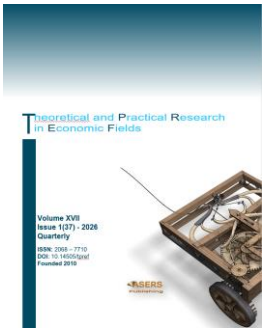
Strengthening Financial Control in Public Procurement as a Way of Counteracting Economic Crimes



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Abstract: Purpose: The relevance of the study is determined by the need to increase the effectiveness of countering economic crimes through the optimization of control mechanisms in the field of public procurement based on indicator-metric monitoring and institutional stratification. The aim of the research is the formalization and verification of the framework for financial control of procurement, considering anti-corruption metrics, digital monitoring, and algorithmic auditing under regulatory variability.
Methodology: The study is based on the application of the following methods: strategic stratification, econometric modelling, decomposition analysis, synthesis modelling, comparative analysis
Findings: The study verified procurement frameworks through stratification, econometric modelling, and decomposition analysis. It was found that KONEPS has the best baseline performance (Cost Savings – 75%, LCR – 0.002, ROI – 12.5) but is limited by cybernetic inertia. The developed framework outperforms the specified metrics: Cost Savings – 82.7%, ROI – 14.2, LCR – 0.0015, CPI – –8.6, MCR – 0.007. The results demonstrate increased control resilience, institutional coherence, and regulatory adaptability.
Originality: The academic novelty of the research lies in the synthesis modelling of a procurement framework optimized by financial monitoring for multi-level control and traceability. The Price Efficiency Index and Monitoring Cost Ratio metrics were introduced for the first time, while LCR and Control ROI were modernized for metric-based performance assessment. Prospects for further research may be the development of a pilot experiment to implement an optimized framework in a limited administrative environment to assess its institutional integration.

Keywords: economic growth; economic empowerment; indicator verification; control resilience; institutional stratification; predictive monitoring module; metric-based performance.

JEL Classification: H57; D73; H83; O38; K42; C53.

Introduction

Strengthening financial control in the field of public procurement is a key element in countering economic crimes, which create a high-risk environment for budget funds misuse and destroy fiscal discipline. The inefficiency of existing mechanisms for detecting abuses necessitates the implementation of control tools with a higher degree of

analytical resistance and traceability of entities' actions in the procurement process (Melnyk *et al.* 2022; Kussainov *et al.* 2023).

Insufficient integration of financial monitoring tools and limited algorithmic support for preventive transaction analysis significantly reduce the effectiveness of managerial response to risks in public procurement. The use of digital processing tools for large data sets, analytical indicators, and structured control models creates the potential for reorienting procurement policy towards proactive anomaly detection (Poliova *et al.* 2024; Kobets *et al.* 2025).

Scientific gap. Despite the rapid diffusion of e-procurement and compliance digitalization, the literature remained fragmented in linking anti-corruption control mechanisms to a unified, metric-validated financial monitoring architecture that was robust under high regulatory variability and measurable through operational efficiency and leakage-reduction indicators.

Research questions. (RQ1) Which validated public procurement frameworks demonstrated the highest control effectiveness under comparable efficiency and integrity metrics? (RQ2) Which financial monitoring instruments and control modules most strongly improved procurement performance in terms of savings, price efficiency, cycle time, leakage intensity, and control ROI? (RQ3) How could a synthesis model integrate these mechanisms into an interoperable framework with institutional traceability and scalable anomaly detection?

The purpose of this study was to develop and validate a financially monitored public procurement control framework that quantifiably reduced procurement leakage under high regulatory variability by applying anti-corruption metrics, digital monitoring, and algorithmic audit procedures.

Research objectives:

1. Stratify existing public procurement frameworks according to structural and functional characteristics.
2. Formulate an indicator system for assessing the effectiveness of financial control.
3. Identify typical defects and inefficiencies in existing procurement control practices.
4. Develop an architectural model of an optimized public procurement framework.
5. Conduct a formalized comparison of the basic and optimized frameworks.

1. Literature Review

Public procurement is a high-risk segment of public finance management characterized by increased vulnerability to economic abuse, institutional fragmentation of control mechanisms, and limited accountability of fund managers. In the context of regulatory polyvalence, digitalization of processes and multiplicity of legal regimes, there is a need for a systematic analysis of scientific approaches to financial control as determinants of combating corruption and torts in the procurement sector.

