# THE USE OF BIG DATA IN THE DETECTION OF ECONOMIC CRIMES IN PUBLIC PROCUREMENTS

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## ABSTRACT

The article deals with the role of digital transparency tools in the fight against corruption, especially in public administration. The research aimed to assess how such technologies as blockchain, open government data, e-procurement, and e-government services increase transparency and accountability while reducing corruption risks. The study fills a gap in the literature by proposing a new approach to combating corruption through digital solutions. The study covers 10,000 procurement contracts from the European Union (EU), using modern methods such as Big Data (BD) analytics, statistical analysis, simulation model. These approaches have significantly improved the detection of fraud-related anomalies compared to traditional methods based on manual checks and limited data. The study compares the effectiveness of digital transparency initiatives in several countries, revealing the conditions under which these tools are most effective. Besides, such challenges as insufficient digital literacy and barriers to implementation are discussed. The results showed that digital transparency helps to reduce corruption by improving access to information and simplifying processes, but its success depends on political and economic infrastructure. The article provides recommendations for policymakers on the effective use of digital tools in different governance systems, significantly contributing to understanding the interaction of technology and anti-corruption reforms.

**Keywords:** *Economic Crimes, Public Procurement, Fraud, BIG DATA, Network Analysis.*

## 1. INTRODUCTION

The integration of big data (BD) analytics has revolutionized various sectors, significantly enhancing decision-making processes and operational efficiency [1]. In the public sector, particularly in public procurement, the adoption of digital technologies offers a transformative approach to improving transparency and accountability [2]. However, economic crimes such as fraud and corruption in public procurement continue to undermine the integrity of government operations and erode public trust. This research focuses on addressing these issues through the innovative use of BD analytics [3]. The scope of this study is delimited to analyzing public procurement contracts within the European Union (EU) across key sectors, including infrastructure, healthcare, and technology [4]. By employing advanced machine learning algorithms, such as random forests, support vector machines

(SVM), and K-means clustering, combined with statistical analyses and network visualization [5], this research aims to uncover patterns of fraudulent activities and anomalies in procurement data.

The scope of this study is delimited to the application of Big Data (BD) analytics for detecting economic crimes within public procurement systems in the European Union (EU). This research primarily focuses on identifying fraud in procurement contracts across three key sectors: infrastructure, healthcare, and technology. It investigates the effectiveness of various machine learning (ML) techniques, such as Support Vector Machines (SVM), K-means clustering, and Random Forest, alongside natural language processing (NLP) and network analysis, to improve fraud detection accuracy. The research aims to provide practical insights for policymakers and procurement authorities, illustrating how these technologies can enhance transparency and accountability, while identifying and mitigating risks associated with procurement fraud.

This paper contributes to the existing body of knowledge by filling significant gaps in the literature. It provides a detailed examination of specific BD algorithms tailored for fraud detection in procurement, alongside a cross-sectoral analysis that highlights variations in fraud patterns [6]. Furthermore, it evaluates barriers to the implementation of BD technologies and offers practical strategies for policymakers to strengthen governance frameworks.

The findings of this study hold practical implications for improving the transparency and accountability of procurement processes. By leveraging real-time monitoring and predictive analytics, public authorities can proactively identify and mitigate economic crimes, ensuring more efficient use of public resources and fostering trust in governance systems.

The research objectives are:

1. To assess the current state and effectiveness of BD use in detecting economic crimes in public procurement.

2. To analyze specific methodologies and techniques for fraud detection using BD analytics.

3. To identify and address barriers faced by public institutions in implementing BD technologies.

4. To evaluate the impact and effectiveness of BD analytics in detecting anomalies and preventing fraud in procurement systems.

Economic crimes, particularly fraud and corruption, pose a significant threat to the integrity of public procurement systems. Despite the increasing reliance on Big Data analytics, existing solutions have not fully addressed the challenges of detecting complex fraud patterns. This study seeks to explore how advanced BD technologies can improve anomaly detection and provide actionable insights for preventing economic crimes. Specifically, it examines how BD can be used to identify fraudulent procurement behaviors in large-scale contracts and across various sectors, while identifying the barriers to widespread implementation.

