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TRANSFORMING INDUSTRIES WITH ARTIFICIAL INTELLIGENCE: PRACTICAL ASPECTS

This article reveals the transformative impact of Artificial Intelligence (AI) in various industrial sectors, emphasizing its pivotal role in enhancing operational efficiency. It explores AI-driven predictive maintenance in manufacturing, highlighting improved equipment reliability and cost efficiency through data analytics and machine learning. It also shows AI's significant influence in reshaping supply chain and logistics, focusing on enhanced efficiency and data-driven decision-making. Furthermore, it addresses AI's integration in quality control, safety, and product design. Finally, the article discusses AI's contribution to end-to-end optimization in industry, revealing its capability in automating complex processes and enabling smarter decision-making. Overall, this analysis emphasizes AI's growing popularity and its transformative potential across different industrial applications.

Keywords: artificial intelligence, industry, operations efficiency, predictive maintenance, end-to-end optimization.

JEL classification: L86, O14, O33

Statement of the problem. In recent years, Artificial Intelligence has emerged as a transformative force in industry, reshaping the way businesses operate and develop. AI's capability to analyze vast amounts of data, learn patterns, and make informed decisions is revolutionizing different sectors from manufacturing to healthcare. This article analyzes the various use cases of AI in industry, providing insights into how this technology is enhancing efficiency, quality, safety, and innovation.

Analysis of recent research and publications. Current research in AI's application across various industrial sectors shows a diverse and impactful integration. The article from Maintenance World [1] reveals AI-driven predictive maintenance in industrial manufacturing, highlighting the use of AI and ML in revolutionizing equipment maintenance. Similarly, ISM World [2] and Quantic [3] discuss AI's transformative role in supply chain and logistics, emphasizing efficiency and data-driven decision-making. Nature's article [4] offers a scientific perspective on AI's implementation in industry, often grounded in empirical research. Quality Digest [5] focuses on AI's integration with cobots in quality inspection, a significant innovation in manufacturing. GoCreate [6] and Product School [7] discuss AI's influence on product design and development, noting advancements in customization and efficiency. McKinsey's [8] provides a strategic view on AI's role in 2023, discussing generative AI's breakthroughs in various sectors. The articles from

BuiltIn [9] and DataVersity [10] discuss AI trends in 2023, indicating major shifts and future directions. Technology Review [11] and CIO Axis [12] explore cutting-edge AI trends and their reshaping of industries. These articles collectively highlight AI's growing pervasiveness and its transformative potential in different industrial applications.

Objectives of the article. The goal of the article is to examine the current landscape of AI use in industry and the future prospects of its implementation.

Summary of the main research material. The exploration of Artificial Intelligence's applications across various industries in 2023 reveals its pivotal role in driving product quality and operational efficiency. From enhancing maintenance and repair processes to revolutionizing design and product development, AI's impact is profound and far-reaching.

We can identify several of the following directions for the use of AI in industry (Figure 1):

1. Maintenance and Repair. In the dynamic world of industrial manufacturing, AI-driven predictive maintenance has revolutionized maintenance strategies. This shift, leveraging the power of data analytics and machine learning, enables industries to proactively predict and prevent equipment failures, significantly reducing downtime and maintenance costs [1].

AI-Driven Predictive Maintenance. AI and ML algorithms process vast amounts of data from sensors, logs, and other sources to identify patterns and anomalies,

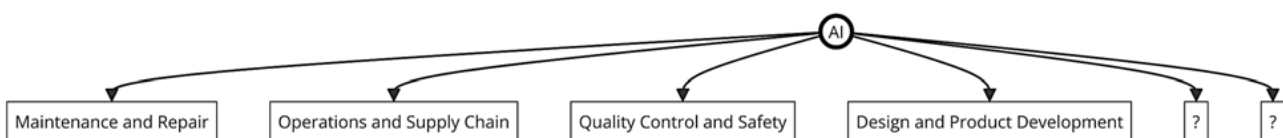


Figure 1 – Possible directions of use AI in industry

predicting equipment malfunctions before they occur. This proactive approach has become a cornerstone of modern predictive maintenance strategies, enhancing accuracy and providing actionable insights for maintenance teams.