The initial impetus for the discussion is the generalization of Murzac and Vasiliţa (2025), who systematized international best practices for combating corruption in public procurement, focusing on regulatory adaptability, digital transformation of procedures, and socio-institutional accountability. It is proven that the effectiveness of anti-corruption policy is determined by the practical implementation of transparent and resilient administrative mechanisms, not by regulatory declarativeness.

In this context, Baskoro (2025) proves the effectiveness of a synergistic model of combating corruption in public procurement, which combines regulatory deregulation, civic oversight, and digital interventions (e-procurement, real-time surveillance). It is noted that technological determination of transparency and participatory control reduce discretionary abuse and minimize the normative adaptive behaviour of corrupt actors.

In support of this thesis, Suryani and Setiany (2025) empirically proved that the digitalization of procedures (e-procurement), internal control, and whistleblowing mechanism have a statistically significant preventive effect on fraud in public procurement. The obtained results confirm the effectiveness of the three-component model of anti-corruption accountability.

At the same time, the results of Omata *et al.* (2025) detail the structural causes of compliance violations, emphasizing that the key triggers of fraud in public procurement are asymmetry of accountability, insufficient effectiveness of internal control, dispositive tolerance of management, and lack of institutionalized monitoring (R^2=0.579). The appropriateness of implementing a unified anti-corruption policy, regulated audit cycles, and digital tools for detecting compliance violations is argued.

In turn, Maksum and Suparno (2025) proved the effectiveness of a complementary model that combines administrative preventive control with criminal-jurisdictional response as a tool for combating corruption in the field of public procurement. Regulatory conflicts, institutional duplication, and a lack of procedural differentiation between disciplinary and tortious offences were identified.

Complementing this conclusion, Adhi *et al.* (2025) identified the persistent criminalization of public procurement through overpricing, fictitiousness, and favouritism. The limited effectiveness of anti-corruption regulation was proven due to the fragmentation of norms, weak institutional capacity and political interference.

Deepening the understanding of risks, Pérez-Morote *et al.* (2025) identified critical risks in public procurement management – lack of transparency, violation of contracting procedures, inconsistency of competencies and budget regulations. The use of a risk index to quantify the effectiveness of ex-ante and ex-post financial control is justified within the COSO model.

Particular attention to sectoral distortions was brought by the results of Stamouli *et al.* (2025), who revealed the systemic corruption of public procurement in the healthcare sector, reinforced by the emergency regime and reduced transparency during the pandemic. It is proven that the crisis context activates mechanisms of state-corporate deviation in the supply of medical goods. In the context of strengthening institutional foundations, Yanuarisa *et al.* (2025) recorded the intensification of research on internal audit as a key tool for governance-compliance in public procurement, with an emphasis on the integration of Big Data, RPA and risk-oriented methodologies. The relevance of a multi-theoretical approach (institutional, stakeholder, stewardship) is proven to overcome the deficit of institutional autonomy, auditor independence and methodological singularity.

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In conclusion, Negedu *et al.* (2025) demonstrated that the institutional implementation of sustainable public procurement in low-income jurisdictions is blocked by administrative non-autonomy, regulatory entropy, lack of e-procurement infrastructure, and high levels of clan dispositivity. The need for the implementation of a multi-criteria approach (environmental-socio-economic stratification) through regulatory harmonization and subnational governance decompression is argued.

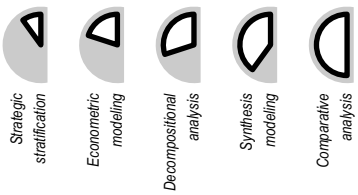
The review demonstrated the dominance of the issues of regulatory entropy, institutional inconsistency, procedural opacity, and lack of controlling autonomy in the field of public procurement. The identified analytical paradigm indicates the need for formalized research on financial control as a key anti-tort tool in the context of systemic corruption.

2. Methods and Materials

2.1. Research Design

The study was conducted in several stages illustrated below (Figure 1).

Figure 1. Research Procedure



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2.2. Methods

The study employed the following methods:

1. *Strategic stratification* – used for taxonomic grouping of public procurement frameworks using the SWOT analysis model, which allowed to systematically identify structural and functional advantages, organizational and technological shortcomings, institutional development vectors and external risks.

2. *Econometric modelling* – implemented through the construction of an indicator evaluation system (Procurement Cost Savings, Control ROI, MCR, LCR, etc.), which allowed to quantitatively verify the control effectiveness of the frameworks.