## 1.1. Problem statement and research questions

Economic crimes in public procurement, particularly fraud and corruption, pose significant risks to the integrity of government operations and the public trust. Despite the growing implementation of digital tools, such as Big Data (BD) analytics, many challenges remain in effectively detecting and preventing these crimes. Public procurement processes continue to be vulnerable to manipulation, leading to inefficiencies and misuse of public funds. Existing solutions often lack the scalability and adaptability needed to address complex, evolving fraud patterns across diverse sectors. This study aims to address these gaps by focusing on how Big Data analytics can enhance the detection of economic crimes in public procurement and identify the barriers to implementing these solutions.

To guide the research, the following questions are explored:

1. How effective are current Big Data analytics methods in detecting economic crimes, specifically fraud, in public procurement contracts?

2. What are the primary barriers hindering the adoption of Big Data technologies in fraud detection within public procurement systems?

3. How can Big Data techniques, such as machine learning, network analysis, and natural language processing, improve the identification of fraud patterns in procurement contracts?

## 2. LITERATURE REVIEW

The study of BD technologies for the detection of economic crimes, in particular in public procurement, has become a relevant direction in the academic community. Many researchers study this issue, assessing how technological progress can increase transparency and reduce corruption. The author [7] analyses the role of information and communication technologies (ICT) in the fight against corruption, which in turn contributes to economic development. His research demonstrates that ICTs implementation increases government

accountability and streamlines procurement processes, reducing corruption risks. Effective ICT integration is key to sustainable economic development, but differences in their implementation across sectors can limit their overall impact. The research by [8] examines how internal auditing, risk management, and big data analytics can prevent financial crimes. They emphasize the effectiveness of internal controls, which, together with BD technologies, help to detect and reduce fraud in public procurement. However, the lack of integration of BD analytics can limit the realization of its potential. The researcher [9] offers a broader vision, analysing the adoption of BD-based surveillance technologies for algorithmic control in various fields, including law enforcement. The study emphasizes that algorithmic models are capable of detecting procurement anomalies that are useful for fraud detection. He also notes the risks associated with privacy and bias in surveillance systems, pointing to the need for further research to develop fairer algorithms.

The authors [10] focus on BD analytics in the audit context, revealing their potential in detecting fraud in public procurement. By analysing large data volumes, auditors can detect anomalies that indicate possible cases of fraud. Despite the significant potential, the integration of analytics with traditional audit methods remains important. The researchers [11] examine the socio-economic and environmental aspects of crime, focusing on public procurement fraud in different cities. They reveal the connection between socio-economic conditions and economic crimes. The use of BD technologies together with socio-environmental data can improve the detection of procurement irregularities. The study also emphasizes the importance of local research to better understand specific contexts. The authors [12] analyse the role of public participation in public procurement in the context of the digital economy, emphasizing that public involvement through BD technologies can increase the transparency of processes. They argue that active use of public feedback can have a positive impact on fraud detection, but effectiveness requires the integration of powerful data and analytical tools.

While much of the existing research has highlighted the potential of BD technologies in detecting fraud [7], [8], [10], this study uniquely integrates a sector-specific approach, employing machine learning models alongside traditional statistical methods to identify fraud in public procurement. Unlike previous studies, which focus primarily on individual technologies or narrow sectors, this research presents a more comprehensive, cross-sectoral analysis, applying techniques to contracts in diverse fields like infrastructure, healthcare, and technology. Additionally, this study highlights how advanced ML techniques such as K-means clustering and network analysis can uncover hidden patterns of fraud that traditional methods may overlook.

The author [13] explores global procurement trends using the case of Sri Lanka, demonstrating how global changes can contribute to detection of irregularities. Although the study offers important findings, it does not cover specific big data tools for procurement fraud detection. The researchers [14] examine the impact of public procurement on business policy, noting that complex systems can inadvertently create opportunities for fraud. They believe that BD technologies can increase the transparency of processes, but their complexity leaves barriers to efficiency. The authors [15] explore the potential of smart contracts to prevent procurement corruption. They argue that combining blockchain technology with BD analytics can significantly reduce fraud by automating processes. However, the implementation of smart contracts still needs further research. The authors [16] evaluate e-procurement in Bangladesh, pointing out its role in improving processes and reducing corruption. They confirm that e-procurement reduces fraud risks due to reduced human intervention, but its potential can be increased through the integration of BD analytics.