Leveraging Multisource Data Analysis. Predictive maintenance now employs multisource data analysis, combining sensor data, historical records, and external databases to offer a comprehensive assessment of equipment health. This holistic view allows for more detailed and accurate predictions.

Predictive Maintenance as a Service (PMaaS). The rise of PMaaS has democratized predictive maintenance, making it accessible to smaller companies without substantial capital investment. PMaaS providers offer scalable solutions, encompassing data collection, analysis, and maintenance recommendations, allowing a broader range of companies to benefit from advanced predictive maintenance technologies.

Integration with Enterprise Resource Planning (ERP) Systems. Integrating predictive maintenance with ERP systems has streamlined maintenance management. This integration provides real-time data insights, enabling manufacturers to optimize maintenance schedules, reduce unscheduled downtime, and enhance overall operational efficiency.

The Role of Digital Twins in Maintenance Simulation. Digital twins, or virtual replicas of physical equipment, are transforming maintenance simulation. Manufacturers use digital twins to test various scenarios, optimize maintenance strategies, and anticipate maintenance needs. This technology enhances equipment reliability and reduces costs by enabling data-driven decision-making.

Predictive maintenance increases equipment uptime and productivity, reduces maintenance expenditure, and improves workplace safety. By proactively addressing maintenance issues, industrial manufacturers can enhance operational efficiency, reduce risks, and ensure employee safety.

The future of predictive maintenance in industrial manufacturing is promising. With the integration of AI and ML, the rise of PMaaS, ERP system synergies, and digital twin technology, manufacturers are poised to achieve unprecedented operational efficiency and safety improvements. Embracing these advancements positions enterprises at the forefront of technological innovation in industrial manufacturing.

2. Operations and Supply Chain. In the competitive landscape of industrial operations, AI has become a driving force in enhancing efficiency and agility in operations and supply chain management. By integrating AI, industries are empowered to navigate complex supply networks, optimize workflows, and respond swiftly to market changes [2].

AI significantly enhances operational efficiency by automating routine tasks and optimizing operational workflows. Machine learning algorithms analyze vast amounts of data to identify patterns and inefficiencies, allowing industries to streamline processes and increase overall productivity. For example, generative AI models have been instrumental in transforming supply chain management, leading to improved efficiency, cost savings, and better operations [3].

AI transforms supply chain management by offering increased transparency and visibility, thus enabling better forecasting and demand planning. By analyzing historical data and identifying trends, AI models make accurate predictions about future demand, helping companies optimize production and distribution strategies.

Generative AI is revolutionizing procurement processes by enabling more effective risk assessment of suppliers and monitoring real-time data sources for early warnings of emerging risks. This data-driven analysis allows procurement teams to minimize supply chain disruptions and ensure stable, ethical, and reliable supply bases.

While AI offers substantial benefits, its implementation in operations and supply chain management comes with challenges, including data privacy and security, high implementation costs, and integration with legacy systems. Companies need to address these challenges to harness AI's full potential effectively.

The future of AI in operations and supply chain management is incredibly promising, with predictions indicating significant advancements and increased adoption. By 2026, 75% of large enterprises are expected to have adopted «intralogistics smart robots» in their warehouses, and more than 75% of commercial supply chain management application vendors will deliver AI embedded in their applications [3].

The integration of AI into operations and supply chain management is essential for industrial competitiveness. AI not only optimizes existing processes but also opens doors to new possibilities and innovations, ensuring industries remain agile, efficient, and sustainable in an ever-evolving marketplace.

