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Review

Red Flag Indicators as a Tool for Detecting Potential Irregularities in Public Procurement

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Abstract: Public procurement involves substantial public expenditure and complex interactions between contracting authorities and economic operators, making it particularly vulnerable to irregularities, fraud, corruption, and restrictions on competition. Effective control therefore requires mechanisms capable of identifying risk before irregularities produce significant financial consequences. Red flag indicators provide such an early-warning mechanism by drawing attention to procurement procedures and behavioural patterns that warrant closer examination. This paper analyses the role of red flag indicators in detecting potential irregularities in public procurement, with particular emphasis on their possible application in the Republic of Serbia. The research adopts a qualitative approach combining a review of relevant literature and regulatory frameworks with an examination of European practices. The analysis identifies restricted competition, a low number of bids, repeated contract awards to the same supplier, frequent contract amendments, and other observable procurement patterns as relevant indicators of increased risk. However, the presence of an individual indicator should not be interpreted as evidence of an irregularity; its analytical value depends on the procurement context and its interaction with other risk factors. Drawing on international experience and the characteristics of the Serbian public procurement system, the paper proposes an integrated red flag framework accompanied by a conceptual risk-scoring model. The model is designed to support the prioritisation of procurement procedures for additional control rather than to determine whether an irregularity has occurred. Its potential integration into the electronic Public Procurement Portal could provide a basis for a more systematic, data-driven, and preventive approach to procurement oversight in Serbia.

Keywords: *Public procurement; red flag indicators; potential irregularities; financial control; risk management; transparency.*

1. Introduction

Public procurement is one of the principal mechanisms through which public resources are transformed into goods, services, and works required for the functioning of public institutions. Its significance, however, extends beyond the administrative process of purchasing. The volume of financial resources involved, the complexity of procurement procedures, and the interaction between

public authorities and private economic operators create an environment in which inefficient spending, restrictions on competition, conflicts of interest, fraud, and corruption may occur. Consequently, the quality of procurement control has a direct bearing on both the protection of public funds and the integrity of public-sector operations [1]. The Serbian public procurement framework is based on the principles of economy and efficiency, competition, transparency, equal treatment, and non-discrimination of economic operators [2]. Compliance with these principles is essential, but formal compliance alone cannot eliminate procurement risk. A procedure may satisfy formal requirements while still displaying patterns that warrant closer examination. This is particularly relevant to financial control, whose purpose extends beyond identifying violations after they have occurred to recognising circumstances associated with an increased risk of irregularities.

Red flag indicators become relevant precisely in this context. They represent observable circumstances or patterns that may signal an increased level of risk and therefore justify additional analysis. Their occurrence does not establish that fraud, corruption, collusion, or another irregularity has taken place. Instead, red flags function as an early-warning mechanism that helps distinguish procedures requiring greater supervisory attention from those displaying a lower risk profile [3,4]. Such an interpretation has important methodological consequences. Treating every red flag as evidence of misconduct could direct control resources towards procedures that are unusual but entirely legitimate. Conversely, disregarding recurring combinations of suspicious patterns may allow genuinely high-risk procedures to remain unnoticed. The analytical value of red flags therefore lies not simply in identifying individual warning signs, but in evaluating their relevance and combination within the specific circumstances of a procurement procedure. Empirical research supports this risk-based interpretation. Fazekas et al. [5]demonstrate how electronic procurement records can be used to construct objective indicators of corruption risk by linking observable characteristics of procurement procedures with restrictions on competition and patterns of contract allocation [5]. Ferwerda et al. [6] show that individual red flags differ in their ability to distinguish corrupt from non-corrupt procurement [6]. More recent empirical research confirms that commonly recognised warning signs can vary substantially in their predictive value, reinforcing the need to validate rather than mechanically apply individual indicators [7]. The growing availability of procurement data has further expanded the possibilities for risk-oriented control. Electronic procurement generates structured information on bidders, contract values, deadlines, amendments, award patterns, and other characteristics of individual procedures. These data make it possible to move beyond exclusively case-by-case and ex-post control towards systematic screening of a larger number of procurement procedures [8]. In Serbia, the electronic Public Procurement Portal represents not only an instrument for conducting procurement procedures but also a potentially valuable source of data for risk-oriented control. Nevertheless, the existence of extensive electronic records does not in itself create an effective control mechanism. Data must first be transformed into analytically meaningful indicators, which must then be interpreted within an appropriate risk-assessment framework. The central research problem addressed in this paper arises from the gap between the availability of procurement data and their systematic use for the early detection of risk. Accordingly, the subject of the paper is the application of red flag indicators as a tool for detecting potential irregularities in public procurement. The aim is to examine their methodological role within a risk-based control system and assess the possibilities for their application in the Republic of Serbia.

