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Industry 4.0 in Transportation: Blockchain technology

Rebecca Neumannová[1], Katarína Repková Štofková [2]

1 University of Žilina, Žilina, Slovakia, neumannova1@stud.uniza.sk
2 University of Žilina, Žilina, Slovakia, katarina.repkova@uniza.sk

INTRODUCTION

✓ Background information and Market Context

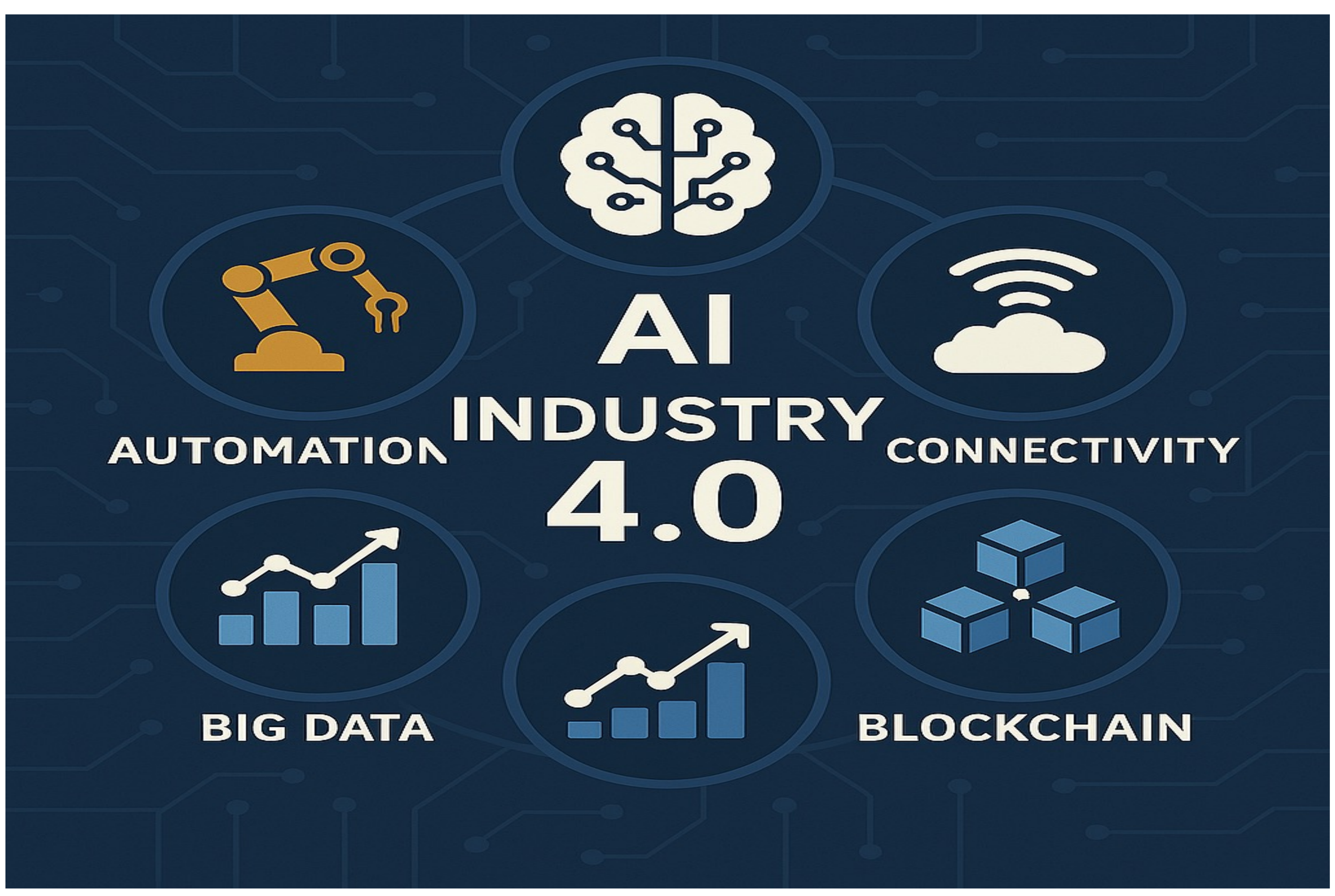
The Fourth Industrial Revolution (Industry 4.0) is driving significant digital transformation in the transportation sector. Emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain are reshaping supply chains, enhancing transparency, and addressing long-standing inefficiencies. Complex logistics networks require secure, decentralized, and real-time solutions.

✓ Problem Statement and Stakeholders

Traditional transportation systems face inefficiencies, lack of trust, fraud, and insufficient traceability. Stakeholders such as logistics providers, regulators, suppliers, and customers demand reliable, tamper-proof systems. Blockchain offers a promising framework to address these issues through decentralization, transparency, and immutability.

✓ Research Objectives and Expected Impact

The study aims to explore how blockchain improves transparency, traceability, and sustainability in transportation. It investigates integration with IoT and AI, identifies implementation challenges, and proposes strategic solutions. The expected impact includes more efficient logistics, reduced environmental footprint, and groundwork for future innovations under Industry 5.0.



MATERIALS, METHODS & IMPLEMENTATION

The research combines a literature review with qualitative analysis of real-world blockchain use cases (e.g., DHL, FedEx, Walmart). Data were sourced from academic journals, industry reports, and case studies. A conceptual framework was developed using inductive and deductive reasoning to outline integration pathways of blockchain with IoT and AI in transportation.

RESULTS

✓ Academic Findings and Innovation

Blockchain enhances visibility and trust in logistics through real-time tracking, smart contracts, and secure data sharing. Integration with IoT allows sensor-based monitoring (e.g., temperature-sensitive goods), while AI enables predictive analytics and route optimization. The research highlights reduced fraud, shorter delivery cycles, and increased data integrity.

✓ Practical Applications

Companies such as FedEx use blockchain for claims automation; Walmart traces food origin in seconds rather than days. These applications reduce administrative overhead, enable compliance with regulations, and support sustainable logistics practices through better resource management and reduced emissions.

CONCLUSION & IMPLEMENTATION PATH

Blockchain is a transformative technology for Industry 4.0 transportation systems. It boosts transparency, efficiency, and sustainability. However, high costs, scalability, and regulation remain key barriers. Recommended strategies include pilot projects, phased implementation, stakeholder collaboration, and education initiatives. Future research should focus on scalable architectures, cross-border regulatory alignment, and blockchain's role in the transition to Industry 5.0.

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