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METHODS FOR THE IMPROVEMENT OF CORPORATE INFORMATION SYSTEMS BASED ON BIG DATA AND BLOCKCHAIN TECHNOLOGIES

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Abstract: The digital transformation of industrial enterprises has highlighted the need for corporate information systems (CIS) capable of supporting data-driven decision-making, process optimization, and strategic management. In this paper, we explore how to enhance CIS by the combined use of Big Data and blockchain technologies. In this paper, a business-process-oriented CIS model is developed within the framework of a corporeal central database that aggregates the flows of production, management, and business information. It contributes to transparency, data integrity, and managerial effectiveness via real-time monitoring, analytics and decision support. This paper contrasts both approaches using the example of transaction systems based on a relational database against systems based on a blockchain distributed ledger, and makes the case for a blockchain as the superior technology for decentralizing, immutability, and safe document management. The results show that the complementary application of Big Data and blockchain technologies forms a methodological and technological basis for the digital transformation of corporate information systems to increase the efficiency, reliability, and competitiveness of industrial enterprises.

Keywords: Big Data, Blockchain; Corporate Information Systems, Industrial Enterprises, Digital Transformation, Data-Driven Management, Distributed Ledger Technology, Business Process Optimization.

Citation: Shamurotovich. K. A. Methods For The Improvement Of Corporate Information Systems Based On Big Data And Blockchain Technologies. American Journal of Economics and Business Management 2026, 9(3), 10-18.

Received: 10th Feb 2026

Revised: 24th Feb 2026

Accepted: 1st Mar 2026

Published: 6th Mar 2026



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1. Introduction

In the context of digital transformation, corporate information systems (CIS) play a decisive role in improving management efficiency, competitiveness, and sustainability of modern enterprises. The growing complexity of production and business processes, along with the rapid increase in data volumes, has significantly reduced the effectiveness of traditional corporate information systems designed to process limited and structured data [1]. As a result, enterprises increasingly require advanced digital solutions capable of supporting data-driven decision-making.

One of the key technological drivers of this transformation is Big Data. Increasing application of sensors, industrial automation systems, enterprise resource planning platforms and digital communication channels has resulted in generation of large quantities of diverse data sets. Big Data technologies allow to process and analyze both;

structured and unstructured data, so organizations can reveal hidden patterns, predict future trends, and optimize production and management processes [2]. In the context of industrial enterprises, these technologies enable predictive analytics, digital modelling, and quality management systems supporting such a move from reactive to proactive and adaptive management models [3, 4].

In parallel to Big Data, blockchain has attracted considerable attention as an enabling technology that can be used to increase the transparency, security and trustworthiness of the organizational information systems. Blockchain technology is underpinned by a distributed ledger architecture that provides nonrepudiation, decentralization, modification-resistant data integrity, and tamper resistance. Hence, such properties are especially valuable for use cases ranging from the management of corporate documents and financial transactions to intra-departmental data exchange within complex organizational architectures [5, 6].

A partner who, as a national strategic priority, recognizes how important it is to facilitate the digitalization of industrial enterprises and management systems in Uzbekistan. In recent years, the emphasis has been on building up digital infrastructure, on automating the business processes, on deploying new information technology in core sectors of the economy. However, the actual using of Big Data and blockchain technologies within the corporate structure is very limited. The main reasons for these problems are poor integration / consolidation of data sources, insufficient automation of production processes, poor data quality, and lack of qualified specialists. This creates a mission-critical demand for evidence-based methods to enable the digital technologies and enhance enterprise systems upgrades.

In this regard, the present study focuses on the development of methods for improving corporate information systems based on the integrated application of Big Data and blockchain technologies. The proposed approach is oriented toward industrial enterprises and takes into account the current conditions and challenges of digital transformation in Uzbekistan.