Despite the achieved results, there are significant gaps. Although many researchers recognize the potential of BD analytics in fraud detection, there is a lack of detailed analysis of specific algorithms and their accuracy in public procurement. More comprehensive cross-national studies are needed to assess the global relevance of big data tools. Many studies, for example, [15], offer advanced technology while acknowledging the need for further empirical testing. So, the existing literature provides a foundation for understanding the use of big data in procurement fraud detection, but further research is required. The need to integrate big data analytics with emerging technologies such as blockchain and artificial intelligence (AI) is particularly urgent to address issues of scalability, algorithmic bias, and privacy. These unexplored areas offer significant opportunities for further research in the fight against economic crime.

## 3. METHODS

### 3.1. Research design

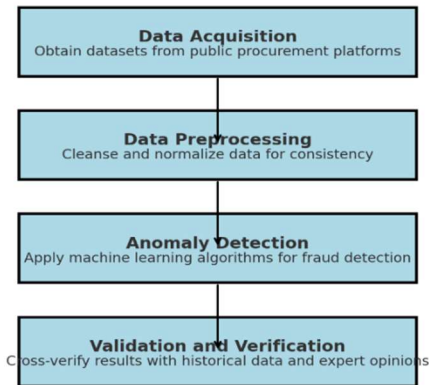The empirical study was conducted in four stages. Figure 1 presents brief description of each of them.



*Figure 1: Research Stages*
*Source: developed by the author based on [17]*

### 3.2. Sampling

The sample consists of public procurement contracts in the EU concluded in 2020-2022, covering a total of 10,000 deals. This time period was chosen to provide sufficient data to reflect current procurement practices and the current regulatory framework. The sample included different sectors such as infrastructure, healthcare and technology, which ensured statistical validity and diversity of the analysis (Table 1).

*Table 1: Distribution of the Sample by Sector*

| Sector | The number of contracts | Percentage (%) |
|---|---|---|
| Infrastructure | 4,000 | 40.0 |
| Health care | 3,000 | 30.0 |
| Technologies | 2,000 | 20.0 |
| Other | 1,000 | 10.0 |
| In general | 10,000 | 100.0 |

*Source: developed by the author based on [18], [19]*

The sample includes unique contracts that are selected based on several criteria:
- Statistical reliability. This sample provides a significant amount of data, which increases the statistical power of the analysis. This makes it possible to make reliable estimates and reduce the margin of error, in particular, to identify anomalies that indicate economic crimes;
- Variability. The selected size includes a variety of contracts in different sectors, price categories and regions, which allows for a comprehensive overview of public procurement practices. This is critical for detecting economic crimes, which can vary by sector or region.

The choice of such a data volume was justified by the need to ensure statistical reliability, which would allow a detailed investigation of potential economic crimes, while covering a variety of industries. The contracts were selected according to specific criteria:
- Cost threshold. Only contracts above €50,000 are included to focus on purchases with a higher risk of fraud;
- Diversity of sectors. Contracts from various sectors such as infrastructure, healthcare and technology provide a comprehensive analysis of public procurement practices.

### 3.3. Methods

Three main methodologies are used for detailed data analysis and detection of economic crimes:

1. BD analytics. The basis of the study was machine learning algorithms for data classification and detection of procurement anomalies. Such techniques as random forest, support vector machines (SVM), and K-means clustering were used. Natural language processing (NLP) is used for the analysis of textual data, revealing key characteristics of contracts. Network analysis shows relationships between bidders and contracts, which may indicate conspiracy.

2. Statistical analysis. The detected anomalies are evaluated using descriptive statistics to generalize data characteristics, as well as hypothesis testing to determine statistically significant differences.

3. Simulation models. The simulation models, in particular Monte Carlo simulations, are developed to assess the impact of identified anomalies on procurement and analyse the effectiveness of various intervention strategies.

### 3.4. Tools

- Python. For machine learning (Scikit-learn) and data analysis (Pandas).
- NLP: NLTK and SpaCy for text processing.
- Network visualization: Gephi and NetworkX in Python.
- Statistical analysis: R and SPSS.
- Simulations: Python with NumPy and SciPy.
- Scenario modelling: Excel supplemented with Python scenarios.

## 4. RESULTS

Analysis of the above-mentioned sample shows that the infrastructure sector (4,000 contracts - 40%) occupies the largest share of procurements, which indicates a large volume of government orders for infrastructure projects. These contracts often involve large financial deals, making them vulnerable to corruption and fraud. Examples of contracts include the construction of roads, bridges, and public buildings. The health sector accounts for 30% of the contracts, highlighting the importance of public health procurement. Anomalies in this sector can have serious consequences for public health. Examples of contracts are the purchase of medical equipment, drugs, and medical services. Technology makes up 20% of the sample, indicating a growing reliance on digital solutions in the public sector.

