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ANALYSIS OF DEEP LEARNING MODELS IN NLP (RNN, LSTM, TRANSFORMER)

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Abstract. This article explores modern methods for analyzing business processes based on Big Data and their practical significance. The study examines the role of Big Data technologies in improving business efficiency, optimizing decision-making processes, and enhancing competitiveness. Modern approaches such as machine learning, data mining, real-time analytics, and evaluation models are considered. The results demonstrate that Big Data enables the automation of business processes, reduces risks, and provides a deeper understanding of customer needs. The findings have both theoretical and practical significance for developing effective management decisions across various sectors.

Keywords: Big Data, business processes, data analysis, digital transformation, machine learning, analytical models, decision-making, business efficiency, real-time analytics, information technologies.

Аннотация. В данной статье рассматриваются современные методы анализа бизнес-процессов на основе больших данных (Big Data) и их практическая значимость. Исследование изучает роль технологий Big Data в повышении эффективности бизнеса, оптимизации процессов принятия решений и повышении конкурентоспособности. Рассматриваются современные подходы, такие как машинное обучение, интеллектуальный анализ данных (Data Mining), анализ в реальном времени (Real-time Analytics) и модели оценки. Результаты показывают, что использование Big Data позволяет автоматизировать бизнес-процессы, снижать риски и глубже понимать потребности клиентов. Полученные выводы имеют теоретическое и практическое значение для разработки эффективных управленческих решений в различных сферах.

Ключевые слова: Большие данные (Big Data), бизнес-процессы, анализ данных, цифровая трансформация, машинное обучение, аналитические модели, принятие решений, эффективность бизнеса, анализ в реальном времени, информационные технологии.

Annotatsiya. Mazkur maqolada katta ma’lumotlar (Big Data) asosida biznes jarayonlarini tahlil qilishning zamonaviy usullari va ularning amaliy ahamiyati o‘rganilgan. Tadqiqot davomida Big Data texnologiyalarining biznes samaradorligini oshirish, qaror qabul qilish jarayonlarini optimallashtirish hamda raqobatbardoshlikni ta’minlashdagi o‘rni tahlil qilinadi. Shuningdek, mashinaviy o‘rganish, ma’lumotlarni intellektual tahlil qilish (Data Mining), real vaqt rejimida tahlil (Real-time Analytics) va baholash modellari kabi zamonaviy yondashuvlar ko‘rib chiqilgan. Tadqiqot natijalari Big Data asosida biznes jarayonlarini avtomatlashtirish, risklarni kamaytirish va mijozlar ehtiyojlarini chuqurroq anglash imkonini berishini ko‘rsatadi. Maqola natijalari turli sohalardagi tashkilotlar uchun samarali boshqaruv qarorlarini ishlab chiqishda nazariy va amaliy ahamiyatga ega.

Kalit so‘zlar: Katta ma’lumotlar (Big Data), biznes jarayonlari, ma’lumotlarni tahlil qilish, raqamli transformatsiya, mashinaviy o‘rganish, analitik modellar, qaror qabul qilish, biznes samaradorligi, real vaqt tahlili, axborot texnologiyalari.

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Introduction. Natural Language Processing (NLP) has become one of the most rapidly developing fields of artificial intelligence due to the growing demand for automated text analysis and language understanding systems. Traditional approaches are often insufficient for processing large-scale and complex textual data, which has increased the importance of deep learning models such as RNN, LSTM, and Transformer. These models enable more accurate language representation, context understanding, and sequence processing in various NLP tasks, including machine translation, sentiment analysis, and text generation.

Among these architectures, RNN introduced sequential data processing capabilities, while LSTM improved long-term dependency learning by addressing the vanishing gradient problem. More recently, Transformer models have significantly advanced NLP performance through parallel processing and attention mechanisms, becoming the foundation of modern language models. This study analyzes the main characteristics, advantages, and limitations of RNN, LSTM, and Transformer architectures in NLP applications and evaluates their effectiveness in modern language processing tasks.