The analysis does not attempt to establish the existence of irregularities in individual procurement procedures. Instead, it focuses on the potential of red flag indicators to identify procedures that merit additional control or audit attention. The main research hypothesis is that the systematic application of appropriately selected red flag indicators can improve the identification of potentially high-risk procurement procedures and contribute to a more efficient allocation of control resources. On this basis, the paper develops a conceptual framework for integrating selected indicators into a risk-scoring model adapted to the Serbian public procurement environment.

2. Methodology of the Study

2.1. Irregularities and risk in public procurement

Public procurement is governed by principles intended to ensure competition, transparency, equal treatment of economic operators, and efficient use of public resources. These principles provide the normative basis for procurement control, but their practical implementation is affected by the complexity of individual procedures, market conditions, institutional capacity, and the behaviour of participants. Consequently, procurement risk cannot be assessed solely by determining whether formal procedural requirements have been satisfied [1].

The Serbian Public Procurement Law requires contracting authorities to safeguard competition, transparency, equal treatment, and non-discrimination throughout procurement procedures [2]. From a control perspective, however, an important distinction must be made between non-compliance and risk. An irregularity represents a deviation from applicable rules or established procedures, whereas a risk indicator points to circumstances in which such a deviation may be more likely to occur.

Irregularities may arise from different causes and should not automatically be equated with fraud or corruption. Procedural errors may result from inadequate knowledge, organisational weaknesses, poor planning, or incorrect interpretation of procurement requirements. Fraud and corruption, by contrast, involve intentional conduct and therefore require a different evidentiary and investigative approach. Treating all deviations as equivalent would reduce the analytical usefulness of a risk-based control system and could lead to inefficient allocation of supervisory resources [3,8]. Risk may emerge at any stage of the procurement cycle. During planning and preparation, restrictive qualification criteria or unnecessarily specific technical requirements may reduce effective competition. During the award stage, unusually low participation, repeated awards to the same economic operator, or suspicious similarities between competing bids may justify additional examination. During contract implementation, repeated amendments, significant increases in contract value, or extensions of completion deadlines may indicate weaknesses in planning or, in some circumstances, a heightened risk of irregularity [1]. Bid-rigging deserves particular attention because its effects extend beyond an individual procurement procedure. Coordination between economic operators may create the appearance of competition while effectively preventing the market mechanism from functioning. This can result in higher prices, reduced value for money, and inefficient use of public resources. Collusive bidding therefore represents an important competition and procurement risk.

For preventive control, the relevant question is not whether every unusual procurement characteristic represents an irregularity, but whether combinations of observable characteristics can help identify procedures that require closer examination. This provides the conceptual basis for applying red flag indicators.