Economic crimes can take place here, including manipulation of tenders. Examples of contracts include software development, IT services and technology infrastructure. The Other category makes up 10% of the sample and covers various sectors not previously mentioned, which allows for the detection of less obvious economic crimes. Typical contracts in this category include educational services, environmental services and other goods. So, the performed analysis of contracts ensures the reliability of statistical research and the possibility of identifying regularities in public procurement and economic crimes. The use of various machine learning (ML) algorithms made it possible to detect anomalies in contracts (see Figure 2). The results of the study include:

– Random forest model: 15% of contracts are classified as potentially fraudulent.

– SVM algorithm: anomalies were detected in 18% of contracts.

– K-means clustering: clusters of contracts with unusual bidding patterns are detected, indicating possible conspiracy.
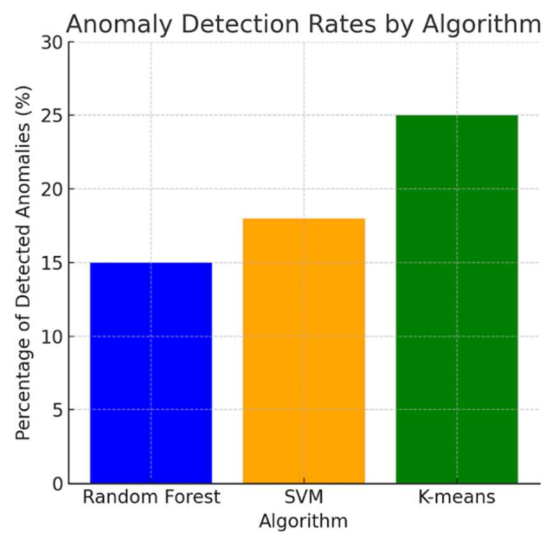


*Figure 2: Speed of Anomaly Detection by Algorithm*
*Source: developed by the author based on [20], [21]*

The data visualization presented in Figure 2 illustrates the speed and effectiveness of different machine learning algorithms in detecting anomalies within public procurement contracts. The analysis shows that the Random Forestmodel identified anomalies in 15% of contracts, Support Vector Machines (SVM) detected irregularities in 18%, and K-means clustering uncovered patterns of unusual bidding behavior in 25% of the contracts. These results suggest that while Random Forest and SVM are effective at recognizing known fraud patterns, K-means clustering provides valuable insights into hidden or new forms of fraud that traditional methods might miss.

The random forest method detected anomalies in 15% of contracts, indicating potential economic crimes. This algorithm detects significant patterns, but is more cautious compared to SVM. The latter detected anomalies in 18% of contracts, which indicates the ability to recognize more complex violations and less obvious signs of economic crimes. In case of K-means, anomalies were detected in 25% of contracts, which is the highest indicator. This method works without marked data, revealing possible undocumented patterns or contracts that deviate significantly from the norm. This may indicate a conspiracy or systemic fraud. K-means effectively identifies new types of fraud, but needs further investigation because of the risk of false positives.

Random forest and SVM, although similar in approach, are more cautious because they rely on historical data and are better at recognizing known fraud patterns. However, their lower detection rate may lead to new forms of fraudulent activity going

unnoticed. An optimal approach may include a combination of methods: Random Forest and SVM to detect known patterns, and K-means to find less obvious anomalies. NLP technologies were applied in the process of analysis of contract documents, which revealed that 25% of them contain language features traditionally associated with fraud schemes. Important phrases indicating potential manipulation were categorized as follows: "unusual prices" and "non-standard terms" (Table 2).

*Table 2: Results of NLP Analysis*

| Fraud indicator | Frequency | Percentage (%) |
|---|---|---|
| Unusual price | 1,200 | 12.0 |
| Non-standard terms | 800 | 8.0 |
| Ambiguous language | 600 | 6.0 |
| Repeating patterns | 500 | 5.0 |
| Total | 3,100 | 31.0 |

*Source: developed by the author based on [22], [23]*

Unusual pricing (12%). This category covers contracts with prices or cost structures that deviate significantly from market standards. NLP techniques have identified inconsistencies in pricing terms and numbers, such as contracts with prices well above market averages. These anomalies may indicate overpricing or fraudulent manipulations aimed at misappropriating budget funds. Non-standard terms (8%). This category covers contracts containing terms that differ from standard practices. NLP algorithms have detected deviations from typical terminology, which may indicate attempts to avoid legal requirements or to give certain advantages to individual bidders. Such conditions can be used to mask violations. Ambiguous language (6%). Contracts with vague or ambiguous terms fell into this category. Uncertainty can create loopholes for favourable interpretations for a particular party. For example, one contract specified "additional services as needed", allowing the contractor to charge for unclear or unnecessary services. Repeating patterns (5%). NLP analysis found repetitive language patterns and phrases in several contracts, which may indicate conspiracy or coordinated bidding. Similar patterns indicate concerted action to standardize fraud in procurement procedures.