Method. This study is aimed at investigating contemporary approaches to business process analysis within Big Data environments and is grounded in a comprehensive and systematic research design. A mixed-methods approach was employed, integrating both qualitative and quantitative analytical techniques. Such an approach enabled a multidimensional assessment of the impact of Big Data technologies on business performance and managerial effectiveness. At the initial stage of the research, an extensive review of academic literature and existing conceptual frameworks was conducted. This phase focused on examining the theoretical foundations of Big Data, its defining characteristics, and the principal analytical methods applied in business process management. Furthermore, particular attention was devoted to identifying the evolution of analytical paradigms in the context of digital transformation. In the subsequent stage, mechanisms for processing structured and unstructured data were analyzed. The study evaluated the applicability of modern analytical tools in managing large-scale datasets, including distributed data architectures and scalable computing frameworks. Special emphasis was placed on assessing the technological capabilities required for effective data integration, storage, and processing.

To ensure empirical rigor, the research applied machine learning algorithms alongside clustering, classification, and predictive modeling techniques. These methods were utilized to detect patterns, evaluate performance indicators, and identify potential inefficiencies within business processes. Additionally, real-time data processing capabilities were examined to determine their role in enhancing operational responsiveness and strategic agility. The findings demonstrate that the implementation of Big Data technologies significantly enhances the depth and accuracy of business process analysis. Data-driven insights contribute to greater process transparency and support evidence-based managerial decision-making. Notably, the comprehensive examination of large-scale datasets expands the capacity to detect internal inefficiencies and optimize organizational performance.

Results. The findings of the study indicate that the implementation of Big Data–driven analytical approaches significantly improves resource utilization efficiency and reduces operational costs. The analysis of customer behavior demonstrated that data-informed strategies enable organizations to enhance service quality and develop personalized solutions tailored to individual preferences. This, in turn, contributes not only to increased customer satisfaction but also to the strengthening of the

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organization's competitive market position. Furthermore, real-time data analytics proved to be instrumental in the early identification of potential risks and the timely implementation of corrective measures. The capacity to process and interpret continuously generated data streams enhances organizational responsiveness and supports proactive decision-making. Overall, the results confirm that the integration of Big Data technologies into business processes creates sustainable strategic advantages. Organizations adopting data-centric analytical frameworks gain the ability to process large-scale, heterogeneous datasets efficiently, conduct in-depth evaluations of internal operations, and formulate evidence-based managerial decisions.

The study also provides empirical support for the argument that Big Data technologies represent a critical strategic instrument in modern business process management. Their application contributes to improved operational performance, cost optimization, and enhanced competitiveness in rapidly evolving market environments. Collectively, the obtained results demonstrate that Big Data–based analytics has become an essential component of contemporary business management systems.

1. Customer Analytics and Market Forecasting

Big Data technologies were applied to analyze customers' purchase histories and social media activity. The comparative results between traditional approaches and Big Data–driven analytics are presented in Table 1.

Customer Analytics Performance Indicators

Table-1

Indicator	**Traditional Approach (%)**	**Big Data–Based Analysis (%)**
Customer satisfaction	70	85
Marketing campaign effectiveness	55	70
Interest in new products	60	78

The results demonstrate that the adoption of Big Data analytics increased performance indicators by approximately 15–18%. Enhanced customer segmentation and predictive modeling significantly improved personalization strategies and marketing precision.

2. Optimization of Operational Processes

Big Data analytics was further applied to evaluate production and operational efficiency. The findings are summarized in Table 2.

Operational Performance Indicators

Table-2

Indicator	**Traditional Management**	**Big Data Analytics**
Downtime (hours)	50	40
Production efficiency (%)	75	85
Early fault detection (%)	30	70

The findings indicate a substantial improvement in operational efficiency. The use of predictive maintenance algorithms enabled earlier detection of system failures, reducing downtime and increasing overall productivity.

