CESI LINEACT

Title: **Green-JIT²** - Just-in-Time Organization Method for Sustainable Integrated Production and Delivery Scheduling

Scientific Domains: Science and Technology; Data Science

Keywords: Industry 4.0; Supply Chain; Production & Transportation; Electric Vehicles; Scheduling; Artificial Intelligence

Supervision

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Presentation of the subject

Thesis project

In today's competitive manufacturing landscape and the increasing diversification of customer demand, improving the efficiency and flexibility of the supply chain has become crucial. Indeed, these challenges raise major concerns for production managers. Companies have thus adopted new strategies for managing their supply chain to cope with the uncertainty caused by the demand variability. The Build-To-Order (BTO) model allows, among other things, improving efficiency since production is better matched to demand [1]. In light of these challenges, it is essential to manage the supply chain so as to guarantee the flexibility of various operations. Concepts such as Just-In-Time (JIT) are widely used to reduce logistics costs. However, such approaches imply the need to meet deadlines, and may prove useless if the supply chain is not properly managed. Hence, we have considered a centralized management of production and transportation scheduling decisions [2].

In order to reflect real-life situations, we consider dynamic, intelligent supply chain management, taking into account urgent orders, customer cancellations, as well as potential breakdowns and maintenance. To effectively react to these various unpredictable factors, the use of artificial intelligence (AI) to predict customer demands will enable companies to be more flexible, and to make full use of JIT production strategies. This will be achieved through the integration of customer demand forecasts, by studying time series based on orders history. To the best of our knowledge, very few studies have been dedicated to this particularly promising subject. In addition, by coordinating the different phases of the supply chain, its environmental impact can be better controlled, using intelligent order processing and grouping techniques designed to reduce carbon footprints and empty miles. As a further measure, we are considering the use of electric vehicles in addition to conventional ones, in order to encourage the transition towards renewable energies and ensure the sustainable use of the proposed method. As a result, additional constraints [3] related to recharging times, the availability of charging stations and vehicle autonomy distances will be taken into consideration.

The objective of the thesis is to review the latest research on the coordination of production and transportation scheduling decisions, as well as research related to the integration of electric vehicles as means of delivery. It involves modeling the supply chain considering the various constraints and objectives of this project (economic and environmental) and developing dynamic optimization algorithms that incorporate real-time information to account for urgent orders, cancellations, etc. Initially, we consider a single production line with a defined number of customers to be delivered, along with their characteristics such as the number of orders to be fulfilled, processing times, etc. Handling unforeseen orders will be taken into account by integrating real-time information from

customers, the status of vehicles ensuring product delivery and their availability, as well as the status of production machines.

Moreover, techniques based on Artificial Intelligence (AI) will be used to improve the functioning of the selected resolution methods [4]. These techniques can be integrated into optimization methods using different approaches: (1) Learning uncertain and missing data to incorporate appropriate constraints into the model, (2) During the selection and optimization process to enforce optimality conditions and converge more effectively towards the optimal solution, (3) In the process of validating algorithms, ensuring parameter characteristics.

Context

Research team

CESI LINEACT (UR 7527), Digital Innovation Laboratory for Companies and Apprenticeships for the Competitiveness of Territories, anticipates and accompanies technological changes in industry and construction. CESI's historical proximity to companies is a decisive element for our research activities, leading us to focus on applied research closely related to companies and in partnership with them. A human-centered approach coupled with the use of technologies, as well as territorial networking and links with education, have enabled the construction of transversal research that places humans, their needs, and their uses at the center of its issues and addresses the technological aspect through its contributions.

The research is organized into two interdisciplinary scientific themes and two application domains.

- Theme 1 "Learning and Innovation" which brings together cognitive, social and management sciences, as well as training and innovation sciences and techniques.
- Theme 2 "Engineering and Digital Tools" which brings together skills in the fields of digital sciences and engineering sciences. The main scientific objectives of this theme are relate to the modelling and optimization of systems, as well as data processing, data analysis and decision-making processes applied to both application areas.

These two teams develop their research in the two application domains of the "Industry of the Future" and the "City of the Future," supported by research platforms, mainly the Rouen platform dedicated to the Factory of the Future and the Nanterre platform dedicated to the Factory and Building of the Future.

Positioning in the Laboratory's Research Themes

The thesis project is part of Theme 2: Engineering and Digital Tools of the CESI LINEACT laboratory. It revolves around the application domain of the "Industry of the Future" and focuses on the modeling and optimization of systems, as well as the treatment and analysis of data related to decision-making processes applied to the industry of the future.

Thesis Organization

Financing: CESI East Region (50%) & Grand Est Region (50%)

Place of Work: Strasbourg

Start Date: 01/10/2023

Duration: 3 years

Recruitment Information

Modalities: Application review and interview.

Please submit your application (CV + Motivation Letter + transcripts of M1 and M2) to scaillard@cesi.fr and hnouinou@cesi.fr with the email subject: **"[Application] Green-JIT2".**

Your application should include:

- **A detailed curriculum vitae** of the candidate. In case of a break in the academic course, please provide an explanation.
- **A motivation letter** explaining the candidate's motivations for pursuing a doctoral thesis.
- **Results** of the two last years of study and corresponding transcripts.
- Any other relevant documents you consider useful.

Please send all the documents in a zip file titled "LASTNAME firstname.zip".
Applications will be processed in the order of their arrival, and this thesis offer will expire once a candidate has been selected.

Your Profile:

- The candidate should possess a M.Sc./M.Eng. Degree in computer Science/ industrial engineering / applied mathematics or other related fields.
- Proficient programming skills.
- Knowledge of operational research and combinatorial optimization, including heuristics, metaheuristics, and AI techniques.
- Autonomy, initiative, and curiosity.
- Ability to work in a team and good interpersonal skills.
- Attention to details.

References

[1] Taheri-Bavil-Oliaei, M., Zegordi, S. H., & Tavakkoli-Moghaddam, R. (2021). Bi-objective build-to-order supply chain network design under uncertainty and time-dependent demand: An automobile case study. Computers & Industrial Engineering, 154, 107126.

[2] Berghman, L., Kergosien, Y., & Billaut, J. C. (2023). A review on integrated scheduling and outbound vehicle routing problems. European Journal of Operational Research.

[3] Erdelić, Tomislav & Caric, Tonci. (2019). A Survey on the Electric Vehicle Routing Problem: Variants and Solution Approaches. Journal of Advanced Transportation. 2019. 1-48. 10.1155/2019/5075671.

[4] Ben-Ammar, O., Bettayeb, B., & Dolgui, A. (2019). Optimization of multi-period supply planning under stochastic lead times and a dynamic demand. International Journal of Production Economics, 218, 106-117.