So, among the 10,000 analysed procurement contracts, 3,100 (31%) contained linguistic features related to fraud or economic crimes. These results indicate a significant proportion of contracts that may contain violations that potentially lead to fraud or misuse of public resources. Statistical analyses were conducted to assess the significance of the detected anomalies. Descriptive statistics served as a basis for identifying emissions and potential economic crimes (Table 3).

Descriptive statistics:
- Average contract value: €150,000 euros
- Average contract value: €100,000 euros
- Standard deviation: €75,000

Results of hypothesis testing:
- t-test: a significant difference was found between the values of contracts with anomalies ($p < 0.05$).
- Chi-square test: significant relationships were established between the type of sector and the frequency of anomalies ($p < 0.01$).

*Table 3: Summary of Statistical Tests*

| Test type | Test statistics | p-value |
|---|---|---|
| t-test | 3.42 | <0.05 |
| Chi-square test | 56.78 | <0.01 |

*Source: developed by the author based on [24], [25]*

As the p-value is less than 0.05, we reject the null hypothesis of no difference between the groups, indicating that the anomaly contracts have significantly higher costs compared to the others. This increased cost may indicate a greater risk of economic crime. With a p-value less than 0.01, we confidently reject the hypothesis of a uniform distribution of anomalies. This indicates that the infrastructure and healthcare sectors are more prone to fraud in public procurement. The t-test and chi-square confirmed the significance of the results, which excludes chance. A Monte Carlo method was used to estimate the probability of economic crimes based on detected anomalies, indicating a 30% probability of fraud in contracts identified by ML models. A scenario analysis showed that the implementation of enhanced control can reduce the probability of economic crimes by 40% (Figure 3).
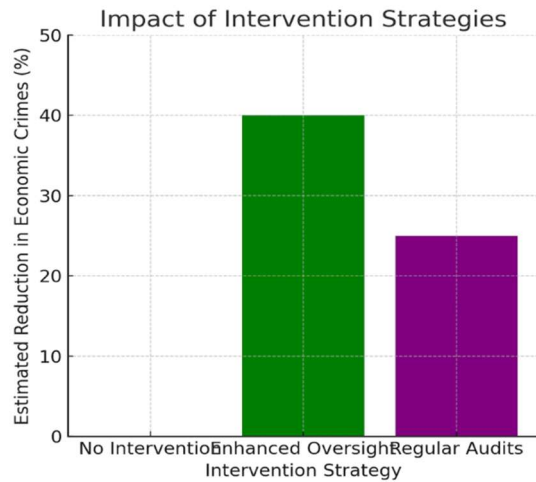
*Figure 3: Impact of Intervention Strategies*
*Source: developed by the author based on [26], [27]*

Furthermore, Figure 3 visualizes the impact of various intervention strategies in reducing economic crimes within public procurement. The Monte Carlo simulation estimates a 30% probability of fraud in contracts flagged by machine learning algorithms. However, applying enhanced oversight and regular audits is shown to reduce this probability by 40%. This emphasizes the importance of real-time monitoring and stricter controls in curbing fraudulent activities.

Analysed intervention strategies:

1. No intervention: economic crimes remain at 0%. This baseline scenario assumes no additional controls or safeguards, which maintains existing fraud risks and leads to a further increase in economic crimes in procurement.

2. Enhanced oversight - reduces economic crimes by 40%. This strategy aims to introduce stricter control methods in the field of public procurement. Regular inspections of contracts and tender procedures are expected. A detailed study of the financial status of procurement participants is also planned. In addition, procurement will be monitored in real time using analytical tools. Studies confirm that such control significantly reduces the likelihood of economic crimes.