3. *Decomposition analysis* – used to identify effective and defective practices in the functioning of frameworks and assess their potential for optimization by means of financial monitoring.

4. *Synthesis modelling* – used to formalize the architecture of the optimized framework with the introduction of predictive and analytical monitoring modules to strengthen the structural coherence and interoperability of the control process.

5. *Comparative analysis* – used to compare the base and optimized frameworks according to key performance metrics, which provided a formalized assessment of the effectiveness of optimization.

2.3. Sample

The study involved a targeted selection of public procurement frameworks, the effectiveness of which has been empirically confirmed in terms of anti-corruption resistance, procedural transparency, and institutional accountability. The sample was based on available data on real achievements in reducing economic abuses, which allows it to be used as a benchmark for formalizing control mechanisms – Table 1.

Table 1. Validated Public Procurement Frameworks with Low Corruption Vulnerability: A Selection of Empirically Effective Models

Framework name	Country of implementation (year of implementation)	Mechanisms of action	Proven effectiveness	Relevant studies
KONEPS	South Korea (2002)	Digitization of the entire procurement cycle, supplier registry, automated supervision	▪ Reduction of corruption losses by ≈75% over 10 years (OECD, 2022) ▪ Savings of ≈1.4 billion USD annually through automation	Kim and Shin (2024); Jae Moon (2024)
ProZorro	Ukraine (2016)	Open API, analytical risk indicators, civic oversight (DoZorro)	▪ 36+ milliard UAH savings from 2016 to 2024 ▪ Over 35 thousand procurements stopped after signals from DoZorro ▪ Transparency International: recognized as one of the most transparent systems in the world	Nefodova *et al.* (2025); Brick Murtazashvili *et al.* (2024)
OCDS	Colombia, Mexico (2015)	Standardized open data, machine-readable contracts, full-cycle control	▪ In Colombia – procurement costs reduced by 14%, contracting time reduced by 60% ▪ In Mexico – corruption complaints in the health sector decreased after the implementation of OCDS	Ghaffari-Tabrizi (2025); Behar-Villegas (2024)
Integrity Pacts	Bulgaria, Latvia (2000)	Contractual transparency obligation, independent monitoring, preventive control	▪ In Bulgaria – elimination of over 20 corruption risks in EU projects ▪ In Latvia – cancellation of tender due to violations discovered at an early stage	Puksas *et al.*(2025); de Vries and Nemec (2025)
MAPS (OECD)	Lithuania, Uganda, (2015) etc.	Indicative assessment of system maturity, GAP analysis, regular monitoring	▪ In Lithuania and Uganda – after MAPS implementation: 40% reduction in average procedure duration ▪ Recognized as a transparency tool in 60+ countries	Nyathore *et al.* (2024); Hamiza and Rulangaranga (2025)
TED + eCertis	EU (2014)	Uniform document flow rules, TED publicity, digital verification	▪ The level of detected irregularities within EU Tenders decreased by ≈30% from 2015 to 2022. ▪ Harmonization of procedures reduced discretion in the winners' selection	Telles (2025); Paraskeva and Tsoulfas (2025)

Source: created by the authors

2.4. Instruments

This study is based on formalized economic metrics (Table 2) to measure fiscal efficiency, procedural efficiency, and anti-corruption resistance of public procurement frameworks. The proposed indicators provide a quantitative

assessment of the degree of controllability of the procurement cycle and allow identifying systemic deviations relevant for the analysis of countering economic crimes.

Table 2. Instrumental Metrics for Assessing the Effectiveness of Financial Control in Public Procurement

Metric name	Short description	Mathematical formula	Relevant studies
Procurement Cost Savings	Specific budget savings resulting from procurement procedures under controlled frameworks.	Savings Rate = (Planned Budget − Final Contract Value) / Planned Budget × 100%	Gorgun *et al.* (2025)
Price Efficiency Index	Reflects the deviation of the contract price from the market price.	PEI = (Contract Price − Market Price) / Market Price × 100%	The metric is formalized for the first time for comparison with market prices as a relative deviation.
Monitoring Cost Ratio	Ratio of monitoring costs to total contract volume.	MCR = Oversight Costs / Total Contract Value	The metric is formalized for the first time as an analytical indicator of monitoring effectiveness
Average Procurement Cycle Time	Average duration of the full procurement cycle – from announcement to contract conclusion.	APCT = Σ(Duration of Procurement_i) / N	Boykin *et al.* (2025)
Loss-to-Contract Ratio	Specific amount of financial losses caused by violations to the volume of contracts concluded.	LCR = Detected Losses / Total Contract Value	The metrics modified to focus on losses specifically in relation to contract volume.
Competition Rate	Average number of suppliers per procurement procedure.	CR = Σ(Number of Bidders) / Number of Tenders	de Oliveira Leite *et al.* (2025)
Cancellation/Appeal Rate	Share of invalid or contested procurement procedures.	CAR = (Cancelled + Appealed Procedures) / Total Procedures × 100%	Henty (2025)
Control ROI	Profitability of control activities in relation to financial benefits.	ROI_control = (Savings + Recovered Losses) / Oversight Costs	A modified metric that adapts financial ROI to the scope of public procurement control.

