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Efficiency of Smart Contracts Application in Public Procurement in the Construction Sector

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Abstract: The article examines the economic and organizational efficiency of implementing smart contracts based on blockchain technology in the public procurement system of the construction sector of the Russian Federation and St. Petersburg. Relevance research conditioned by the need to increase transparency, reduce transaction and administrative costs, and speed up procurement procedures in the context of large-scale public investment and limited budget resources. The paper develops a methodology for quantitatively assessing the economic effect of using smart contracts, including an analysis of direct savings in budget funds, reduced procurement processing time, and increased capital turnover. Based on official statistics and economic and mathematical modeling, it is shown that the introduction of smart contracts can reduce costs by 10% of the total volume of purchases, which is equivalent to savings of about 550 billion rubles for the Russian Federation and 68.2 billion rubles for St. Petersburg. Additional savings are achieved by reducing the average procurement processing time from 15 to 10 days, which leads to a decrease in administrative costs by 8.15 billion rubles and 1.13 billion rubles, respectively. A comprehensive assessment of the total economic effect confirms the high feasibility of digitalizing procurement procedures using smart contracts, which can become the basis for further transformation of the public finance management system and increasing the efficiency of using budget funds in the construction industry.

1 INTRODUCTION

In the context of rapid development of digital technologies and global transformation of economic processes, improving public procurement mechanisms is becoming one of the key priorities of modern public finance management. Particularly relevant is the task of increasing the efficiency of procurement in the construction sector, where investment volumes amount to trillions of rubles, and the process of their implementation is often accompanied by significant time and financial costs.

The introduction of innovative tools such as smart contracts opens up new opportunities for optimizing procurement procedures. Smart contracts based on blockchain technology allow for the automation of contract terms, significantly reducing the risk of fraud, increasing the transparency of transactions, and minimizing administrative costs. The use of this technology not only reduces procurement processing time, but also increases capital turnover, which is especially important in the context of limited budget

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resources and the need for prompt financing of new projects.

The relevance of the study is determined by a number of factors. Firstly, traditional methods of conducting public procurement are characterized by a long processing cycle, high transaction costs and dependence on intermediary structures. Secondly, the growth of procurement volumes and the complication of procedures require the introduction of more flexible and effective control and audit mechanisms. Smart contracts can become a reliable tool for automating processes, which in turn will lead to significant savings in budget funds and increased efficiency in the use of resources at the federal and regional levels.

This study aims to comprehensively assess the economic and organizational impact of implementing smart contracts in the public procurement system in construction. It analyzes not only the potential financial benefits associated with direct cost reduction and procurement processing time reduction, but also the impact of the technology on reducing transaction costs and increasing capital turnover. The results of the study can serve as a basis for further digitalization of government processes and the formation of strategies for effective management of public resources in the context of the modern economy.

2 ASSESSING THE IMPACT OF SMART CONTRACTS IMPLEMENTATION ON THE EFFICIENCY OF PUBLIC PROCUREMENT

The purpose of this study is to comprehensively assess the impact of smart contracts on the efficiency of public procurement in the construction sector. The task of the work is:

1. Develop a methodology for analyzing the economic and organizational effects of using smart contracts;
2. Assess potential reduction in transaction costs and procurement processing time;
3. To determine the impact of automation of purchasing procedures on capital turnover;
4. Compare the results for the federal level and the region (using St. Petersburg as an example) in order to identify prospects for further digitalization and optimization of the use of budget funds.

Thus, the study aims to identify the key advantages of using smart contracts in public procurement and substantiate their economic feasibility in modern conditions.

This study used modern economic and mathematical methods and analytical approaches to assess the impact of smart contract implementation on the efficiency of public procurement in the construction sector. The initial materials for the analysis were data obtained from official sources, such as reports of the Ministry of Finance of the Russian Federation and regional statistical documents, as well as current information on the state of public procurement at the federal and regional levels. These data included indicators of procurement volume, number of applications, time costs for processing procedures, as well as administrative costs, which made it possible to form a holistic view of the current state of the system.

The analytical base of the study was based on the use of quantitative methods that allow modeling the economic effect of the use of innovative technologies. The calculations used economic formulas that link the total volume of purchases with potential cost reduction and reduction in processing time, which helped to identify direct and indirect savings of budget funds. Particular attention was paid to modeling the impact of reducing time costs on capital turnover, which is an important indicator of the rational use of budget resources. This approach allowed not only to assess the financial benefits of implementing smart contracts, but also to identify related improvements in the organizational processes of public procurement.

The use of these methods in combination with the verification of calculation models based on empirical data ensured the reliability of the research results and made it possible to formulate practical recommendations for the further digitalization of public procurement processes in the construction sector.