3. Quality Control and Safety. In recent years, AI has significantly transformed quality control and safety in industrial operations, impacting product integrity and workforce welfare. AI enhances precision and predictive capabilities in these areas, marking a new era in industrial operation [4].

AI algorithms, trained on vast datasets, have revolutionized quality control by detecting defects and irregularities with unparalleled accuracy. These systems analyze images, sensor data, and operational parameters to identify issues in real-time, ensuring product consistency and minimizing waste.

Predictive Safety and Risk Management. AI's predictive analytics plays a critical role in safety. By analyzing historical accident data and current operational metrics, AI models can predict potential safety hazards. This proactive approach enables industries to implement preventive measures, significantly reducing the risk of accidents and ensuring a safer working environment.

Cobots and AI in Quality Inspection. The integration of collaborative robots (cobots) and AI for quality inspection represents a major innovation in manufacturing. Cobots, working alongside AI, leverage their respective strengths to enhance productivity and optimize manufacturing processes. This collaboration is crucial in automated inspection systems, where AI algorithms continuously improve defect-detection capabilities, leading to high-quality control and defect detection [5].

While AI brings numerous benefits to quality control and safety, challenges such as data privacy, security, and

high implementation costs persist. Furthermore, integrating AI with legacy systems poses significant challenges that need to be addressed for effective deployment.

The future of AI in quality control and safety looks promising, with advancements in machine learning, computer vision, and sensor technology. AI systems will become more sophisticated, further enhancing their ability to detect quality and safety issues. Additionally, the integration of AI with other technologies like the Internet of Things (IoT) will enable more comprehensive monitoring and management of quality and safety in industrial settings.

AI's integration into quality control and safety represents a significant step forward for industrial operations. It not only enhances product quality and ensures consistent compliance with safety standards but also fosters a culture of proactive risk management. As AI continues to evolve, its role in ensuring quality and safety in industrial environments is set to become more pivotal, making industries more resilient, efficient, and safe.

4. AI in Design and Product Development. The integration of Artificial Intelligence in design and product development has marked a significant shift in how industries approach innovation and customization. AI's capability to process complex datasets, identify patterns, and predict trends has opened up new frontiers in designing products that are efficient and closely aligned with market demands and consumer preferences.

AI is instrumental in analyzing consumer preferences, market trends, and performance data to suggest product enhancements and innovations. Advanced algorithms can simulate countless design scenarios, helping designers optimize products for performance, aesthetics, and cost-effectiveness. AI-driven design tools have become indispensable in industries like automotive and consumer electronics, contributing to the design of safer, more efficient vehicles, and user-friendly devices [6].

AI-Driven Design Processes. In the design phase, AI plays a critical role in analyzing various design parameters and consumer data. AI algorithms can simulate and test multiple design variations quickly, identifying the most efficient designs in terms of materials, functionality, and aesthetics. This process not only speeds up the design phase but also ensures that the final products are more likely to succeed in the market [7].

Customization and Consumer-Centric Products. AI enables the offering of personalized products by analyzing consumer data and preferences, tailoring products to meet specific customer segments' needs. This level of customization, previously unattainable at scale, is now feasible thanks to AI's data processing capabilities.

AI in Enhancing Product Development Efficiency. AI reduces the time and cost involved in product development. By automating routine tasks in the development process and using predictive models to foresee potential design flaws, AI accelerates the development cycle, crucial in industries where staying ahead of technological trends and consumer expectations is key to maintaining competitiveness.

In the automotive industry, AI has been used to design more aerodynamic and fuel-efficient vehicles. In consumer electronics, AI has developed ergonomic and user-friendly interfaces. AI's role in revolutionizing design and product development is pivotal and growing, enabling

faster, more efficient, and consumer-focused product development [7].

While AI brings numerous benefits to design and product development, challenges such as ensuring data privacy and managing the complexity of AI models persist. Advancements in AI promise even more sophisticated applications in product design and development. The integration of AI with emerging technologies like 3D printing could further revolutionize how products are designed and manufactured.