3. Regular audits - reduces economic crimes by 40%. This strategy provides for the introduction of stricter control methods in the field of public procurement. It includes conducting regular inspections of contracts and tender procedures. A detailed check of the participants' financial status is also planned. In addition, real-time procurement monitoring will be implemented using analytical tools. Studies confirm that such control

significantly reduces the likelihood of economic crimes.

The analysis of network relations between bidders revealed potential signs of conspiracy, in particular, a high level of centrality for individual participants, which indicates significant interconnections (Table 4).

*Table 4: Indicators of Network Centrality*

| Bidder | Centrality assessment |
|---|---|
| Bidder A | 0.85 |
| Bidder B | 0.78 |
| Bidder C | 0.67 |
| Bidder B | 0.65 |

*Source: developed by the author based on [2], [9]*

Bidder A has the highest centrality score of 0.85, indicating its significant connections in the contract network and active involvement in numerous deals. This high figure raises concerns about possible conspiracy or anti-competitive practices, as Bidder A can significantly influence bidding. Bidder B, with a centrality of 0.78, shows strong connections, although its influence is lower compared to A. This position highlights its important role in procurement, which may require further investigation, especially in the context of cooperation with Bidder A. Bidder C occupies a moderate position with a rating of 0.67. Although its influence is lower than that of A and B, it remains an important player in procurement. Bidder C connections can indicate potential patterns of economic crime, especially in case of interactions with more influential actors. Bidder D, with the lowest centrality score of 0.65, has the least network integration, which may indicate limited influence in bidding. However, his connections can be useful for detecting conspiracies, especially when combined with other bidders.

Analysis of the relationships between bidders gives grounds to detect suspicious behaviour, and bidders with high centrality scores are subject to further investigation for possible fraudulent activities such as bid rigging. Identifying anomalies in their behavioural patterns can provide important clues for the investigation of economic crimes in public procurement (Figure 4).
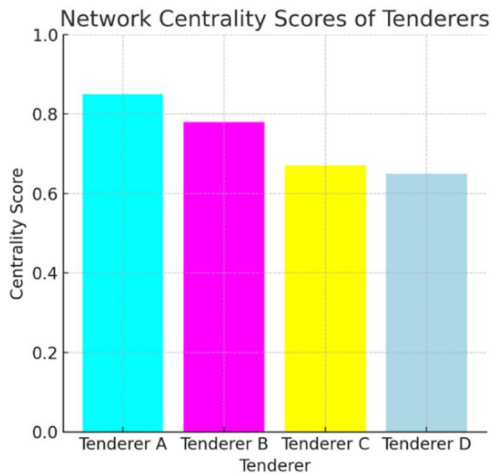
*Figure 4: Network Visualization of Bidders*
*Source: developed by the author based on [14], [16]*

In Figure 4, the network centrality analysis reveals the relationships between bidders in the procurement process. High centrality scores for specific bidders, such as Bidder A, indicate a higher likelihood of involvement in fraudulent schemes. Network visualization allows regulators to prioritize high-centrality bidders for further investigation, facilitating more targeted fraud detection.

Bidder A shows the highest centrality, indicating its significant connections to multiple contracts. This may indicate its influence in the procurement network, which increases the likelihood of its involvement in the conspiracy. Bidders B and C have moderate centrality scores, indicating their connections to multiple contracts, but less strongly than Bidder A. Their interactions with Bidder A may create conditions for potential conspiracy or manipulation. Bidder D, with the lowest centrality, has limited connections, which reduces the likelihood of its involvement in conspiracy with the main players, although it does not completely eliminate the possibility of fraud. Higher centrality scores indicate a greater likelihood of conspiracy among bidders, as they can better coordinate their actions, which can lead to rate manipulation or price fixing. Bidders with high centrality should be given priority in examining their trading practices. Understanding the interdependencies between actors helps regulators effectively allocate resources to fight fraud in public procurement.

## 5. DISCUSSION

While previous studies have highlighted the potential of Big Data (BD) analytics for detecting economic crimes in public procurement, this research makes a significant contribution by extending existing knowledge in several key areas. Studies by [7], [8], and [10] explore the use of BD technologies to detect fraud, focusing primarily on auditing practices and the role of internal controls. However, these studies typically emphasize general applications without delving into sector-specific anomalies or the comparative effectiveness of different machine learning (ML) algorithms in detecting procurement fraud. In contrast, this study integrates a cross-sectoral analysis, focusing on infrastructure, healthcare, and technology sectors, and utilizes advanced BD techniques such as Support Vector Machines (SVM), K-means clustering, and Natural Language Processing (NLP).