Source: developed by the authors

A number of specialized analytical metrics were formalized for the first time in the study, in particular *Price Efficiency Index, Monitoring Cost Ratio,* and *Control ROI*, which not only deepen the range of economic and control indicators, but also provide more accurate detection of latent losses, inefficiency, and structural vulnerability of public procurement procedures. The *Loss-to-Contract Ratio* metric was also modified to increase the specifics of measuring losses in relation to the contract volume, which increases analytical accuracy in risk modelling.

Econometric modelling of indicators was carried out in the Python programming environment using pandas, numpy, scikit-learn libraries, and logical-structural formalization of control processes was implemented using UML modelling in the PlantUML syntax, which ensured consistency between the algorithmic logic and the procedural structure of the financial control system.

3. Results

This study contains a strategic stratification of public procurement frameworks was carried out using the SWOT analysis model (Table 3), which allows structuring their strengths (structural and functional advantages), weaknesses (organizational and technological shortcomings), external opportunities (institutional and political vectors of development), and risks (external threats of a regulatory, cyber or administrative nature). This approach provided a comprehensive assessment of the potential of the frameworks in terms of ensuring financial accountability, digital integration, transparency of procedures and compliance resistance to economic crimes.

SWOT analysis (Table 3) identified the strengths of the frameworks, in particular: digital totality of the procurement cycle (KONEPS), analytical risk indexing (ProZorro), standardized data interoperability (OCDS), contract prevention (Integrity Pacts), indicator diagnostics of system maturity (MAPS), unified validation of subjectivity (TED + eCertis). At the same time, critical flaws were identified: cyber dependence, regulatory inertia, fragmentation of functional modules, low scalability of public oversight, and institutional dependence on external actors. Based on the results, the transition to the calculation of instrumental metrics was justified - Table 2. These indicators became the basis for econometric modelling of control efficiency in the field of public procurement - Table 4.

Table 3. SWOT Analysis of Institutional and Functional Frameworks of Public Procurement from the Standpoint of Anti-Corruption Resistance and Control Effectiveness

Framework	S (Strengths)	W (Weaknesses)	O (Opportunities)	T (Threats)
KONEPS	Full digitalization of the procurement cycle, integration with fiscal and tax systems, levelling the human factor	High deployment costs, technical complexity of scaling in a limited infrastructure	Export of technological model, increase in accuracy of budget forecasting	Cyber threats, technological centralization, risks of digital monopoly
ProZorro	Open data architecture, analytical risk indexing, built-in civic oversight mechanism	Instability of the regulatory environment, technical fragmentation of functional modules	Extension of functionality to other jurisdictions, automated anti-corruption supervision	Political interference, chronic underfunding of modernization
OCDS	Standardized data, interoperability, support of international institutions (OGP, WB)	High threshold of technical competence of administrators, complexity of implementation in weakly institutionalized systems	Integration with ESG indicators, development of civic data science	Risk of pseudo-application (form-over-substance), dependence on the quality of input data
Integrity Pacts	Contractual obligation of transparency, independent oversight, high level of public trust	Dependence on civil society activity, low scalability	Implementation in international grant projects, increase in legal awareness of stakeholders	Imitation of monitoring, resistance from procurement customers
MAPS (OECD)	Methodological flexibility, validity of system maturity assessment, unified diagnostic criteria	Labour-intensive implementation, dependence on external assessment entities	Base for institutional reforms, comparative analytics between countries	Use without further implementation, regulatory and indicator inertia
TED + eCertis	Unification of document flow procedures, increased compliance, digital validation of subjectivity	Limitations in geographical application (mainly EU), complexity of adaptation in third countries	Automation of verification of counterparties, expansion to associated jurisdictions	Regulatory inertia, digital asymmetry between member states