2.2. Analytical role of red flag indicators

A red flag can be understood as an observable circumstance, event, or behavioural pattern associated with an increased level of procurement risk. Its function is diagnostic rather than evidentiary: it provides a reason for further examination but does not establish that unlawful conduct has occurred [4]. The practical interpretation of red flags therefore requires context. A single-bid procedure, for example, may result from restrictive tender conditions, but it may also reflect the characteristics of a highly specialised market with only a limited number of potential suppliers. Similarly, repeated contract awards to the same supplier may indicate favouritism, but they may also result from that supplier's competitive advantage, technical capacity, or stronger market position. An indicator acquires analytical significance only when interpreted in context and, where possible, in combination with other information. The main advantage of red flag analysis is its capacity to support prioritisation. Supervisory and audit institutions cannot examine every procurement procedure with the same intensity. A structured set of indicators can therefore help identify procedures displaying a higher concentration of risk characteristics and direct limited control resources towards them. Red flags are thus primarily a mechanism for risk-based selection rather than a substitute for audit or investigation. Digital procurement substantially expands the possibilities for such analysis. Data on the number of bidders, submission deadlines, contract values, procurement amendments, suppliers, contracting authorities, and award patterns can be processed systematically rather than examined exclusively on a case-by-case basis. Research based on electronic procurement records demonstrates that observable procurement characteristics can be transformed into measurable corruption-risk indicators [4,5]. The availability of data, however, does not guarantee the reliability of a risk model. Ferwerda et al.(2017) show that individual red flags differ in their capacity to identify problematic procurement. More recent evidence reaches a similar conclusion: commonly recognised red flags may differ considerably in their predictive performance, and their usefulness depends on both the characteristics of available data and the context in which they are applied [7]. Increasing the number of indicators does not therefore necessarily improve risk assessment. Recent validation research adds another important qualification. Red flags may capture different dimensions of corruption risk rather than measure a single homogeneous phenomenon. The selection and combination of indicators should consequently be guided by their analytical meaning as well as by their empirical performance [9]. The Open Contracting Partnership (2024) reinforces this data-oriented approach by providing a methodology for calculating procurement risk indicators from structured contracting data across different phases of the procurement process [10]. For Serbia, the principal challenge is therefore shifting from data availability to the ability to transform available data into meaningful risk information.

2.3. Classification and key red flag indicators

For analytical purposes, red flag indicators can be classified according to the phase of the procurement procedure in which the underlying risk becomes observable. Such classification helps identify both the source of potential risk and the stage at which additional control may be most effective. In the planning and preparation phase, relevant warning signs include overly specific technical specifications, disproportionate qualification requirements, repeated modifications of tender documentation, and unusually short deadlines for preparing bids. These characteristics may reduce the number of economic operators capable of participating in a procedure. Their presence does not prove that competition has intentionally been restricted, but it may justify examining whether procurement conditions are proportionate to the subject and value of the contract.

During the contract award phase, attention shifts towards market participation and award patterns. A single bid, a persistently low number of bidders, repeated awards to the same supplier, unusual similarities between competing bids, or repeated cancellations may indicate reduced competitive pressure. Their significance increases when several such characteristics recur for the same contracting authority, supplier, procurement category, or period. The implementation phase presents a different category of risk. Frequent amendments, substantial increases in contract value, repeated extensions of deadlines, and changes to technical requirements after contract award may reveal deficiencies that were not visible during the initial procedure. Some may result from legitimate unforeseen circumstances, while others may reflect inadequate planning or create conditions under which the economic substance of the original competition is altered.

Table 1. Key red flag indicators in public procurement.

Indicator	Potential risk
Single bid received	Restricted competition
Short submission deadline	Potential restriction of competition or favouritism
Frequent cancellation of procedures	Possible manipulation or inadequate planning
Repeated contract awards to the same supplier	Supplier concentration or potential favouritism
Frequent contract amendments	Implementation risk or inadequate planning
Significant increase in contract value	Financial and implementation risk
Related bidders	Potential collusive bidding
Persistently low number of bids	Limited effective competition
Changes in specifications after contract award	Implementation risk or potential favouritism
Unusually high prices	Risk of inefficient use of public funds

Table 1 illustrates an important feature of red flag analysis: most indicators can have more than one explanation. A low number of bids is primarily a competition indicator, but its underlying cause may range from market concentration to restrictive procurement conditions. Frequent amendments may

signal poor planning rather than deliberate abuse. The relationship between an indicator and a potential irregularity is therefore probabilistic rather than deterministic.

Indicators should consequently not be analysed independently whenever sufficient data are available. A single bid may carry limited informational value in isolation. When combined with a short submission deadline, repeated awards to the same supplier, and subsequent increases in contract value, however, it represents a substantially different risk profile. The analytical focus should therefore move from the mechanical detection of individual warning signs towards the identification of combinations and recurring patterns.

