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Doctoral Dissertation
Doctoral Program in Management and Production Engineering (37^{th}cycle)

Enabling Artificial Intelligence Techniques at Operational Level

Applications in Heavy Vehicle Rollover, EV Tariffs Optimization, and SMEs' Risk Assessment

By

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Declaration

I hereby declare that the contents and organization of this dissertation constitute my own original work and this does not compromise in any way the rights of third parties, including those relating to the security of personal data.

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Abstract

This dissertation explores how artificial intelligence (AI) techniques can drastically reduce costs and times in three contrasting yet methodologically linked domains: heavy vehicle rollover prevention, electric vehicle (EV) tariff determination, and Small and Medium Enterprises (SMEs) governance evaluation. Despite their differences, each domain employs a highly comparable three-step data-driven pipeline—*data acquisition*, *data analysis*, and *AI-based solution development*—to address pressing time and cost constraints.

Chapter 1 sets the scene by underscoring the universal importance of time and cost optimization in industrial and organizational processes. It pinpoints the common research gap: the need for advanced AI tools that can process large, diverse datasets swiftly and accurately to inform critical, real-time decisions.

In Chapter 2, a synthetic-data–based approach demonstrates how Long Short-Term Memory (LSTM) networks can reliably predict heavy vehicle rollovers. The generation of high-fidelity simulations reduces the reliance on extensive on-field tests, thereby cutting both testing times and associated expenses.

Chapter 3 addresses EV pricing through a bi-level optimization model, capturing the conflict between providers' revenue goals and users' cost expectations. Although the research is still in development, AI surrogates, trained on optimal solutions from this model, can potentially achieve near-instant tariff recommendations—significantly lowering computational costs and decision turnaround times compared to direct optimization.

Chapter 4 evaluates governance in SMEs using non-financial data (e.g.: board composition, ownership, and managerial indicators). Leveraging machine learning methods, it offers rapid assessments of bankruptcy risk, a tool that can preempt resource-draining insolvency procedures and enable timely organizational reforms.

Finally, Chapter 5 synthesizes these findings, stressing the methodological parallels: large-scale or synthetic *data acquisition*, rigorous *data analysis*, and targeted *AI solution deployment*. Across all cases, the research demonstrates a consistent pattern: AI-driven frameworks accelerate processes, minimize waste, and support data-informed strategies. These insights affirm the transformative power of integrating simulation, machine learning, and optimization to streamline operations in time-sensitive, cost-conscious environments.