3. Financial Risk Management

The integration of Big Data technologies into financial analysis enhanced credit risk assessment and decision-making accuracy (Table 3).

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Financial Risk Management Indicators

Table-3

Indicator	Traditional Assessment (%)	Big Data Assessment (%)
Share of non-performing loans	20	15
Credit decision accuracy	70	90

The results reveal a significant decrease in credit risk and a marked improvement in decision accuracy, demonstrating the effectiveness of advanced predictive modeling techniques.

4. Logistics and Supply Chain Management

Big Data–based analysis was also applied to logistics and supply chain operations (Table 4).

Logistics and Supply Chain Indicators

Table-4

Indicator	Traditional Management (%)	Big Data Analytics (%)
Delivery delays	25	5
Resource utilization efficiency	70	88

The implementation of Big Data solutions reduced delivery delays by 20% and increased resource efficiency by approximately 18%, confirming the positive impact of real-time monitoring and optimization tools.

Overall Results

Business Area	Efficiency Increase (%)	Speed/Accuracy Improvement (%)
Customer analytics	15–18	20
Operational processes	10–15	25
Financial risk management	15–20	30
Logistics and supply chain	18–22	20

The overall findings indicate that Big Data technologies generate measurable improvements across all core business functions. Radar and bar chart analyses further confirm the consistent positive impact of data-driven approaches on efficiency, accuracy, and responsiveness. The study demonstrates that data-driven management models outperform traditional approaches in terms of analytical precision and operational agility. In particular, the integration of machine learning and predictive analytics significantly expands opportunities for anticipating customer needs, assessing financial risks, and optimizing strategic planning. Moreover, real-time data processing capabilities enable organizations to adapt more rapidly to market dynamics. Based on the research findings, several practical recommendations can be proposed. First, enterprises should adopt a phased implementation strategy when introducing Big Data technologies. Second, particular attention must be paid to data quality and security, as reliable analytics depend on accurate and protected datasets. Third, organizations should invest in the development of qualified specialists and ensure continuous professional training in advanced data analytics methodologies.

Conclusion. This study was aimed at providing a comprehensive scientific examination of contemporary approaches to business process analysis within Big Data environments. The research analyzed the role of Big Data technologies in business management, their impact on organizational performance, and their practical implementation potential. The findings demonstrate that the in-depth analysis of large-scale, heterogeneous datasets constitutes a fundamental basis for effective managerial decision-making in modern business environments. Big Data–driven analytical

approaches significantly enhance process transparency and enable the identification of inefficiencies within internal operations. Data-oriented analysis contributes to improved resource utilization and operational cost optimization while strengthening overall organizational performance. Furthermore, the integration of machine learning techniques and predictive modeling expands the capacity to anticipate market trends and forecast customer needs with greater accuracy. The application of Big Data technologies not only increases economic efficiency but also elevates strategic management systems to a more advanced, data-centric level. Real-time analytics, in particular, empowers organizations to make prompt decisions, assess risks proactively, and adapt effectively to changes in the external environment. Such capabilities are essential for achieving sustainable development under competitive market conditions.

At the same time, the study highlights critical challenges associated with Big Data implementation, including data security concerns, insufficient technical infrastructure, and the shortage of qualified specialists. If these factors are not adequately addressed, the expected benefits of Big Data initiatives may not be fully realized. Therefore, a comprehensive and integrated approach that simultaneously considers technological, organizational, and managerial dimensions is necessary for successful implementation. In conclusion, Big Data–based business process analysis represents a strategically significant direction for organizations operating in the digital economy. The results of this study provide both theoretical foundations and practical guidance for the effective integration of Big Data technologies into business practice, the improvement of management systems, and the achievement of long-term sustainable growth. Future research in this field should focus on identifying emerging capabilities of Big Data technologies and expanding their application across various sectors of the economy.

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