2. Methodology

The methodological basis of this study is built on a комплекс analytical approach aimed at investigating the improvement of corporate information systems (CIS) in industrial enterprises through the integrated use of Big Data and blockchain technologies. The research methodology combines theoretical analysis, comparative evaluation, system analysis, and conceptual modeling in order to examine both technological and organizational aspects of digital transformation in enterprise information systems. The study adopts a system-oriented research perspective in which corporate information systems are considered as integrated digital infrastructures connecting production processes, management activities, and business operations within a unified information environment. Such an approach makes it possible to analyze corporate information systems not only as technological platforms for processing enterprise data but also as strategic tools that support managerial decision-making and business process optimization.

The research process consists of several analytical stages. At the initial stage, a theoretical analysis of the evolution of corporate information systems was conducted. Scientific publications, analytical reports, and international studies on digital transformation, Big Data technologies, and blockchain systems were examined. This stage made it possible to identify the key technological factors influencing the development of modern enterprise information systems. The next stage of the research focuses on the analysis of Big Data technologies and their application in industrial enterprises. Particular attention was given to the ability of Big Data technologies to process large volumes of heterogeneous information generated by industrial sensors, enterprise resource planning

systems, and digital communication platforms. Analytical and inductive methods were applied to determine the role of Big Data in real-time monitoring, predictive analytics, and optimization of production processes.

Another important part of the methodology involves the investigation of blockchain technology as a mechanism for ensuring transparency, security, and reliability of corporate data. Comparative analysis was used to evaluate the differences between traditional relational database systems and blockchain-based distributed ledger architectures in terms of data storage structure, transaction verification mechanisms, and information transparency. System and structural analysis methods were also employed to examine the architecture of corporate information systems in industrial enterprises and to identify interactions between production data, management information, and business processes. Based on the results of these analyses, conceptual modeling methods were used to develop a business-process-oriented corporate information system model that integrates Big Data analytics and blockchain mechanisms within a unified corporate data environment.

Overall, the applied methodology provides a comprehensive analytical framework for studying the digital transformation of corporate information systems and for identifying technological approaches that improve enterprise information management, increase operational transparency, and support effective managerial decision-making

3. Literature Review

The transformation of corporate information systems has been widely discussed in the literature within the framework of digitalization and data-driven management. Laudon and Laudon emphasize that traditional corporate information systems were originally designed to support transactional processing and structured data flows, which limits their effectiveness in environments characterized by rapidly increasing data volumes and process complexity [7]. As a result, researchers are looking for emerging digital technologies which may improve the operational features of such systems.

The Big Data technologies are always defined as the divergent point in evolution of corporate information systems. McAfee and Brynjolfsson suggest that Big Data gives organizations access to massive and diverse datasets, which help them to enhance their managerial decisions and to move toward evidence-based management paradigm [8]. Big Data analytics in industrial processes such as predictive maintenance, process optimization, and quality management.

Industry 4.0 has continued to develop the integration of Big Data into industrial information systems. Tao et al. point out that Big Data is an essential pillar of digital twins, enabling simulation, optimization, and prediction of production and business processes throughout the entire product life cycle [9]. The analyzed results highlight that Big Data enhance analytical and forecasting functions of corporate IS in a significant way.

However, despite these benefits, research identifies ongoing difficulties. The complexity in integration of data, data quality problems, and high implementation cost are still the significant impediments to widespread acceptance of corporate systems based on Big Data [10], Chen, Mao and Liu. Such restrictions are notably amplified in the case of large industrial businesses and developing nationalities.

Blockchain technology is something new that has appeared recently and is now being added as another method to solve problems related to transparency and security in corporate information systems. Blockchain was introduced by Nakamoto as a decentralized ledger technology to provide immutability and trust in data without centralized control [11]. The research has since been generalized to other tools outside cryptocurrencies.

In particular, Crosby et al. propose that blockchain may enhance the reliability of corporate information systems through data-evidence integrity, traceability and

auditability in document management and transaction processing [12]. Then Zheng et al. highlight technical and organizational barriers in terms of scalability, system integration, and regulatory requirements that hinder adoption of blockchain in multi-faceted corporate contexts [13].

