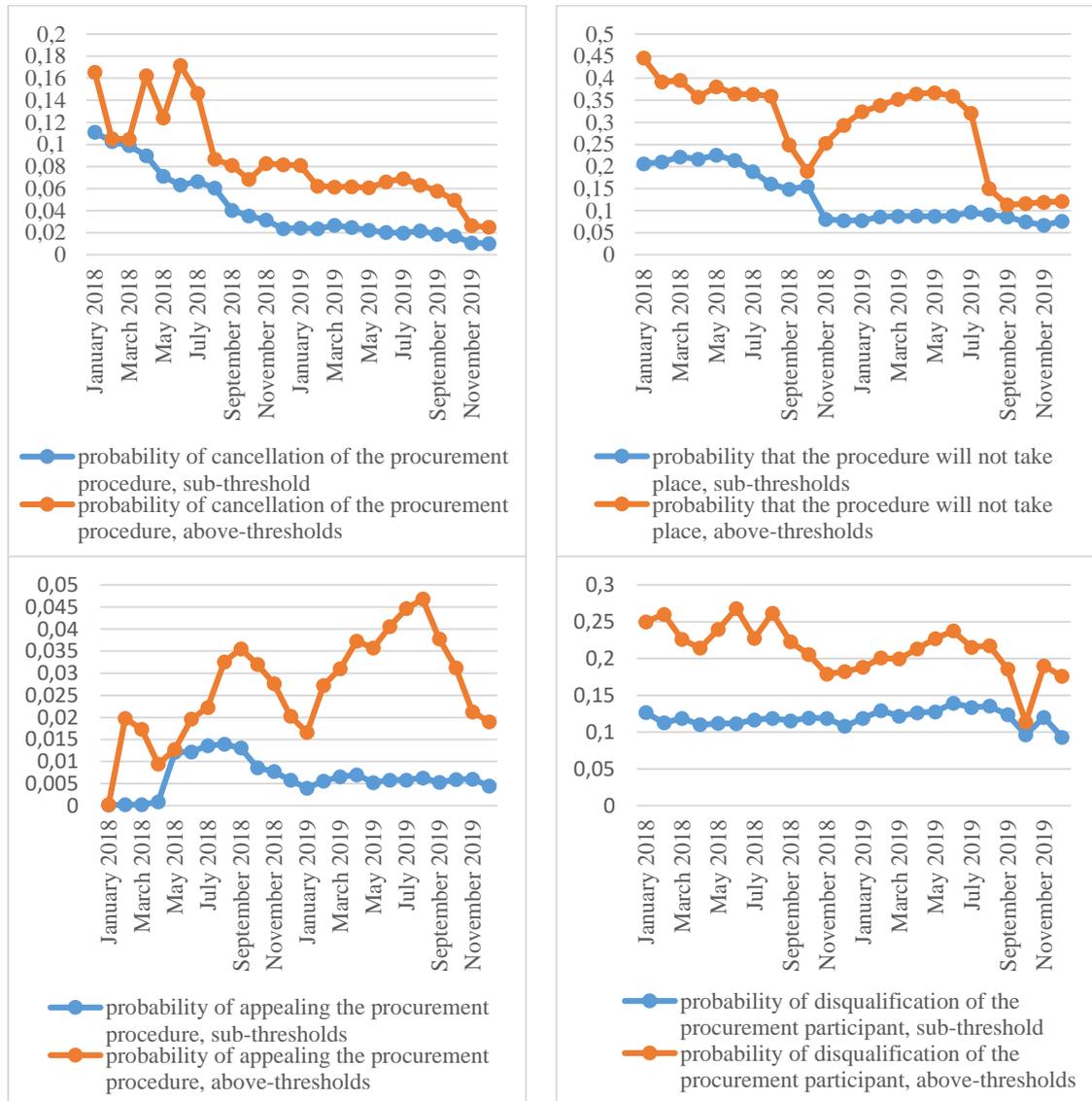


Figure 4: Probabilistic characteristics of public procurement risks

Source: calculated by the authors

The level of this risk reached 45% in January 2018 on both sub-threshold and above-threshold procurement and most of the time during 2018-2019 remained at a level above 35%. At the end of the year, all types of risks were reduced.

The risk of disqualification of public procurement participants is the second risk most likely to be realized.

The level of this risk is higher in above-threshold procurement (from 15% to 30%) against sub-threshold procurement (from 10% to 20%). This is due to the fact that the

qualification requirements for participants are much higher in the implementation of above-threshold procurement. Risk assessments have been calculated using a similar approach.

In order to objectively assess and characterize the level of risks of public procurement, relative to the total expected value of public procurement in terms of sub-threshold and above-threshold values, we calculate VaR-indicators of public procurement (risk value indicators) equal to the quantile of the value distribution function procurement at the selected confidence level of 95%.

Since the determination of VaR is possible for quantities with a normal function of distribution of their values, in order to check whether the distribution of values of the expected value of public procurement can be considered normal, we calculated tables of frequencies of distribution of the expected value of procurement.

The results of calculations of quantitative assessments of public procurement risks for above-threshold procurement are summarized in Table 3 and sub-threshold procurement - in Table 4.