2.4. Comparative perspective on european practice

European procurement practice reflects a broader movement towards digitalisation, transparency, structured procurement data, and preventive integrity mechanisms. These developments create opportunities to move from predominantly retrospective control towards earlier identification of potentially problematic patterns. Nevertheless, there is no single universally applicable European red flag model. National procurement systems differ in their institutional arrangements, data infrastructure, control priorities, and mechanisms for preventing conflicts of interest and restrictions on competition. International experience is therefore more useful for identifying recurring categories of procurement risk than for constructing a simple country-by-country checklist. Competition, supplier concentration, contract amendments, conflicts of interest, restrictive procedural conditions, and the use of non-competitive procedures represent analytically relevant areas because each may reveal circumstances requiring additional examination.

Empirical evidence also calls for caution when transferring indicators between different procurement environments. Decarolis and Giorgiantonio (2022) show that commonly recognised red flags differ in their predictive capacity and that indicators which appear intuitively relevant do not necessarily provide equally strong signals of corruption risk [7]. Red flags should therefore be selected and interpreted according to their analytical relevance rather than treated as a universal checklist.

Table 2. Selected risk areas and their analytical relevance.

Risk area	Analytical relevance
Low bidder participation	May indicate weak or restricted competition
Concentration of awards	May reveal persistent supplier dependence or potential favouritism
Contract amendments	May indicate planning or implementation risk
Conflict of interest	May affect impartiality of procurement decisions
Short or restrictive procedural conditions	May reduce effective market participation
Non-competitive procurement	May increase integrity and value-for-money risks

The comparative perspective does not imply that different national procurement systems employ identical indicators or risk-scoring methodologies. Instead, it identifies common analytical areas that can inform the development of a framework adapted to Serbian conditions. The final selection of indicators for Serbia should depend on domestic data availability, legal requirements, procurement-market characteristics, institutional needs, and subsequent empirical validation.

2.5. Application of red flag indicators in the Republic of Serbia

The digitalisation of Serbian public procurement has created a stronger data foundation for risk-oriented control. The Public Procurement Portal contains structured information on procurement procedures, contracting authorities, economic operators, contract values, participation, deadlines, and changes occurring during the procurement process. From an analytical perspective, these data represent an important resource because a substantial number of red flag indicators could potentially be calculated without introducing an entirely separate reporting system.The availability of data, however, should not be confused with their systematic use for risk assessment. Traditional control generally begins with a selected procedure and subsequently examines its compliance. A data-driven red flag system would partly reverse this logic: procurement data would first be screened for predefined risk characteristics, after which procedures displaying higher-risk profiles could be prioritised for additional examination. Previous empirical research on the Serbian public procurement system also supports the relevance of a risk-oriented approach. Analysis of irregularities identified through procurement control indicates their continuing financial significance and points to the need for more effective mechanisms for directing control activities towards areas of elevated risk [11]. These findings provide a domestic empirical context for considering red flag indicators as a mechanism for prioritising procurement control.

Based on the preceding analysis, several indicators appear particularly suitable for consideration in the Serbian context.

Table 3. Proposed key red flag indicators for the Republic of Serbia.

Indicator	Principal analytical risk
Single bid received	Restricted competition
Repeated awards to the same supplier	Supplier concentration or potential favouritism
Frequent contract amendments	Contract implementation risk
Significant increase in contract value	Financial and implementation risk
Short bid submission deadlines	Potential restriction of competition
Frequent cancellation of procedures	Possible manipulation or planning weakness
High concentration of non-competitive procedures	Reduced market competition
Frequent participation of related bidders	Potential collusive bidding
Numerous modifications of tender documentation	Planning weakness or potential favouritism
Persistently low number of bids	Reduced market competitiveness