In a developing country such as Uzbekistan, the literature shows that the use of Big Data and Blockchain technology in corporate information systems is still not widespread. As indicated in World Bank reports, low levels of automation, weak data infrastructures, and lack of sufficient skilled specialists constrain effective digital transformation [14].

These findings underline the need for methodological approaches tailored to local industrial and institutional conditions.

4. Research Techniques

In the course of this research, general scientific methods of analysis and synthesis, induction and deduction, and comparative analysis were applied. These methods were used to examine the theoretical foundations and practical aspects of improving corporate information systems based on Big Data and blockchain technologies.

The architecture and functional elements of corporate information systems in industrial enterprises and their transformation under digital technologies were investigated by methods of system and structural analysis. We used logical generalization and abstraction to establish the important technological and organizational factors that may affect the usefulness of the Big Data analytics and blockchain-based solutions.

The study uses a methodological framework which involves examination of evidence from scientific publications, analytical reports and regulatory documents in the area of digital transformation, corporate information systems, channels of Big Data, and blockchain technologies.

The information base of the research consists of materials from international scientific journals, reports of global analytical organizations, and official documents related to digital development strategies, including those relevant to industrial enterprises in Uzbekistan.

In addition, conceptual modeling methods were used to substantiate approaches to integrating Big Data and blockchain technologies into corporate information systems. This made it possible to formulate methodological recommendations aimed at enhancing the functional capabilities of corporate information systems under conditions of digital transformation.

5. Results and Discussion

The results of the study confirm that the implementation of Big Data and blockchain technologies significantly enhances the functional capabilities of corporate information systems (CIS) in industrial enterprises. The analysis conducted in Chapter IV demonstrates that contemporary corporate information systems are evolving from auxiliary data-processing tools into comprehensive strategic management instruments that support managerial decision-making, business-process optimization, and long-term planning. It represents the evolution of industrial enterprises along the lines of management paradigms, where integrated information flows turn into an important production and governance resource.

The main scientific result of the study is a new model of corporate information system oriented to the business process of an industrial enterprise (Fig. 1). The new conceptual model introduced by the authors highlights the data repository as the core element of the corporate model and the information environment in which the heterogeneous data produced during production, management and the entire life cycle of business processes are integrated.

The repository is conceptually based on Big Data and blockchain technologies, ensuring data integrity, traceability, and reliability while enabling secure accumulation and processing of large-scale structured and unstructured datasets.