Source: developed by the authors

Table 4. Results of Econometric Calculation of Efficiency Metrics of Validated Public Procurement Frameworks

Framework	Procurement Cost Savings (%)	Price Efficiency Index (%)	Monitoring Cost Ratio	Average Procurement Cycle Time (days)	Loss-to-Contract Ratio	Competition Rate	Cancellation/Appeal Rate (%)	Control ROI
KONEPS	75.0	-7.5	0.006	23	0.002	6.2	1.2	12.5
ProZorro	18.5	-5.2	0.011	28	0.004	4.7	2.8	8.4
OCDS	14.0	-4.6	0.008	31	0.005	5.1	3.1	6.9
Integrity Pacts	10.2	-3.1	0.014	45	0.006	3.4	2.4	4.2
MAPS (OECD)	9.8	-2.9	0.013	35	0.007	4.2	3.6	5.1
TED + eCertis	12.3	-4.2	0.009	26	0.005	5.0	2.9	7.6

Source: calculated by the authors based on open data using research tools

Econometric modelling (Table 4) recorded the differentiated performance of financial control frameworks in public procurement. KONEPS demonstrated dominance in integral indicators: maximized savings (75%), minimized losses (LCR = 0.002), low supervision cost ratio (MCR = 0.006) and the highest ROI of control (12.5). In contrast, the MAPS and Integrity Pacts frameworks showed limited effectiveness in key metrics.

The next stage was the decomposition analysis (Table 5) to identify structural configurations that led to the optimization of the control impact and preventive capacity of the systems in countering economic offences.

Table 5. Decomposition Analysis of Validated Public Procurement Frameworks in the Context of Financial Monitoring

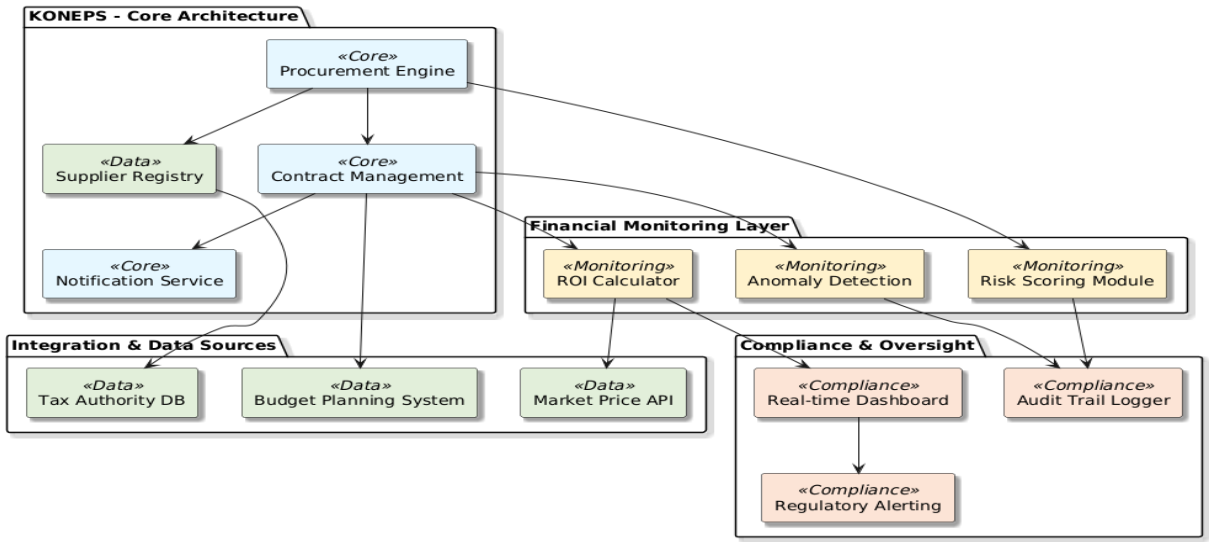
Framework name	Effective practices	Defective practices	Optimization potential through financial monitoring tools
KONEPS	Full digitalization of procedures; centralized supplier registry; automated compliance control	High threshold for inward investment; over-reliance on IT infrastructure	High – adaptive integration with the predictive and risk analytics module is possible
ProZorro	API openness; public oversight (DoZorro); analytical risk model	Fragmentation of technical modules; regulatory turbulence	High – expansion of real-time tools for assessing cost effectiveness
OCDS	Standardized machine-readable data; support for international protocols	High technical threshold for integration; formalization without impact	Medium – requires deepening of analytical reporting based on behavioural patterns
Integrity Pacts	Contractual transparency obligations; independent monitoring	Low scalability; weak institutional integration	Limited – effectiveness depends on the activity of third-party actors
MAPS (OECD)	Indicative diagnostics of system maturity; assessment flexibility	Dependence on external auditors; formalization without verification of actions	Medium – possible increased focus on KPI-financial indicators
TED + eCertis	Uniform document flow standards; digital identification of counterparties	Geographical limitation of application; difficulty of adaptation	High – possible expansion through the automated cost verification and anomaly detection module