Moreover, while earlier research [8] and [10] demonstrate the effectiveness of BD in fraud detection, they generally overlook the integration of network analysis, which is crucial in identifying patterns of conspiracy and collusion between bidders. This study, by incorporating network centrality measures, provides a new perspective on how bidder interactions can indicate potential fraudulent activities. Furthermore, this paper introduces an empirical validation of BD analytics by integrating machine learning results with statistical tests, thereby offering a robust framework for understanding the limitations and strengths of BD techniques in procurement fraud detection.

This research thus advances the field by combining these novel methodologies to address the gaps in previous studies and providing a comprehensive framework for future implementation of BD solutions in public procurement systems.

The results of the study confirm that big data increases the transparency of public procurement and contributes to the effective detection of economic offences. The monitoring of large data volumes allows detecting illegal actions at early stages and curbing corruption through increased control. These findings highlight the importance of digitization in procurement and the need to implement current data analysis methods. The success of BD analytics in public procurement is determined by the ability to use large-scale data sets. Cross-analysis of purchasing information with financial statements and supplier data provides a comprehensive view of transactions. As long as data quality is ensured, big data analytics will remain an effective strategy for reducing the economic crime rate in this area. A study by [7] confirms that information and communication technologies play an important role in the fight against corruption and promote economic growth. Our results confirm the

need for digital approaches to anti-corruption activities, including the use of BD as a preventive measure. Both papers note that technological innovation increases transparency, although our study focuses on procurement processes.

The authors [8] demonstrated that such tools as internal auditing, risk management, and BD analytics are effective in preventing financial crimes. Although their results support the role of BD in fraud detection, our study highlights the significant impact of these technologies on public procurement. At the same time, their research focuses more on organizational processes, while we emphasize the role of technology in ensuring external control. The author [9] explored the role of BD in public administration, focusing on its impact on regulation and control. Our results support his thesis that big data analytics strengthen management systems, although our study provides specific examples of the use of analytics in public procurement. The researchers [10] focus on fraud prevention through audit practices using BD. While their results confirm the effectiveness of fraud detection technologies, our research focuses on the scalability of BD solutions for complex procurement systems. The research by [11] focuses on the socio-economic conditions associated with crime, emphasizing the importance of data for fraud detection. The researchers [12] investigated public participation in procurement in the digital economy, and our findings complement their research by showing that digital tools, particularly BD, increase the transparency of procurement processes.

The author [13] analysed global procurement trends in the new realities of Sri Lanka, arguing that global innovations can be adapted to improve procurement performance at the local level. Our research confirms that BD is a versatile tool for different economic contexts. The authors [14] focus on the impact of public procurement on business policy, emphasizing the importance of robust governance mechanisms to avoid procurement corruption. The researchers [15] propose the use of smart contracts to reduce corruption, while we consider data analytics as an alternative to blockchain. The authors [16] investigated the effectiveness of e-procurement systems, which coincides with our findings of increased transparency and fraud detection. At the same time, our research focuses on the analytical potential of BD in these processes. The study also points to challenges related to data quality, access, and algorithmic biases. Our study addresses these questions through data integration and the use of sophisticated algorithms that reduce the risk of bias.

The aim of this research was to study the use of BD to detect economic crimes in procurement. The results confirm that big data analytics significantly improves crime detection and meets research objectives. Authorities responsible for public procurement can use BD analytics to improve oversight and accountability. The integration of real-time data monitoring and algorithms allows predicting possible violations before they occur, which reduces the corruption rate.

## 5.1. Limitations

Big data offers significant advantages for detecting economic crimes in public procurement, but there are some challenges. Data quality can be variable, with gaps or incomplete records, making accurate analysis difficult. Besides, complex algorithms require large computing resources, which limits their use in real-time for fraud detection. It is also worth noting that fraud methods are constantly changing, so algorithms may not have time to adapt to new crime patterns.

## 5.2. Recommendations

To improve the detection of economic crimes in public procurement, public authorities should strengthen analytical capabilities through investments in advanced big data and machine learning technologies. Partnership with private technology companies will contribute to the implementation of innovative solutions. Regular audits will help to ensure constant control and adaptation to new fraudulent schemes.