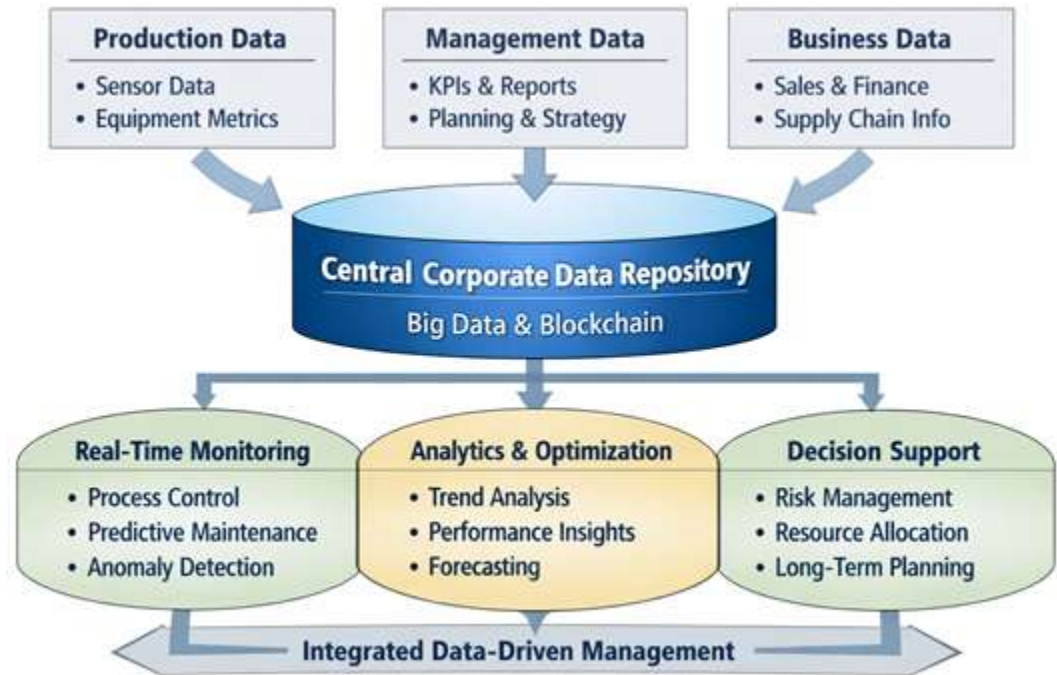


Fig. 1: Business process oriented corporate information system model for an industrial enterprise

According to the model, production-level data—including sensor readings, equipment condition parameters, and technological indicators—are continuously transmitted to the central corporate data repository. At the management level, key performance indicators (KPIs), reporting information, and strategic planning data are integrated into the same environment. Similarly, financial, sales, and supply-chain information flows are integrated at the business level. Combining these data from multiple level exhibits an integrated corporate information space which spans across all the functional domains in the enterprise. This integrated system allows to store and analyze large amounts of different data in one place, empowering business managers to monitor their enterprise operations in the real-time and making management decisions more timely, accurate and valid. These results show that the efficiency of corporate information systems is primarily reliant on ability to process Big Data across functional layers.

As illustrated in Fig. The central corporate data repository is the backbone of three related functional contours: real-time monitoring, analytics and optimization, and finally, decision support. The real-time monitoring contour gives round-the-clock operational control of production, underlying processes, early anomaly detection, and predictive maintenance of equipment. It supports analytical and optimization contour deep analysis of data, trend identification, performance evaluation and forecasting, which can provide ongoing support for the improvement of technology and the business process. A control output from the decision-support contour provides management with analytical insights for risk management, resource allocation, and strategic planning. Collectively these contours pave the way towards the transition from sporadic information usage to the integrated data driven management model.

The research results confirm that Big Data technologies are generating technological conditions for improving the transparency, flexibility and efficiency of industrial and business processes. The data from production management systems, operational metrics and managerial information is integrated into a single corporate information system which

helps enterprises move away from disconnected information repositories towards a cohesive digital management environment[15]. Hence, it can identify the deviations in production and business processes in the early stages and rectify the deviations in evidence-backed time.

In addition to the conceptual model presented in Fig. 1, the study provides a comparative assessment of traditional transaction-based corporate information systems and blockchain-based distributed systems. The results of this comparison are summarized in Table 1, which systematizes the distinguishing characteristics of relational database-based distributed systems and blockchain-based distributed ledger systems within corporate transaction environments.

The relative study shows that moronic enterprise data systems, traditionally based on relational database models, have centralized data storage, structured data formats and allow data to be altered and even wiped clean. These systems usually have tabular representation of information and a centralized mechanism used for verification of documents. Although this architecture guarantees operational stability and compatibility with the current enterprise software landscape, it introduces a risk around data integrity, provenance, and tampering.