The proposed indicators differ in their analytical meaning and should not automatically receive equal importance. Some describe characteristics of an individual procedure, such as a short submission deadline. Others become more informative only when observed longitudinally, including repeated awards to the same supplier or a persistently low number of bidders. A future Serbian risk model should therefore combine procedure-level indicators with historical patterns relating to contracting authorities, suppliers, and procurement categories. The interaction between indicators is equally important. A procedure characterised by a single warning sign may have a plausible and legitimate explanation, whereas the simultaneous presence of several related indicators may warrant a different level of control attention. This provides the rationale for moving from a simple red flag checklist towards a structured risk-scoring approach. The Serbian system already has important prerequisites for such development, particularly an established electronic procurement infrastructure and the availability of structured data. The remaining challenges are both analytical and institutional: defining measurable indicators, determining their relative significance, linking relevant information, establishing appropriate thresholds, and specifying how supervisory institutions should respond to different levels of calculated risk.

A red flag system should therefore not be viewed primarily as another layer of administrative control. Its purpose would be to make existing control more selective. By identifying procurement procedures with a greater concentration of relevant risk characteristics, supervisory and audit resources could be directed towards cases in which additional examination is most justified. Several limitations must nevertheless be recognised. A model based exclusively on structured procurement data cannot identify every form of irregularity, particularly those that leave no observable trace in the available variables. Poorly calibrated thresholds may also generate excessive numbers of false alerts. Automated screening should therefore complement rather than replace professional judgement, audit procedures, and detailed examination of individual cases. The main potential of red flag indicators in Serbia consequently lies not in the automatic detection of wrongdoing, but in providing a systematic mechanism for selecting higher-risk procurement procedures for further control. This logic forms the basis for the integrated red flag system and risk-scoring model developed in the following section.

3. Key Findings and Implications

3.1. From ex-post control to risk-based procurement monitoring

The practical value of red flag indicators lies primarily in their ability to support a more selective approach to procurement control. Traditional control mechanisms generally focus on procedures that have already been completed or on cases selected for examination on the basis of complaints, audit plans, institutional priorities, or other available information. Such controls remain indispensable, but their retrospective character limits their capacity to identify emerging risks before financial consequences occur. Risk-based monitoring introduces a different logic. Instead of treating all procurement procedures as equally relevant from a control perspective, available data are used to identify those displaying characteristics associated with elevated risk. This does not replace ex-post control; it adds a preventive dimension by helping supervisory institutions determine where more detailed examination may be justified. This approach is particularly relevant in procurement systems

that process a large number of procedures. Control institutions operate with limited financial, technical, and human resources and cannot subject every contract to the same level of scrutiny. Effective control therefore depends not only on the quality of individual audits or inspections but also on the ability to select procedures in which additional examination is most justified.

Risk indicators can support this selection by converting procurement data into information relevant to control priorities. International approaches to procurement integrity recognise the importance of transparency, competition, preventive mechanisms, and risk management throughout the procurement cycle [7]. Digitalisation alone, however, does not constitute effective risk management. An electronic system may improve transparency and data availability without automatically identifying procedures that deserve additional control. The gap between collecting procurement data and using them for risk assessment therefore remains a central analytical challenge. The framework developed in this paper addresses that gap by screening procurement data through predefined indicators, combining individual signals into a broader risk profile, and using the resulting assessment to prioritise procedures for additional examination. The objective is not to automate decisions about the existence of irregularities, but to improve the information available for setting control priorities.

3.2. Concept of an integrated red flag indicator system

Drawing on the literature review and the examination of the Serbian procurement environment, this paper proposes an integrated red flag indicator system that could potentially be incorporated into the existing Public Procurement Portal. The underlying principle is straightforward: information already generated during procurement procedures should serve not only administrative processing and transparency but also systematic risk screening. Each procedure would be examined against a predefined set of measurable indicators. Activated indicators would contribute to its overall risk profile, making it possible to distinguish procedures with a higher concentration of warning signs from those displaying fewer risk characteristics.

