Contribution ID: **99** Type: **Apresentação regular**

A Hybrid Framework for the Integrated Production and Routing Problem with Sequence-Dependent Setups and Multi-Period Constraints

This work addresses the Integrated Production Routing Problem (IPRP), a challenging combinatorial optimization problem inspired by the real-world operations of a Brazilian furniture manufacturer. The IPRP involves coordinating production and distribution decisions over a finite planning horizon, divided into periods, for multiple products characterized by heterogeneous attributes, such as weight, size, and number of components. This IPRP incorporates several constraints, including sequence-dependent setups, safety stocks and limited production capacity during periods, heterogeneous vehicle fleets, multi-period routing, and customers with multiple time windows and deadlines. The objective is to minimize the total cost, which comprises setup costs, inventory holding, and transportation expenses. This integration of production and distribution decisions introduces temporal and spatial interdependencies rendering the problem NP-hard and computationally intractable for realistic instances when using exact methods. To tackle this problem, we propose a hybrid approach that combines a Variable Neighborhood Search metaheuristic with an embedded Integer Programming model. The proposed approach is evaluated through extensive computational experiments on benchmark instances, demonstrating its effectiveness in solving the IPRP and handling its inherent combinatorial complexity.

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Session Classification: Session 4.4 - Operations management and logistics