AI's role in transforming design and product development is pivotal and growing. By enabling faster, more efficient, and consumer-focused product development, AI is not just an enabler but a catalyst for innovation in various industries. As AI technology continues to evolve, its potential to further enhance design and development processes seems boundless, opening up new possibilities for innovation and customization in industrial products.

5. End-to-End Optimization with AI in Industry. Implementation of Artificial Intelligence (AI) has brought a transformative approach to achieving end-to-end optimization in the industrial sector, enabling industries to fine-tune every aspect of their operations for maximum efficiency and effectiveness [8; 9].

AI's role in streamlining operations has become more critical in 2023, with generative AI tools increasingly used in marketing and sales, product and service development, and service operations. These AI high performers, organizations that attribute a significant portion of their EBIT to AI use, are leading the way in leveraging AI for product and service development, including product-development-cycle optimization and new AI-based product creation.

In supply chain management, AI is creating more resilient and efficient networks. Predictive analytics help forecast demand accurately, optimize inventory levels, and select the best logistics routes, thereby ensuring a smoother and more efficient supply chain. The integration of AI into supply chain management is expected to become a standard practice, with AI high performers already using AI more often than others in risk modeling and supply chain management.

Despite the significant opportunities AI presents for end-to-end optimization, challenges remain, particularly in terms of integration with existing systems and the need for large-scale data processing capabilities. Additionally, the rapid advancement of AI, especially in generative AI, is outpacing current regulations and ethical considerations. As AI becomes more integrated into operations, companies must navigate these challenges effectively [8].

Looking ahead, AI is expected to become even more sophisticated in its ability to optimize industrial operations. The integration of AI with emerging technologies like the Internet of Things (IoT) and blockchain is predicted to usher in a new era of hyper-connected, transparent, and efficient industrial ecosystems. However, increased regulation and a focus on explainable AI will shape the development and deployment of these technologies [10].

AI's impact on end-to-end optimization in industry is profound and far-reaching. By enabling smarter, data-driven decision-making and automating complex processes, AI is helping industries achieve unprecedented

levels of operational efficiency. As AI technology continues to advance, its role in shaping the future of industrial operations is poised to grow even further, promising more integrated, adaptive, and efficient industrial ecosystems.

6. Emerging Areas and Future Trends in AI for Industry. The landscape of Artificial Intelligence (AI) in industrial applications is rapidly evolving, with new trends and technologies emerging at an unprecedented rate. The integration of AI into various industrial sectors is not only optimizing existing processes but also paving the way for innovative applications and future developments [11].

One significant trend is the growing use of AI in autonomous systems and robotics. For example, next-gen technologies will make a major impact across industries in the coming year, emerging as the linchpin in autonomous vehicles and intelligent traffic management systems, and fueling smart factories and autonomous logistics industries, pushing the boundaries of efficiency and agility [12].

AI's role in sustainable and green technologies is another emerging area. AI is being used to optimize energy consumption, manage waste, and enhance renewable energy production. This application aligns with global efforts towards sustainability and reduced carbon footprints, making industries more environmentally friendly and efficient.

In consumer-facing industries, AI is revolutionizing customer interaction and experience. The synergy between conversational and generative AI will deepen, enhancing AI accessibility through open-source movements and multilingual language models. The rise of multimodal AI in customer support will mark significant advancements, as chatbots evolve beyond text, embracing dynamic, human-like interactions [8].

AI's predictive analytics are increasingly applied to enhance workplace health and safety. By analyzing data from various sensors, AI can identify potential safety hazards, enabling industries to implement preventive measures. This is particularly crucial in sectors like mining and manufacturing, where workplace hazards are prevalent.

The integration of AI with the Internet of Things is set to create smarter, more interconnected industrial environments. This convergence will enable real-time data collection and analysis, leading to more responsive and adaptive industrial systems. The combination of AI and IoT holds immense potential for future industrial applications.