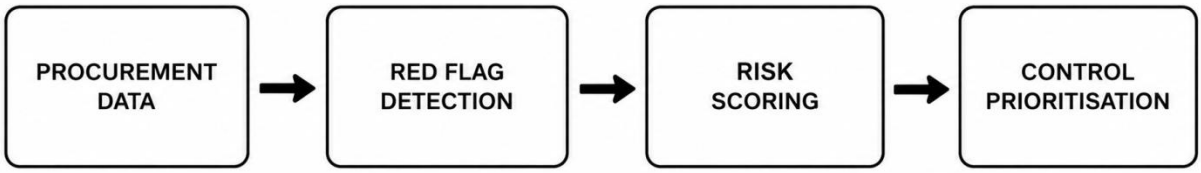

Figure 1. Proposed integrated red flag framework.

The first stage involves processing structured information available within the electronic procurement environment. Relevant variables may include the number of bids received, submission deadlines, successful suppliers, contract values, amendments, cancellations, and changes occurring during contract implementation.

The second stage identifies predefined warning signs. No judgement about legality would be made at this point; the system would merely determine whether the conditions established for individual indicators had been met. In the third stage, activated indicators are combined into a risk score. This step is important because individual red flags should not generally be interpreted in isolation. Several

warning signs occurring simultaneously may provide a stronger basis for additional examination than a single indicator considered independently. The final stage links the calculated risk to control planning. Procedures with higher scores could receive priority for additional review, while the competent institution would retain responsibility for deciding whether and how control should be conducted. This architecture is consistent with research demonstrating that observable characteristics of procurement procedures can be transformed into measurable indicators of corruption risk and restrictions on competition [5,6,8]. More recent research also demonstrates the potential of procurement-level composite risk indicators to support risk-based audit selection [12]. The growing availability of standardised procurement data further strengthens the practical potential of such approaches [13]. The value of an integrated system lies in connecting procurement data, indicators, risk assessment, and control response within a single analytical process rather than producing a list of isolated warning signs.

3.3. Proposed risk-scoring model

To operationalise the framework, this paper introduces a conceptual risk-scoring model. It follows the general logic of composite risk indicators used in public procurement research, in which individual warning signs are combined to obtain an aggregate measure of procurement risk [4,13]. For the purposes of the model, the total risk score is calculated as follows:

$$\mathbf{R = w_1 I_1 + w_2 I_2 + ... + w_n I_n}$$

where **R** represents the total risk score, **I** represents an individual red flag indicator, **w** represents the weight assigned to that indicator, and **n** represents the number of indicators included in the model. Each indicator takes the value **1** when the corresponding red flag is present and **0** when it is absent.

Table 4. Proposed Risk-Scoring Model.

Indicator	Score
Single bid received	5
Short submission deadline	3
Frequent contract amendments	5
Significant increase in contract value	4
Repeated awards to the same supplier	3
Repeated cancellation of procurement procedures	4
Numerous modifications of tender documentation	3
Limited number of bidders across multiple procedures	4

Based on the cumulative score, procurement procedures may provisionally be classified into four risk categories:

- 0–5 points – Low risk
- 6–10 points – Medium risk

- 11–15 points – High risk
- More than 15 points – Very high risk

For illustration, consider a procurement procedure in which a single bid is received (5 points), the submission deadline is unusually short (3 points), and frequent contract amendments subsequently occur (5 points). The resulting score would be:

R = 5 + 3 + 5 = 13 points

Under the proposed classification, the procedure would fall into the high-risk category and could therefore be prioritised for additional examination. A score of 13 would not constitute evidence of an irregularity; it would indicate a combination of characteristics warranting greater control attention.

The scoring structure is deliberately simple. Its principal advantage is transparency: both the factors contributing to the score and the resulting classification can be identified directly. The model could therefore serve as an initial screening mechanism within an electronic procurement environment.

The numerical weights assigned to individual indicators have not been derived from statistical testing of Serbian procurement data. They should be interpreted as conceptual values rather than empirically validated estimates of the relative importance of individual risk factors. The same applies to the thresholds separating low, medium, high, and very high risk. These thresholds are illustrative and serve only to demonstrate the operational logic of the conceptual model; they should not be interpreted as empirically established cut-off values. This methodological qualification is important because recent validation research suggests that procurement red flags may capture different dimensions of corruption risk rather than a single underlying construct [9]. A simple additive score should therefore be regarded as an initial analytical framework whose structure requires empirical examination before operational implementation. Future application would require calibration of both weights and thresholds using Serbian procurement data and comparison with independently established audit or control outcomes. Until such validation is performed, the model should be interpreted as a transparent framework for risk prioritisation rather than as a predictive instrument.