Table 3: Statistical estimates of the cost characteristics of public procurement risks in above-threshold procurement

Indicators	Risk of cancellation of the procurement procedure	Risk that the procurement procedure will not take place	Risk of appealing the procurement procedure	Risk of disqualification of the participant
2018				
Average value of risk assessment	522522891,09	468289944,77	161540793,22	30369610571,04
The standard deviation of the cost estimate of risk	475977186,07	494551086,83	196395124,37	73913648117,30
Variation of the cost estimate of risk	91,09%	105,61%	121,58%	243,38%
2019				
Average value of risk assessment	745970646,78	1007978193,72	96946432,16	1312023241,27
The standard deviation of the cost estimate of risk	699553623,49	609072408,93	63621341,81	724218388,76
Variation of the cost estimate of risk	93,78%	60,43%	65,63%	55,20%
2018-2019				
Average value of risk assessment	475543722,49	509924334,26	137714986,33	13018768698,69
The standard deviation of the cost estimate of risk	587119348,44	617085748,07	159853292,97	48649237510,91
Cost at risk, VAR	1441269112	1524940065	400650255	93039643467
The total value at risk	96406502899			
Cumulative risk of public procurement	47,85%			

Source: authors' calculations

Table 4: Quantitative risk assessments of public procurement in sub-threshold procurement

Indicators	Risk of cancellation of the procurement procedure	Risk that the procurement procedure will not take place	Risk of appealing the procurement procedure	Risk of disqualification of the participant
2018				
Average value of risk assessment	4526153302,26	4738741838,41	4339546073,76	3830891947,16
The standard deviation of the cost estimate of risk	6656071484,08	4625735620,49	8729026880,50	3259557149,33
Variation of the cost estimate of risk	147,06%	97,62%	201,15%	85,09%
2019				
Average value of risk assessment	5733219792,15	8573202986,72	6081006510,89	18654570799,30
The standard deviation of the cost estimate of risk	4301519882,77	2441631225,58	3469600566,59	29250724848,36
Variation of the cost estimate of risk	75,03%	28,48%	57,06%	156,80%
2018-2019				
Average value of risk assessment	5190039871,70	6847695469,98	5297349314,18	11983915315,84
The standard deviation of the cost estimate of risk	5363959804,53	3997205454,98	6261664278,55	22628308940,75
Cost at risk, VAR	14012968611,00	13422513360,28	15596870513,50	49204171348,81
The total value at risk	92236523833,60			
Cumulative risk of public procurement	12,05%			

Source: authors' calculations

As these data show, the total risk of above-threshold public procurement in 2018-2019 is 47.85%, while the total risk of the sub-threshold public procurement in 2018-2019 is equal to 12.05%.

In order to assess the value of the aggregate risk indicator of public procurement, we suggest using the classical approach, which involves the allocation of four risk zones depending on the indicator values (Table 5).

Table 5: Gradation of risk zones depending on the values of the aggregate risk indicator

The value of the aggregate risk indicator	Risk Zone
0 – 0,1	Minor risk
0,1 – 0,3	Permissible risk
0,3 – 0,6	Increased risk
> 0,6	Unacceptable risk

Source: Stupakov and Tokarenko (2005)

In our opinion, such a scale is acceptable for assessing the public procurement effectiveness. Therefore, according to these criteria, the aggregate risk of above-threshold public procurement is increased, while the aggregate risk of sub-threshold public procurement is insignificant.

Thus, the aggregate risk in above-threshold procurement is increased due to the high probability that, firstly, the procurement procedure will not take place and, secondly, the disqualification of participants.

For audit purposes, this necessitates the adjustment of the scope of audit procedures, which depend on the assessed risk of the audited entity.

The estimated risk of individual procurement procedures according to the above method can be used when identifying the effectiveness of the organization of procurement by individual regions (periods).

Thus, the quantitative and cost analysis of risk assessment in this case is carried out on the basis of selected analytical data of the Prozorro system of territories, or one or a group of customers.

5. CONCLUSIONS AND RECOMMENDATIONS

Estimation of efficiency Performance management will vary significantly from one context or situation to another, so adapting general approaches to determining the effectiveness of the use of public funds requires methodologies that would answer the questions of specific situations “What are the generative mechanisms of this particular design of PMS?” and “How do they interact with the particular context?” (Pollitt, 2013).

The research methodology is based on the application of statistical and analytical methods on the data on the conducted procurement procedures during 2018-2019.

In Ukraine, the operation of an open electronic public procurement system has created a unique opportunity for accessible analytics in the context of all announced procurement procedures.

The calculations were performed in terms of sub-threshold and above-threshold procurement. The total amount of processed data for 2018 is 1.084 million procurement procedures, and for 2019 - 1.238 million procurement procedures, which is 100% of the declared procurement procedures for this period. Based on the results of the study, it is proposed to supplement the existing methods of assessing procurement risk indicators to conduct an audit assessment of procurement effectiveness.

Procurement efficiency was assessed via four types of risk: the risk of cancellation of the procurement procedure, the risk that the procurement procedure will not take place, the risk of appealing the procurement, the risk of disqualification of the participant separately for sub-threshold and above-threshold procurement. The riskiest periods of procurement were

established and the aggregate risk indicator of public procurement was calculated at the level of 47.85%. This enabled assessing the impact of certain types of risk on the procurement effectiveness and adjusting the scope of audit procedures to verify individual procurement.

We see the further direction of the research in determining the risks of procurement by types of selected procedures, which will generate analytical data for risk management in the supply chain management.

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