Source: created by the authors

Decomposition analysis of validated frameworks (Table 5) revealed a variable level of integrative potential for the application of financial monitoring tools. The KONEPS, ProZorro and TED + eCertis frameworks demonstrated a high level of adaptability to the implementation of predictive-risk, anomaly-oriented, and ROI-centric control modules. In contrast, OCDS and MAPS (OECD) were characterized by average potential due to the technical complexity of the interface and the focus on formalized diagnostics without verified impact, and Integrity Pacts - by limited functional scalability because of the dependence on exogenous stakeholders.

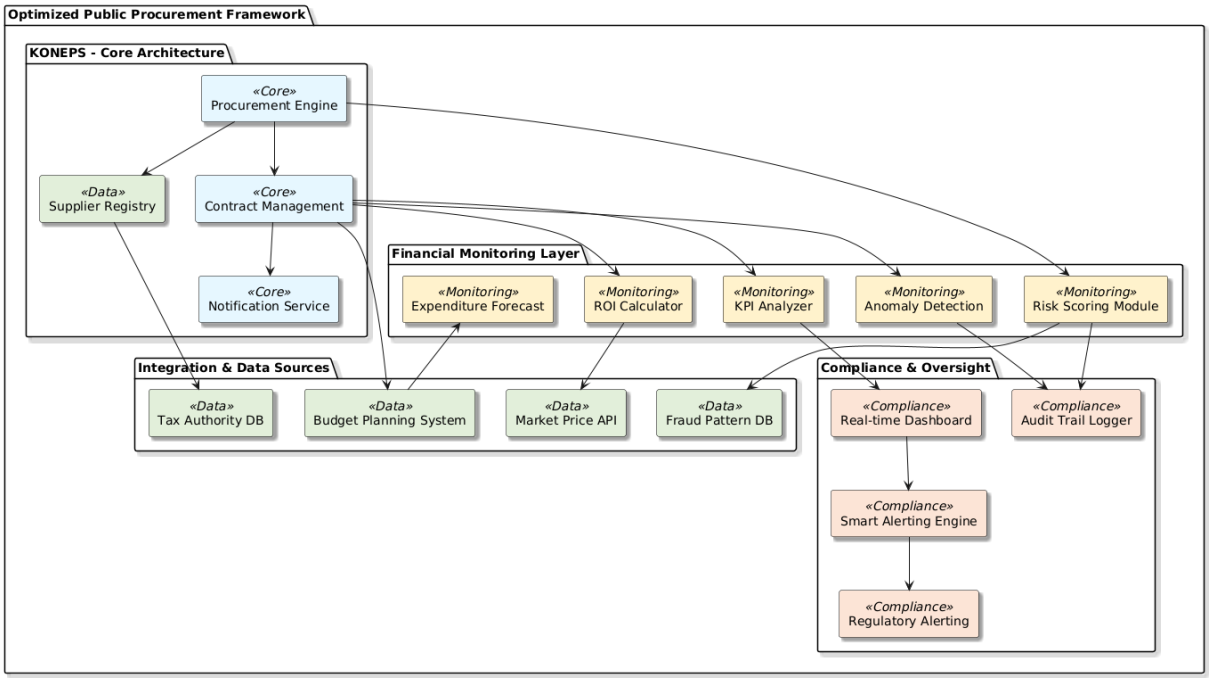
The generalization of the results of the SWOT analysis (Table 3) and econometric modelling (Table 4) identified KONEPS as the basic prototype of the framework with the highest integrative potential (Table 5). On its basis, synthesis modelling of an adaptive financial monitoring system was carried out in the UML environment, which became the next step towards the formalization of a highly effective tool for countering economic offences in the field of public procurement (Figure 2, Figure 3).