3.4. Potential implementation in the Serbian public procurement system

The practical feasibility of this approach depends largely on whether the indicators can be calculated from information available within the Serbian electronic procurement system. Indicators based on bidder numbers, contract values, deadlines, cancellations, amendments, and supplier award histories appear particularly suitable for automated processing.

Previous research on the role of information technologies in Serbian public procurement control indicates that digital tools and data availability provide an important basis for improving monitoring, while the wider application of more advanced analytical technologies remains an area for further development [13]. A red flag system could represent a practical step towards converting existing digital information into structured risk signals. Integration into the existing Public Procurement Portal would offer an important practical advantage by reducing the need for a separate data-collection mechanism. Risk assessment could be performed as procurement data are generated, with the resulting scores made available to authorised control institutions. The process could begin when a procurement procedure is created and continue as new information becomes available. Some indicators could be calculated during the tender phase, others immediately after contract award, and

a third group during implementation. The risk profile would therefore remain dynamic, changing as additional warning signs emerge.

Such continuous updating is particularly relevant during contract implementation. A procedure that initially appears to have a relatively low risk profile may subsequently experience repeated amendments, extensions, or increases in value. Updating the score would allow the system to reflect these developments rather than relying exclusively on information available at the time of contract award.

The model could also support different control institutions without requiring them to perform identical functions. Procurement monitoring bodies could use risk scores for general supervision, internal audit units could incorporate them into audit planning, and external audit institutions could use them as one source of information when selecting procurement transactions for examination. The score would thus serve as risk information rather than substitute for the statutory responsibilities of individual institutions. Implementation would nevertheless require several safeguards. Indicator definitions would need to be sufficiently precise to ensure consistent calculation, and the model would require periodic review as procurement behaviour and available data evolve. Its effectiveness would ultimately depend on feedback from actual control results. If procedures classified as high risk repeatedly produce no significant findings, indicator weights or thresholds may require adjustment. Conversely, frequent serious irregularities among procedures classified as low risk would suggest that relevant variables are missing. Risk assessment should therefore be treated as an iterative process rather than a permanently fixed scoring formula.

3.5. Analytical and practical implications

The framework has two principal implications. The first concerns the organisation of procurement control. A red flag system could enable supervisory resources to be allocated according to observable risk characteristics rather than distributed uniformly across procedures. This could strengthen the preventive function of financial control without requiring every procurement procedure to undergo intensive examination. The second concerns the role of data in public procurement oversight. Digitalisation creates value for control only when available information is transformed into analytically useful signals. The model illustrates one possible path for this transformation: procurement data become indicators, indicators form a risk profile, and the resulting profile provides information for control prioritisation.

Automated analysis nevertheless has clear limits. Procurement risk cannot be reduced entirely to numerical variables. Market structure, technical complexity, emergency circumstances, the characteristics of the procured goods or services, and other contextual factors may explain patterns that would otherwise appear suspicious. Automated scoring should therefore identify questions for controllers to examine rather than provide predetermined answers.

Red flag indicators are consequently most useful when they complement professional judgement. Data analytics can process volumes of information that would be difficult to examine manually, while auditors and controllers can interpret the resulting signals within their legal, economic, and institutional context. Combining these two elements provides a more balanced basis for preventive procurement control than relying exclusively on either automated screening or manual selection.

The Serbian framework presented here should be regarded as a starting point for an empirically tested risk-management system. Its practical development would require calibration of indicators and thresholds, validation against control outcomes, and periodic reassessment of predictive performance. Research on the validation of procurement risk measures further indicates that individual red flags may capture different dimensions of corruption risk, reinforcing the need for empirical testing before a composite score is applied operationally [9]. Only after such validation could the effectiveness of the framework in identifying higher-risk procurement procedures be assessed. At its current stage, the conceptual model provides a basis for subsequent empirical research rather than a final risk-assessment methodology.