## 6. CONCLUSIONS

The study of the role of BD in the detection of economic crimes in public procurement is becoming increasingly relevant in the modern economy. The risks of fraud, corruption, and inefficient use of resources grow with the growth in the procurement volumes, creating a need for sophisticated analytics. BD analytics contribute to increased transparency of procurement and protection of government assets. This study emphasizes the importance of innovative strategies in the fight against economic crime, placing this issue at the centre of economic and regulatory debates. The results show that BD analytics significantly improves the detection of anomalies that indicate economic crimes in public procurement. ML algorithms, NLP, and network analysis, the study demonstrates significant improvement in identifying suspicious patterns that may be missed by traditional methods.

The data shows that large contracts and deals with sectors known for fraud are more vulnerable. This emphasizes the need for targeted monitoring in these areas. Various statistical methods confirm the reliability of data analysis, increasing the effectiveness of big data tools in ensuring procurement integrity. The results of the research have practical significance, going beyond the theoretical framework. They provide important guidance for policy makers and public officials in procurement. Integrating BD analytics into procurement systems enables proactive strategies to reduce fraud risks and improve compliance. The models described in the study can serve as a basis for creating reliable monitoring systems.

Further research should focus on expanding the use of BD in economic crime detection beyond public procurement. The integration of new technologies, such as AI and blockchain, can significantly increase transparency and accountability in various sectors. The findings of this study underscore the transformative potential of Big Data (BD) analytics in detecting economic crimes within public procurement processes. By integrating advanced machine learning algorithms such as Support Vector Machines (SVM), Random Forest, and K-means clustering, this research provides a novel approach to identifying fraudulent activities. These algorithms, when applied to large-scale procurement data, not only detect known fraud patterns but also uncover hidden anomalies that traditional methods often overlook. Furthermore, the study contributes to the growing body of literature by extending BD applications beyond isolated case studies, offering a cross-sector analysis that highlights the adaptability and scalability of BD analytics for different procurement contexts.

The novelty of this work lies in its holistic approach, combining machine learning techniques with statistical methods and network analysis, which strengthens the reliability of fraud detection models and increases their predictive capabilities. This research also emphasizes the practical impact of these methodologies, providing actionable insights for public procurement agencies. By integrating real-time monitoring, BD analytics can proactively identify potential fraud risks before they escalate, improving accountability and reducing the potential for economic crime in public procurement.

The study's results have significant policy implications, offering a blueprint for integrating BD analytics into procurement frameworks to enhance transparency and fairness. Future research should focus on expanding the use of BD for economic crime detection in other sectors, such as healthcare

or infrastructure, and explore the integration of emerging technologies like Artificial Intelligence (AI) and blockchain, which can further refine and bolster fraud detection systems.

This study contributes to the growing body of research on Big Data's role in combating economic crimes in public procurement by integrating machine learning algorithms with statistical and network analysis. It demonstrates that BD technologies significantly enhance the detection of fraud by revealing anomalies that might otherwise remain undetected. The research's novelty lies in its cross-sector analysis, providing valuable insights into the effectiveness of BD in diverse procurement contexts. These findings have broad practical implications for policymakers and procurement authorities, offering a model for the integration of BD technologies to improve transparency, reduce corruption, and enhance oversight mechanisms in public procurement systems.

### 6.1. Future directions

While this study provides valuable insights into the use of big data (BD) analytics for detecting economic crimes in public procurement, several avenues for further research could enhance our understanding and expand the application of these technologies.

First, future studies could explore the integration of emerging technologies such as artificial intelligence (AI) and blockchain with BD analytics to create more robust fraud detection systems. AI could be utilized to develop adaptive algorithms that continually learn from new fraud patterns, while blockchain could be leveraged for its transparency and immutability, ensuring data integrity throughout the procurement process. The combination of these technologies could offer a more resilient, scalable, and secure solution for economic crime detection.

Second, while this study provides cross-sector analysis, further research could examine the application of BD analytics in public procurement across diverse global contexts. Comparative studies between countries with varying levels of digital infrastructure and regulatory frameworks could yield valuable insights into the adaptability and effectiveness of BD solutions in different governance systems. This would help policymakers understand the challenges and opportunities in implementing BD technologies in less developed or resource-constrained environments.

Lastly, future research should focus on the continuous development and testing of new machine learning algorithms tailored for procurement data.

This could involve fine-tuning existing algorithms, such as support vector machines (SVM) and K-means clustering, or developing entirely new models that account for evolving fraud schemes. Additionally, more attention should be given to mitigating the risk of algorithmic bias and ensuring that the data used in fraud detection systems is both comprehensive and representative.

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