Figure 2. Synthesis Model of the Basic Prototype of the Public Procurement Framework (based on KONEPS)



Source: created by the authors using research tools in the UML environment

Figure 3. Synthesis Model of an Optimized Prototype of a Public Procurement Framework (based on KONEPS)



Source: created by the authors using research tools in the UML environment

The synthesis modelling of the optimized public procurement framework provided structural formalization of the control logic with an emphasis on financial and analytical integration. The implementation of the KPI Analyzer, Smart Alerting Engine, and external sources of predictive and anomalous analysis (Expenditure Forecast, Fraud Pattern DB) modules increased the functional detailing of monitoring tools. The model architecture created the prerequisites for the validation of cognitive informativeness, regulatory and financial traceability, and control interoperability. Given the improvements made, repeated econometric modelling was performed with subsequent comparative analysis of the values of efficiency metrics between the basic KONEPS prototype and the optimized version of the framework (Table 6).

Table 6. Comparative Analysis of Performance Metrics

Metrics	KONEPS metric (base prototype)	Average value (for validated frameworks)	Framework optimized by financial monitoring tools
Procurement Cost Savings (%)	75.0	23.3	82.7
Price Efficiency Index (%)	–7.5	–4.6	–8.6
Monitoring Cost Ratio	0.006	0.0102	0.007
Average Procurement Cycle Time (d)	23	31.3	21
Loss-to-Contract Ratio	0.002	0.0048	0.0015
Competition Rate	6.2	4.77	6.5
Cancellation/Appeal Rate (%)	1.2	3.0	1.0
Control ROI	12.5	7.45	14.2

Source: calculated by the authors using Python analytics based on a synthesis model

According to the results of comparative econometric modelling (Table 6), the framework optimized by financial monitoring tools demonstrated an integral advantage over the basic KONEPS prototype and the average indicators of validated solutions for all criterion metrics. In particular, Procurement Cost Savings increased to 82.7% (versus 75.0% in KONEPS and 23.3% on average), Control ROI reached 14.2, which is 13.6% higher than KONEPS and 90.6% higher than the average level. Loss-to-Contract Ratio was reduced to 0.0015 (25% lower than KONEPS), which indicates increased anti-corruption resistance. Price Efficiency Index was deepened to -8.6%,

which indicates a better correspondence of the contract value to market conditions. The Average Procurement Cycle Time was reduced to 21 days, the Competition Rate was increased to 6.5, and the Cancellation/Appeal Rate was reduced to 1.0%, demonstrating improved contractual stability and market inclusiveness.

So, the optimized model confirmed its financial performance, control efficiency, and operational sustainability, providing a normatively validated and technically scalable architecture for systemic monitoring of public procurement.

4. Discussion

The need for a discursive comparison of the results of this study with current conceptual and empirical models is justified in view of the growing polysemy of public procurement strategies and the variability of approaches to ensuring their effectiveness. Such a comparative analysis identified the limits of relevance, integration potential, and structural diversification of the financial and monitoring framework in the context of global practices.

da Silva (2025) demonstrated the normative and value relevance of socio-ecological criteria in public procurement mechanisms as a tool for achieving the Sustainable Development Goals (SDGs). In contrast, this study proves the priority of financial and monitoring optimization as determinants of control effectiveness and institutional resistance of the framework.

Lagström and Ek Österberg (2025) found that the procedural implementation of SPP is accompanied by regulatory and discursive polysemy, where primary connections between sustainable development and procurement provoke secondary conflicts of priorities. In turn, the emphasis in this study is shifted to metrical verification of efficiency through financial and monitoring stratification without dependence on discursive ambivalence.

Sturm *et al.* (2025) found structural asymmetry in the procurement market driven by a hierarchical network of suppliers, high levels of concentration and barriers to entry, which generates risks of supplier dominance. The same study proposed an alternative model focused on deconcentrating contractual interaction, increasing competitiveness and strengthening financial and indicator monitoring to minimize systemic imbalances.

Cheng *et al.* (2025) empirically demonstrated a U-shaped relationship between public procurement and CTFP driven by the rent-innovation dichotomy and CSR moderation. Instead, our study favours financial monitoring reconfiguration as a means of offsetting rent costs and incentivizing supplier efficiency.

Forster *et al.* (2024) developed an institutional-agent framework for the phase analysis of complex procurement for stratifying the policies and competencies of public buyers across life cycle cycles. This study demonstrates that modular financial monitoring integration provides cross-phase cost traceability, improving regulatory compliance and strategic manageability.