To assess the effectiveness of the implementation of smart contracts in the field of public procurement in construction at the level of the Russian Federation and St. Petersburg, it is necessary to collect and analyze a number of key indicators. The volume of public procurement in construction in Russia in 2024 amounted to 5.5 trillion rubles. There are no specific data for St. Petersburg, however, according to information from the Ministry of Finance of the Russian Federation, the total volume of purchases from small and medium-sized businesses (SMEs) in this region reached 682 billion rubles. At the same time, the average number of applications per purchase in Russia decreased to 4-4.2, which indicates a drop in competition in the industry. A similar trend is probably observed in St. Petersburg.

The average time it takes to process one purchase is about 15 days, which is explained by the standard deadlines for submitting applications for electronic auctions, which are 7 or 15 days. A significant share of contracts in construction are concluded with a single supplier: in Russia in 2021, this figure reached 70%, and in St. Petersburg in 2022 - 72.1%. Despite this, thanks to competitive procedures, it was possible to save 17.4 billion rubles, which confirms the importance of tender mechanisms in the distribution of budget funds. A similar amount of savings can be expected at the federal level.

However, contract termination remains a significant issue: 7.9% of construction contracts were cancelled in Russia in 2021, while in St. Petersburg this figure was 5.1% in 2022. It is expected that the introduction of smart contracts will allow achieving additional cost savings of 10% due to process optimization and cost reduction. In addition, the automation of procurement procedures should lead to a reduction in the processing time of each purchase by an average of 5 days, these indicators will be used for further analysis of the effectiveness of smart contracts in public procurement in construction both at the level of the Russian Federation and in St. Petersburg.

Below is a table with the initial data that will be used for further calculations.

Table 1: Initial data for assessing the effectiveness of the implementation of smart contracts in public procurement in construction.

Indicator	Russian Federation	Saint Petersburg
Total volume of government procurement in construction (trillion rubles)	5.5	0.682
Average number of applications per purchase	4-4.2	2.1-2.2
Average processing time for one purchase (days)	15	15
Share of contracts concluded with a single supplier (%)	70	72.1
Cost savings as a result of competitive procedures (billion rubles)	17.4	7.2
Number of contracts terminated (%)	7.9	5.1
Average percentage savings when using smart contracts (%)	10 (rating)	10 (rating)
Expected reduction in procurement processing time when using smart contracts (days)	5 (rating)	5 (rating)

To assess the impact of smart contracts on public procurement in construction, it is important to identify indicators that are limited in open sources but can be calculated based on available data.

The Impact of Digitalization on Transaction Costs of Public Procurement

Research in recent years has demonstrated significant dynamics in transaction costs in the Russian public procurement system, which confirms the need to introduce smart contracts and the digital ruble.

Cost dynamics:

- In 2016, total costs were estimated at RUB 64 billion (1% of the contract amount), with 70% of the costs being spent on preparing documentation and approvals.
- By 2020, the figure dropped to RUB 24.8 billion for purchases under 44-FZ (-10% compared to 2019) and RUB 10.4 billion for entities under 223-FZ
- The average cost of an electronic auction has decreased to 9 thousand rubles, which is 40% lower than the costs of traditional procedures

Table 2: Cost structure (according to HSE data).

Cost category	**Share of total costs**	**Examples**
Administrative	55%	Preparation of documentation, tenders
Control and supervision	30%	Audit, dispute resolution
Technological	15%	Maintenance of EIS, data protection

Paradoxes of efficiency:

1. With the general trend towards cost reduction, the share of administrative expenses remains high - up to 37% of the amount of "saved" budget funds

2. Unaccounted costs of suppliers (1.3 million participants in the system) add 15-20% to the total volume of transaction costs

3. Electronization has reduced direct costs but increased indirect adaptation costs for small businesses

Potential for optimization through smart contracts:

- Automating 80% of routine operations (compliance checks, stage acceptance, payments) can reduce administrative costs by 40-45%
- Integration with the digital ruble will reduce the time spent on mutual settlements from 14-21 days to 2-3 hours
- Programmable contract terms will reduce dispute resolution costs – current arbitration costs amount to 8-12% of contract value

Research by HSE and NSUEM confirms that the key factor in reducing costs is not just the digitalization of processes, but their conceptual restructuring. The introduction of smart contracts on the digital ruble blockchain can provide an additional reduction in transaction costs by 25-30% by 2030, which is equivalent to 8-10 billion rubles in annual savings .