Table 1

Comparative analysis of information systems used in transaction environments

No.	Distinguishing characteristics of corporate information systems in transaction environments	Distributed DB based on relational data model	Blockchain-based distributed ledger system
1	Data placement	Centralized	Decentralized
2	Type of stored data	Structured data	Structured and unstructured data
3	Form of result representation	Tabular format	Any electronic document format
4	Data operations	Insert, update, delete	Append only (immutable records)
5	Document authenticity verification	Centralized control; data can be modified	Cryptographic verification; tamper-resistant
6	Speed of information accumulation	Moderate	High
7	Openness and transparency of information resources	Low	High

In contrast, blockchain-based distributed ledger systems are characterized by decentralized data placement, immutable append-only data structures, and cryptographic verification of transactions. Blockchain technology records all operations on the basis of transparency and traceability and organizes data in document format that can be either structured or unstructured as shown in Table 1. The fact that it is impossible to change previous records makes corporate data much more reliable and increases interorganizational trust. These features matter most for industrial businesses which operate in complicated supply chains and multi-level management hierarchies.

Blockchain integration in the corporate information system model illustrated in Fig. Incorporate 1 to build upon the common corporate data repository and enable tracking and secure accumulation and document and transaction life-cycle transfer of anything in any format. When integrated with Big Data analytics, the blockchain-based data validation creates an uninterrupted oversight of information flows throughout the production, management, and business domains. In turn enabling enterprises with greater operational transparency, executive discipline, and process accountability[16].

Also, the comparative analysis brings out the fact that the application of Big Data and blockchain technologies initiates some organizational and technological constraints. Such as; increased architectural complexity of corporate information systems, huge expenses on infrastructure and maintenance, the requirement of high qualified specialists in data engineering, cybersecurity, and distributed systems management. Thus, besides enabling technical deployment, these technologies need enabling and adapting methodological framework, regulatory support, and organizational readiness in industrial enterprises.

In conclusion, the model analysis results (Fig. The content layout (Fig.1.) and the comparative estimation (Table 1.) provide undeniable evidence that the joint combination of Big Data and blockchain technologies creates a strong technological and methodological basis for the digital transformations of corporate information systems. These suggested method- loges change to decentralized, verifiable, and information informed organization networks from focused and alterable information conditions.

This transition contributes to improved operational efficiency, enhanced data integrity, and increased strategic competitiveness of industrial enterprises in the context of Industry 4.0.

6. Conclusion

This study examined the transformation of corporate information systems (CIS) in industrial enterprises under conditions of digital transformation and substantiated the role of Big Data and blockchain technologies in enhancing their functional capabilities. Our findings support the notion that advanced digital technologies can transform corporate information systems from traditional transaction-processing transaction-based tools into sophisticated data-driven management platforms able to support decision making, process optimization, and strategic planning.

The research makes a principal contribution in development of process-oriented model of corporate information system based on a centralized corporate data repository, which integrates production, management and business flow of information. It was shown that the integration and analytical processing of heterogeneous data into one space allows to perform real-time monitoring of business processes, to increase the degree of validity, relevance and timeliness of managerial decisions made by the company, and to move towards integrated management based on data driven paradigm. Set of functional contours of monitoring, analytics and optimization and decision support specified in the model is a logical continue the for increasing operational transparency and controllability of processes in industrial enterprises.

The assessment of transaction systems based on relational databases and blockchain based distributed ledger systems proved again the advantages of certain aspects of blockchain technologies, such as maintaining decentralization, immutability of records, cryptographic verification, and information resource transparency. These features that contribute to data integrity and traceability of transactions, as well as trust (or mutual distrust) among organizational units, are particularly vital when the complexity of the involved industrial environment requires secure document management and information exchange. Simultaneously, the study pointed practical limitations with the use of Big Data as well as & blocks technologies such as the increased complexity of systems, high costs of related infrastructure and the necessity for skilled specialists.

The results, as a whole, prove that the combined use of Big Data analytics with blockchain mechanisms forms a common technological and methodological platform for digital transformation of corporate information systems in industrial enterprises. The presented solutions are intended to increase the efficiency of management, the reliability

of information and the competitiveness and sustainability of enterprises in the era of Industry 4.0 and continuing processes of digitalization.

The outcomes received are proposed to be used as a methodological basis for additional studies on digital corporate architectures and practical activities focused on digitalization of corporate information systems of industrial enterprises, including those in developing economies which are undergoing digital transformation.

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