Patrucco *et al.* (2025) identified a positive correlation between strategic goal setting, use of PPI tools and the effectiveness of innovation-oriented procurement. In contrast, the results of this study demonstrate that the integration of financial and control monitoring ensures an increase in procurement efficiency by strengthening the metrics of control ROI, loss-to-contract ratio and procurement cycle time.

Arnholtz *et al.* (2025) found that the effectiveness of labour clauses in public procurement depended on their institutional integration with collective bargaining systems and their ability to balance socio-economic tensions. Our study also demonstrated that financial monitoring mechanisms can perform a complementary function with regard to social indicators of contractual provision.

Israel (2025) showed that an innovation-oriented environment and networked cooperative ties critically influence the level of SME involvement in public procurement through the intermediary effect of collaborative interaction. In this study, institutional inclusion of suppliers is achieved through structural optimization of the control mechanism, which reduces transaction barriers and activates the participation of small economic agents. Andersson *et al.* (2025) identified a low level of algorithmic maturity of AI in public procurement, limited to the stage of organizational planning and assessment of potential efficiency. In contrast, AI is implemented in our study as a functional component of the cognitive-analytical core of the framework with signs of process institutionalization.

Gilbert and Celestin (2025) empirically confirmed that the implementation of e-procurement in COMESA leads to a statistically significant decrease in fraud (–66.7%) and an increase in institutional integrity (+20 points). This study demonstrates a similar transparency effect, but emphasizes the systemic institutionalization of control monitoring, and not only on digital tools.

The discursive analysis identified conceptual discrepancies between existing approaches to public procurement and the emphases of the current study. The comparison showed that the proposed framework is oriented towards financial and monitoring optimization, institutional traceability and cognitive functionalization of

control procedures, while alternative models focus on regulatory, socio-ecological or innovation domains, which leads to a multi-level functional stratification of approaches.

Limitation

The lack of empirical implementation of the optimized framework in a functional environment limits the verification of its regulatory effectiveness and control robustness. The model currently remains theoretically validated without confirmation of its applied resilience.

Recommendations

It is recommended to develop an experimental pilot for the framework implementation in a limited administrative environment to assess its institutional integration. It is appropriate to conduct a phased analysis of control effectiveness, indicator manageability, and regulatory traceability.

Conclusions

The study implemented a phased analytical verification of public procurement frameworks through strategic stratification (SWOT), econometric modelling (Tables 4–6), and decomposition analysis (Table 5). It was identified that KONEPS provides the highest basic efficiency among the validated systems: Procurement Cost Savings – 75%, Loss-to-Contract Ratio – 0.002, Control ROI – 12.5. At the same time, the model is characterized by a high entry threshold and cybernetic dependence.

The optimized prototype formed by synthesis modelling tools in the UML environment demonstrated an integral advantage in all criterion metrics: Cost Savings – 82.7%, ROI – 14.2, LCR – 0.0015, CPI – 8.6, MCR – 0.007, which indicates an increase in financial performance, control resistance and regulatory interoperability. The model is recommended for pilot implementation as a standard for adaptive financial monitoring in public procurement systems.

The academic novelty of the study is the synthesis modelling of a public procurement framework optimized by financial monitoring tools, which provides institutional traceability, multi-level control stratification and cognitive analytical manageability of procedures. The *Price Efficiency Index* and *Monitoring Cost Ratio* metrics were formalized for the first time in this study, as well as the *Loss-to-Contract Ratio* and *Control ROI* indicators were modernized, which allow for a metric assessment of control efficiency, transparency, and effectiveness of procurement.

The study contributed an applied, reproducible evaluation pipeline that integrated SWOT-based stratification, econometric metric verification, decomposition of effective/defective control practices, and UML-based synthesis modelling into a single decision framework for selecting and upgrading procurement control architectures. This approach operationalized evidence-based benchmarking between baseline and optimized configurations and strengthened the analytical linkage between monitoring design choices and measurable outcomes in efficiency, integrity, and procedural stability.

The practical significance of the research results is the creation of a functionally suitable framework for implementation in electronic procurement monitoring systems in order to reduce transaction losses, increase control profitability and optimize procedural efficiency. The proposed metrics are suitable for integration into digital control tools and can serve as a formalized basis for making management decisions in the field of public finance.

Declarations

Credit Authorship Contribution Statement: The authors equally contributed to the present research, at all stages from the formulation of the problem to the final findings and solution.

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of use of generative AI and AI-assisted technologies: The authors declare that they have not used generative AI (a type of artificial intelligence technology that can produce various types of content including text, imagery, audio and synthetic data.

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