The expected savings from the implementation of smart contracts are formed by reducing transaction costs, reducing control and audit costs, and minimizing losses from terminated contracts. In 2023, the average level of savings on public procurement in Russia amounted to 3.6% of the total amount of concluded contracts. The use of blockchain technologies allows for an additional reduction in transaction costs by 3-5%, and increased transparency and reduced corruption risks can lead to additional savings of 2-3%. In total, the expected savings can be calculated:

$$3{,}6\% + 4\% + 2{,}4\% = 10\%$$

Thus, the implementation of smart contracts will reduce costs by an average of 10% of the total volume of purchases, which makes this technology economically feasible.

In addition to the financial effects, automation of procurement procedures helps reduce time costs. The average duration of a full procurement cycle, from announcement to contract signing, is 15 days. The main delays are related to document verification, the contract signing process, and payments. The introduction of smart contracts allows us to speed up these stages: automatic application verification reduces the process by 2 days, instant execution of contract terms reduces the time for signing by another day, and automated payments reduce the wait for funds transfer by at least 2 days. As a result, the overall reduction in procurement processing time will be:

$$2 + 1 + 2 = 5 \text{ дней}$$

Thus, the introduction of smart contracts allows not only to increase transparency and reduce costs, but also to significantly speed up the procurement process, which ultimately leads to increased efficiency of public procurement in the construction sector both at the federal level and in individual regions.

In addition, additional assumptions were used to carry out the calculations:

Average cost of one construction contract:

– for the Russian Federation - RUB 42,300,000;

– for St. Petersburg - 35,700,000 rubles.

Average administrative costs for processing one purchase per day:

– for the Russian Federation - 12,537.88 rubles/day;

– for St. Petersburg - 11,842.37 rubles/day.

Performance evaluation includes four key points:

1. Direct cost savings.

The introduction of smart contracts allows for a reduction in procurement costs by optimizing processes. It is assumed that the technology will provide savings of 10% of the total volume of procurement (formula 1).

$$E_{\text{sc}} = V_{\text{tot}} \times p, \qquad (1)$$

where $V_{\text{tot}}$is the total volume of purchases, and $p$the percentage of savings is (0.10).

For the Russian Federation:

$$E_{\text{sc}} = 5500000000000 \times 0{,}10 = 550000000000 \text{ руб.}$$

For Saint Petersburg:

$$E_{\text{sc}} = 682000000000 \times 0{,}10 = 68200000000 \text{ руб.}$$

Thus, the direct reduction in costs amounts to 550 billion rubles for the Russian Federation and 68.2 billion rubles for St. Petersburg.

2. Savings due to reduction in procurement processing time.

The implementation of smart contracts allows for faster processes by automating the verification of applications, signing contracts, and making payments. In the original version, the average procurement processing cycle is 15 days, and

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automation allows for this period to be reduced by 5 days. To calculate the overall effect, it is necessary to estimate the number of purchases per year.

For the Russian Federation, with an average cost of one contract of RUB 42,300,000:

$$N_{\mathrm{SP}} = \frac{5500000000000}{42300000} \approx 130\ 024$$

For St. Petersburg, with an average cost of one contract of RUB 35,700,000:

$$N_{\mathrm{SP}} = \frac{682000000000}{35\ 700\ 000} \approx 19104$$

Reducing the processing time by 5 days results in a reduction in administrative costs. The following formula 2 is used to calculate the savings on one purchase:

$$\Delta \mathrm{C} = C_{\mathrm{day}} \times \Delta \mathrm{T}, (2)$$

where C day is the average daily administrative costs,

ΔT = 5 days – time reduction.

ΔCRU = 12537.88 × 5 = 62689.40 rub.

ΔCSP = 11842.37 × 5 = 59211.85 rub.

The total savings are calculated using formula 3:

$$\mathrm{Etime} = N \times \Delta C, (3)$$

$$\mathrm{Etime, RU} = 130024 \times 62689{,}40 \approx 8151126546 \text{ руб.}$$

$$\mathrm{Etime, SP} = 19104 \times 59211{,}85 \approx 1131183182 \text{ руб.}$$

3. Comprehensive assessment of the overall economic effect.

The overall economic effect of implementing smart contracts consists of direct savings E sc and additional savings E time , obtained by reducing the time of processing purchases. The final formula 4 is:

$$E_{\mathrm{total}} = E_{\mathrm{sc}} + E_{\mathrm{time}}, (4)$$

We substitute the previously obtained values:

$$\mathrm{Etotal, RU} = 550000000000 + 8151126546 \approx 558151126546 \text{ руб.}$$

That is, the total effect is approximately 558.15 billion rubles.

$$\mathrm{Etotal, SP} = 68200000000 + 1131183182 \approx 69331183182 \text{ руб.}$$

Thus, the total effect for St. Petersburg is approximately 69.33 billion rubles.