5. Conclusion

Public procurement involves substantial public expenditure, complex administrative procedures, and continuous interaction between public institutions and economic operators. These characteristics make public procurement particularly important from the perspective of financial control. Effective oversight should therefore extend beyond identifying irregularities after they have occurred and support the early recognition of procedures displaying an increased level of risk.

The analysis indicates that red flag indicators can provide a useful basis for such an approach. Their principal value lies in identifying circumstances that warrant additional examination rather than in proving the existence of fraud, corruption, collusion, or other irregularities. A single bid, a short submission deadline, repeated awards to the same supplier, or frequent contract amendments may have legitimate explanations. Their analytical relevance increases when such characteristics recur over time or appear in combination with other warning signs. Empirical research supports this interpretation. Observable characteristics extracted from electronic procurement records can be transformed into measurable indicators of corruption risk, although individual red flags differ in their discriminatory and predictive capacity. More recent studies also demonstrate that commonly recognised warning signs should not be interpreted mechanically and that procurement risk may have a multidimensional structure [4,6,8,13]. For Serbia, the development of electronic public procurement creates an important opportunity to strengthen risk-oriented control. The Public Procurement Portal provides structured information that could potentially support the automated identification of selected warning signs. Previous research on irregularities and the role of information technologies in Serbian public procurement also highlights the relevance of more selective control and greater analytical use of available procurement data.

The central contribution of this paper is the development of an integrated conceptual framework connecting procurement data, red flag detection, risk scoring, and control prioritisation. Within this framework, selected indicators are combined into an aggregate risk score that can support the identification of procedures requiring greater control attention. Rather than replacing audit, inspection, or professional judgement, the framework provides a transparent mechanism for directing limited control resources towards procedures displaying a higher concentration of risk characteristics.

The risk-scoring model represents the operational component of this framework. Its deliberately simple structure makes the calculation transparent and allows the factors contributing to a

procedure's risk classification to be identified directly. Such transparency is particularly relevant to financial control, where analytical tools should support rather than obscure professional decision-making. The broader methodological logic of using procurement-level composite indicators for risk-oriented control is supported by previous research on corruption-risk measurement and risk-based audit selection (Fazekas & Kocsis, 2020; Lisciandra et al., 2022).

The model nevertheless remains conceptual. Neither the weights assigned to individual indicators nor the thresholds distinguishing low, medium, high, and very high risk have been derived from statistical testing of Serbian procurement data. The resulting classifications should therefore be interpreted as signals for control prioritisation rather than predictions of irregularity. This represents the principal methodological limitation of the present study.

The scientific contribution is primarily analytical and methodological. The study systematises relevant procurement red flags, relates them to different stages and dimensions of procurement risk, and develops a transparent mechanism for integrating selected indicators into a framework adapted to the Serbian procurement environment. From a practical perspective, it demonstrates how information already generated through electronic procurement could potentially be transformed into risk signals supporting more selective control.

Future research should focus on empirical validation of the model. Data from the Serbian Public Procurement Portal could be used to examine the frequency and distribution of individual indicators, their relationships with one another, and their association with independently established audit or control findings. Such analysis would provide an empirical basis for recalibrating indicator weights, determining more reliable risk thresholds, and assessing whether combinations of red flags offer greater discriminatory power than individual indicators.

More advanced analytical methods, including machine-learning techniques, may become relevant once sufficiently large and reliable procurement datasets are available. Their application, however, should follow the empirical validation of the underlying indicators rather than substitute for it. A transparent and interpretable scoring framework provides a more appropriate starting point for developing a risk-based control system.

Ultimately, the value of red flag indicators lies in their potential to improve the selection of procurement procedures for further examination. Their systematic use could strengthen the preventive dimension of financial control by transforming available procurement data into information that supports control priorities. Whether the framework developed in this paper can achieve this objective within the Serbian public procurement system remains an empirical question and represents the logical next stage of research.

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