AI's ability to analyze vast amounts of data and provide strategic insights is expected to play a more significant role in decision-making and strategic planning in industries. This will assist in identifying market opportunities, foreseeing potential challenges, and making more informed decisions [9].

The future of AI in industry is marked by continuous innovation and expansion into new domains. As AI technology advances, its applications are expected to become more diverse and integrated into various aspects of industrial operations. The emerging trends in AI, such as in autonomous systems, sustainable technologies, customer experience enhancement, and IoT integration, point towards an AI-driven industrial revolution.

Conclusions. Artificial Intelligence is profoundly reshaping various industries, significantly impacting maintenance and repair, operations, supply chain, quality control, safety, design, product development, and end-to-end optimization. AI-driven predictive maintenance is transforming industrial manufacturing by enhancing equipment reliability and reducing costs through data-driven decision-making. In operations and supply chain management, AI optimizes processes, improves efficiency, and offers increased transparency and agility. Quality control and safety benefit from AI's predictive capabilities and precision, notably in defect detection and risk management. AI in design and product development leads to efficient, consumer-centric innovations, tailoring products to specific market demands. Lastly, AI fosters end-to-end optimization in industry, enabling smarter decision-making and automation of complex processes, setting the stage for an integrated, adaptive, and efficient industrial future.

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ТРАНСФОРМАЦІЯ ПРОМИСЛОВОСТІ ЗА ДОПОМОГОЮ ШТУЧНОГО ІНТЕЛЕКТУ: ПРАКТИЧНІ АСПЕКТИ

У статті, на основі останніх досліджень вчених, експертів, журналістів досліджується зростаюча роль штучного інтелекту (ШІ) в різних промислових секторах, та його революціонізуючий вплив на підвищення ефективності управління процесами. Основна увага зосереджена на можливостях ШІ аналізувати великі масиви даних, виявляти закономірності та приймати обґрунтовані рішення, що кардинально змінює сфери від виробництва до охорони здоров'я. У статті аналізуються існуючі чотири основні напрямки використання ШІ у промисловості, зокрема його вплив на покращення обслуговування обладнання, підвищення ефективності операційної діяльності, покращення якості та дизайн і розробку продукту. Першим розглядається AI-кероване прогностичне технічне обслуговування в промисловому виробництві, яке змінює підходи до обслуговування обладнання завдяки використанню алгоритмів ШІ. Аналіз даних та машинне навчання, створення симуляцій, поєднання прогностичного обслуговування з системами управління підприємством, дозволяє суттєво покращити рівень обслуговування. Далі висвітлюється роль ШІ у трансформації управління ланцюгами постачання та логістики, акцентуючи на ефективності прийняття управлінських рішень на основі аналізу великих масивів даних, що дозволяє більш детально прогнозувати, робити закупки, організовувати складське господарство. Стаття також охоплює впровадження ШІ у сфері якості та безпеки, зокрема в контексті контролю якості та управління ризиками. Розглядається інтеграція колаборативних роботів (коботів) та ШІ у процеси контролю якості, що є значним нововведенням у виробництві. Окремий акцент робиться на використанні ШІ в дизайні та розробці продукції, де ШІ допомагає аналізувати споживацькі переваги та ринкові тенденції для створення ефективних та відповідних ринковим вимогам продуктів. На закінчення, стаття висвітлює перспективи розвитку ШІ у промисловості, його можливості в подальшій оптимізації виробничих процесів, що також включає автоматизацію комплексних процесів та подальший розвиток прийняття рішень на основі аналізу даних. Матеріал статті підводить до висновку, що запровадження ШІ в управлінні в промисловості покращує ефективність поточних процесів та формує майбутнє цієї сфери.

Ключові слова: штучний інтелект, промисловість, операційна ефективність, прогностичне технічне обслуговування, наскрізна оптимізація.