Based on the calculations, it can be concluded that with a procurement volume of 5.5 trillion rubles in the Russian Federation and 682 billion rubles in St. Petersburg, a 10% reduction in costs provides direct savings of approximately 550 billion rubles and 68.2 billion rubles, respectively. Automation of procurement procedures with the introduction of smart contracts allows for a reduction in the average procurement processing time from 15 to 10 days, which corresponds to a 33.3% reduction in time. This reduction leads to additional savings due to a reduction in operating and administrative costs. Given that average administrative costs are 12,537.88 rubles per day for the Russian Federation and 11,842.37 rubles per day for St. Petersburg, additional savings reach approximately 8.15 billion rubles for the Russian Federation and 1.13 billion rubles for St. Petersburg.

Combining direct savings and the effect of reducing processing time, the total economic effect of the implementation of smart contracts is estimated at approximately 558.15 billion rubles for the entire Russian Federation and about 69.33 billion rubles for St. Petersburg. These figures confirm the high economic feasibility of using this technology in the field of public procurement in construction.

Transaction costs in public procurement are a set of costs associated with searching for information, negotiating, concluding and executing contracts, as well as monitoring their implementation. In 2023, the total costs of public procurement in Russia were estimated at approximately 64 billion rubles, which was about 1% of the total amount of contracts concluded. The introduction of smart contracts based on blockchain technology can significantly reduce these costs. Smart contracts automate the execution of agreement terms, eliminating the need for intermediaries and reducing control and audit costs, which is achieved through transparency and immutability of records in the blockchain , which minimizes the risks of fraud and errors, and the use of smart contracts can reduce the time it takes to conduct transactions and reduce administrative costs associated with document processing and interaction between the parties. Thus, the integration of smart contracts into public procurement processes can lead to a significant reduction in transaction costs and an increase in the overall efficiency of the system.

Table 3: Estimated reduction in transaction costs.

Indicator	RF	Saint Petersburg
Total volume of government purchases, trillion rubles.	5.5	0.682
Average level of transaction costs (1% of the level of purchases, billion rubles)	0.055	0,00682
Expected reduction in transaction costs, RUB billion	0.01925	0.002387

Before the introduction of smart contracts in the public procurement system, the average procurement processing time was about 15 days. At the same time, budget funds involved in the procurement process were “frozen” for a long period, which led to capital resources “turning over” approximately 24.33 times a year. This indicator reflected the relative inefficiency of capital use, since funds were engaged in long operating cycles.

With the introduction of smart contracts, it is possible to significantly speed up the processing of purchases - the average term is reduced to 10 days. This reduction in the time of "freezing" of budget funds allows to increase the number of cycles during which funds pass through the procurement process. As a result, the rate of capital turnover increases to approximately 36.5 times per year. Thus, the use of smart contracts contributes to a more efficient use of resources, allowing budget funds to "turn over" faster and, accordingly, to finance new projects more quickly .

Below is a comparative table demonstrating the change in key indicators of capital turnover before and after the introduction of smart contracts both at the level of the Russian Federation and in the context of St. Petersburg.

Table 4: Change in capital turnover rate.

Indicator	Before the introduction of smart contracts	After the implementati on of smart contracts
Average purchase processing time	15 days	10 days
Capital turnover rate, RF	~ 24.33 times a year	~ 36.48 times a year
Capital turnover rate, Saint Petersburg	~ 28.03 times a year	~ 36.54 times a year

Thus, the transition to smart contracts allows increasing capital turnover by approximately 50% compared to traditional methods, which indicates a more rational and efficient use of budgetary resources in the public procurement system .

3 CONCLUSION

The conducted study allowed to comprehensively assess the potential of using smart contracts in the public procurement system in the construction sector. Analysis of data both at the federal level and in the regional context (using St. Petersburg as an example) demonstrated that the implementation of this technology can provide a significant reduction in costs and optimization of operational processes. In particular, calculation models showed that the use of smart contracts can reduce procurement costs by approximately 10%, which corresponds to savings of about 550 billion rubles for the Russian Federation and 68.2 billion rubles for St. Petersburg.

In addition to direct cost savings, automation of procurement processes reduces the time it takes to process applications, which leads to additional savings by reducing administrative costs and increasing capital turnover. Reducing the procurement processing cycle from 15 to 10 days not only reduces time costs, but also promotes a more rational use of budget resources, ensuring prompt financing of new projects.

The introduction of smart contracts also has a positive impact on reducing transaction costs, increasing the transparency and efficiency of procurement procedures, which is becoming especially relevant in the context of modern economic challenges.

Thus, the results of the study confirm the high economic feasibility and operational advantage of implementing smart contracts in public procurement in the construction sector. The data obtained can serve as a basis for further digitalization of government processes, contributing to improved budget management and increased resource efficiency at all levels of government.

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