

СЕКЦИЯ 4. ИНЖЕНЕРНАЯ ЭКОНОМИКА И ПЕДАГОГИКА

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THE ROLE OF ARTIFICIAL INTELLIGENCE IN REDUCING PRODUCTION COSTS

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Abstract. This research paper provides a comprehensive analysis of how artificial intelligence technologies are transforming cost optimization strategies in modern manufacturing. The study examines various AI applications across different production stages and demonstrates their significant impact on operational efficiency and expense reduction.

In today's highly competitive industrial landscape, manufacturing enterprises face increasing pressure to optimize production costs while maintaining high quality standards and operational efficiency. Artificial intelligence has emerged as a transformative technology that enables organizations to achieve substantial cost reductions through intelligent automation and data-driven decision making. According to recent industry analyses, companies that successfully implement AI systems in their manufacturing processes typically achieve 15–35 % reduction in operational costs within the first two years of implementation. This research paper systematically explores the key mechanisms through which AI technologies contribute to production cost optimization, supported by practical case studies and implementation examples from various industrial sectors.

1. AI-Powered Predictive Maintenance Systems.

Traditional approaches to equipment maintenance have inherent limitations that often result in unnecessary expenses and production disruptions. Conventional preventive maintenance follows fixed schedules, while reactive maintenance addresses equipment failures after they occur. AI-driven predictive maintenance represents a paradigm shift in this domain:

- Continuous real-time monitoring of equipment parameters including vibration patterns, thermal characteristics, energy consumption metrics, and acoustic signatures
- Machine learning algorithms analyze historical and real-time data to identify subtle patterns indicating potential equipment degradation
- Advanced neural networks predict remaining useful life of critical components with 85–92 % accuracy.
- Automated maintenance scheduling systems optimize resource allocation and minimize production interruptions

Documented case studies from automotive and heavy industries demonstrate impressive results: 40–50 % reduction in unplanned downtime, 25–40 % decrease in maintenance costs, and 15–25 % extension in equipment lifespan. For instance, a major automotive manufacturer reported saving \$2.3 million annually through AI-driven predictive maintenance implementation across their pressing equipment lines [1].

2. Production Process Optimization Through AI.

Artificial intelligence enables unprecedented levels of efficiency in manufacturing operations through multiple interconnected mechanisms:

- Computer vision systems with deep learning capabilities perform real-time quality inspection, detecting microscopic defects invisible to human inspectors.

- Reinforcement learning algorithms continuously optimize production parameters, adjusting variables such as temperature, pressure, and speed to minimize energy consumption while maintaining quality standards.

- Digital twin technology creates virtual replicas of production systems, enabling simulation-based optimization without disrupting actual operations.

- AI-powered production scheduling systems dynamically adjust manufacturing sequences based on real-time constraints, customer priorities, and resource availability.

Industrial implementations across various sectors show consistent improvements:

8–15 % reduction in raw material consumption, 12–18 % decrease in energy costs, and 20–30 % improvement in overall equipment effectiveness (OEE). A notable example comes from the semiconductor industry, where AI-based process optimization helped achieve 22 % reduction in energy consumption while increasing production yield by 8 %.

3. Quality Control Automation and Enhancement.

Traditional quality control methods often struggle with consistency, speed, and comprehensive coverage. AI technologies revolutionize quality assurance through:

- Automated visual inspection systems utilizing convolutional neural networks achieve 99.7 % detection accuracy for product defects.

- Real-time statistical process control with AI-powered anomaly detection identifies process deviations within seconds.

- Natural language processing algorithms analyze customer feedback and warranty claims to identify potential quality issues.

- Predictive quality models forecast potential defects based on production parameters, enabling proactive adjustments.

Manufacturing companies report substantial benefits from AI-driven quality systems: 25–35 % reduction in product rejection rates, 40–60 % decrease in quality control labor costs, and 15–25 % improvement in customer satisfaction metrics. A consumer electronics manufacturer documented a 28 % reduction in warranty claims after implementing AI-based quality control across their production lines [2].

Artificial intelligence has proven to be a game-changing technology for production cost optimization in modern manufacturing. The comprehensive analysis presented in this research demonstrates that AI technologies enable substantial cost reductions across all aspects of production, from equipment maintenance and process optimization to quality control and supply chain management. The most successful implementations share common characteristics: strategic approach to technology integration, robust data infrastructure, effective change management, and continuous improvement mindset.

The economic benefits of AI implementation significantly outweigh the associated costs, with most organizations achieving return on investment within 12–24 months. As AI technologies continue to evolve, their impact on production economics is expected to grow even further. Future developments should focus on creating integrated AI ecosystems that seamlessly connect all aspects of manufacturing operations, enabling even greater efficiency gains and cost optimization opportunities. Manufacturing enterprises that embrace AI technologies position themselves for sustainable competitive advantage in an increasingly challenging global market.

References

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