

Leveraging Digital Twins for Proactive Risk Management in Supply Chain Networks: An Empirical Examination of Automotive Industry Practices

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Abstract. The shift towards digital transformation in the automotive sector necessitates advanced methodologies for risk management within supply chains. This empirical study explores the application of digital twins as a proactive risk management tool in automotive supply chains. Utilizing a mixed-methods approach, we analyze qualitative data from key industry stakeholders and quantitative metrics from real-world applications. Our findings indicate that the integration of digital twins significantly enhances risk awareness and mitigation strategies, leading to improved resilience and efficiency. This study contributes to the strategic management literature by providing actionable insights into the operationalization of digital twins in risk management, paving the way for further research in this evolving field.

Keywords: digital twins, risk management, supply chain resilience, automotive industry, proactive strategies, technology integration, empirical analysis

Introduction

In today's rapidly changing global landscape, organizations face unprecedented challenges caused by globalization, market volatility, and technological advancements. These factors have precipitated a crucial need for effective risk management strategies, particularly in supply chain processes where disruptions can lead to significant financial loss and reputational damage. The automotive industry, a cornerstone of the global economy, exemplifies this necessity as it navigates complex supply networks that are increasingly vulnerable to internal and external shocks. In 2024-2026, as the industry continues to grapple with disruptions such as supply shortages, geopolitical tensions, and technological

shifts towards electric vehicles (EVs), adopting innovative risk management approaches becomes imperative. This paper aims to investigate the transformative potential of digital twins in enhancing proactive risk management within automotive supply chains. Digital twins, virtual representations of physical systems, offer real-time analytics and simulations that empower organizations to anticipate and mitigate risks before they escalate into crises. Through a rigorous empirical analysis, this study examines how digital twins are currently utilized in the automotive sector, focusing on their impact on risk perception, decision-making processes, and overall supply chain resilience. By exploring the practices of leading automotive manufacturers and suppliers, we aim to distill key insights and best practices that can inform strategic management stakeholders. This research is structured as follows: first, we provide a literature review that contextualizes the role of digital technologies in risk management, followed by a detailed methodology section outlining our data collection and analysis processes. Next, we present the findings, highlighting the pivotal role of digital twins in reshaping risk management paradigms in the automotive sector. Finally, we conclude with a discussion on the implications of our findings for both practitioners and researchers, as well as suggestions for future research avenues.

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References

1. Khatira, H., & Sarbiya, H. (2025). Regional integration and economic development aspects: The Case of Azerbaijan in the EU Eastern Partnership. *The Business & Management Review*, 16(4), 126-129.
2. Arkabaev, N., Rahimov, E., Abdullaev, A., Padmanaban, H., & Salmanov, V. (2025). Modelling and analysis of optimization algorithms. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi*, 9(1), 161-177.
3. Mamedov, S. E., & Rahimov, E. R. (2024). Information model of vehicle telematics data cluster collection using UAV. *Synchroinfo Journal*, 10(2), 21-27.
4. Барат, И. Э., Рагимов, Д. Р., Рагимов, Э. Р., & Велиев, Г. С. (2023). СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА НЕПАРАМЕТРИЧЕСКИХ, А ТАКЖЕ ИНТЕГРИРОВАННЫХ ПО ПАРАМЕТРУ СРЕДНЕВЗВЕШЕННЫХ ОЦЕНОК ГЕОЭКОЛОГИЧЕСКИХ ИЗМЕРИТЕЛЬНЫХ ДАННЫХ. *Вестник Забайкальского государственного университета*, 29(1), 44-50.
5. Рагимов, Э. (2011). КВАЛИМЕТРИЧЕСКИЕ ПОКАЗАТЕЛИ БЕЗОПАСНОСТИ ПРОГРАММНЫХ КОМПЛЕКСОВ, РЕАЛИЗУЮЩИХ СИСТЕМУ УПРАВЛЕНИЯ КОРПОРАТИВНЫМИ СЕТЯМИ. *Problems of information technology*, 2(1), 18-23.
6. Рагимов, Э. Р. О. (2011). Метрология элементов безопасности программных комплексов, реализующих систему защиты информации корпоративных сетей. *Вопросы защиты информации*, (2), 36-41.

7. Искендерзаде, Э. Б. О., Рагимов, Э. Р. О., & Джейхун, Р. (2024). НОВЫЕ КРИТЕРИИ ОЦЕНКИ ЭМИССИИ С И СО₂ В ВОЗДУХ АВТОМОБИЛЬНЫМ ТРАНСПОРТОМ. Природные системы и ресурсы, 14(2), 47-54.
8. Рагимов, Э. Р. (2012). Определение квалитетических показателей назначения программных комплексов в рамках эксплуатируемой корпоративной сети. Телекоммуникации, (8), 34-40.
9. Рагимов, Э. Р. О. (2012). Методология оптимальной идентификации расположения программных единиц в комплексе безопасных программ, реализующих систему защиты информации корпоративной сети. Вопросы защиты информации, (1), 51-57.
10. Рагимов, Э. Р. (2011). Роль программных комплексов в управлении безопасностью корпоративной информационной системы. Телекоммуникации, (12), 4-7.