PhD Topic – Additional One-Page Description

AI-Enhanced Optimization of Sustainable Multi-Site Production and Multi-Echelon Distribution

Target theme	Supervisor	Host
VI-3	Raca Todosijevic, Associate Professor - HDR	LAMIH UMR CNRS 8201 – INSA Hauts-de-France

Context. In multi-site industrial networks, production planning, site specialization, and transportation are still often optimized separately. This leads to under-filled trucks, weak coordination between sites, higher logistics costs, and avoidable CO2 emissions.

Scientific challenge. The project addresses a key methodological lock: integrating production decisions, industrial site specialization, real loading-rate constraints, and multi-echelon distribution within a single decision framework.

Why theme VI-3?. The topic targets sustainable industrial engineering by jointly improving production, resource efficiency, transport organization, and environmental performance in industrial distribution systems.

Main objective. Develop an AI-enhanced optimization framework able to minimize CO2 emissions and transport costs while improving service level and loading-space utilization in large-scale industrial networks.

Methodological approach

- Integrated modeling of production allocation, site roles/specialization, loading constraints, and multi-echelon routing.
- Hybrid solution methods combining mathematical programming, decomposition, metaheuristics/matheuristics, and learning-assisted search.
- Large-scale computational experiments and sensitivity analyses on representative industrial instances.
- Validation through decision-support scenarios showing trade-offs among cost, service quality, truck fill rate, and CO2 emissions.

Expected scientific contributions and impact

- New integrated optimization models at the interface of production and logistics.
- Scalable AI-enhanced solution procedures for complex industrial distribution networks.
- Managerial insights on when joint production-distribution planning creates the largest environmental and economic gains.

Expected background of the candidate. Operations research, mathematical optimization, network design, vehicle routing, metaheuristics/matheuristics, and sustainable logistics.

Indicative references

- Aloullal, A., Saldanha-da-Gama, F., & **Todosijevic, R.** (2023). Multi-period single-allocation hub location-routing: Models and heuristic solutions. European Journal of Operational Research, 310(1), 53-70.
- Gendron, B., Hanafi, S., & **Todosijevic, R.** (2018). Matheuristics based on iterative linear programming and slope scaling for multicommodity capacitated fixed charge network design. European Journal of Operational Research, 268(1), 70-81.
- Hrabec, D., Hvattum, L. M., & Hoff, A. (2022). The value of integrated planning for production, inventory, and routing decisions: A systematic review and meta-analysis. *International Journal of Production Economics*, *248*, 108468.