Towards an Intelligent Reconfigurable Supply Chain 5.0 Based on Knowledge Graph and Machine Learning

Chaouki Saidi[1, 2,*], Nadia Hamani[1], Mounir Benaissa[2]

[1] Innovative Technologies Laboratory, Jules Verne Engineering School, Saint Quentin, France
[2] OLID-OASIS Laboratories, Higher Institute of Industrial Management of Sfax, Tunisia
* *chaouki.saidi@etud.u-picardie.fr*

In recent years, the world has become increasingly characterized by constant change and uncertainty. This requires traditional supply chain to adapt rapidly and efficiently. In this context, reconfigurable supply chain (RSC) has become a key response to unstable and complex environments. This adaptation relies heavily on effective knowledge management, which coordinates resources and decision-making capabilities within supply chain. Our research focuses on creating the basis for an RSC underpinned by advanced knowledge management. We began with an in-depth literature review of ontological approaches to supply chain management [1]. This analysis revealed the limitations of existing studies, particularly their inability to respond rapidly to changes in the operational context. It also emphasized the crucial role of knowledge management in any reconfiguration process. In this regard, the emergence of new knowledge representation and processing technologies, especially Knowledge Graphs (KG), marks a significant advancement. Knowledge graphs can be used to semantically structure and interconnect knowledge, and they can also support reconfiguration decisions by enabling its dynamic use. Based on this, we reviewed recent KG applications in supply chain management and identified their potential for modeling the complex and interconnected RSC entities. This led us to propose a modeling approach that aligns with the Supply Chain 5.0 principles [2]. Based on this model, we developed a methodology to select the most suitable configuration from a set of predefined alternatives. This method uses the TOPSIS technique to evaluate and recommend the configuration that is best suited to demand fluctuations [3]. As an extension of this research, we developed a formalization of dynamic supply chain reconfiguration. This formalization enables the automatic generation of best configurations in response to changes in demand and facilitates the alternatives evaluation without the need for predefined options [4]. To encourage the adoption of the Supply Chain 5.0 paradigm, we investigated integrating Large Language Models (LLMs), based on recent Artificial Intelligence (AI) advances. These models enable non-expert users to interact naturally with the KG, thereby making the evaluation and reconfiguration processes more accessible without technical complexity. Using LLMs in this way enhances human centricity in reconfigurable supply chains, positioning technology as a decision support tool rather than a replacement for human expertise [5]. We are working towards a future reconfigurable supply chain in which human and AI work together to create supply chains that are more resilient, intelligent and sustainable. From this perspective, we have proposed a research framework integrating all our contributions, including KG modeling, dynamic reconfiguration formalization, the AI role and advanced Technologies [6]. Our current work focuses on applying AI for intelligent supply chain reconfiguration using Machine Learning to predict changes and suggest suitable adjustments [7]. In conclusion, our research aims to lay the foundations for intelligent and self-reconfigurable supply chains that preserve human centricity by enhancing human-machine collaboration. This approach is aligned with the future Industry goals, in which human and technology coexist.

Références :

[1] **Saidi**, **C.,** Rolf, B., Hamani, N., Benaissa, M., Reggelin, T., Lang, S. (2025). A Semantic Framework: Ontology-Driven Knowledge Management for Reconfigurable Supply Chains in the Supply Chain 5.0 era, 11th IFAC Conference on Manufacturing Modelling, Management and Control, IFAC MIM2025. 30 June-3 July 2025, Trondheim, Norway, ***[Accepté].***

[2] **Saidi, C.**, Hamani, N., Benaissa, M., Rolf, B., Reggelin, T., Lang, S., (2025). Modeling Reconfigurable Supply Chains using Knowledge Graphs: towards Supply Chain 5.0, *Production Engineering*, Springer, 2025, **IF = 1.7**, https://doi.org/10.1007/s11740-025-01342-1

[3] **Saidi**, **C.,** Hamani, N., Benaissa, M. (2025). A novel Configuration Selection Approach based on Knowledge Graphs Enablers for Reconfigurable Supply Chain, Information Systems and e-Business Management, Springer, 2025, **IF = 2.3**, ***[soumis]***.

[4] **Saidi**, **C.,** Hamani, N., Benaissa, M., (2025). A novel Approach based on Knowledge Graph for Dynamic Supply Chain Reconfiguration considering Demand Fluctuations, International Journal of Production Research, Taylor and Frencis, 2025, **IF = 8.3**, ***[soumis]***.

[5] **Saidi**, **C.,** Yaddaden, A., Hamani, N., Benaissa, M. (2025). GraphRAG for Human Centricity in Supply Chain Reconfiguration, The International Conference on Intelligent and Fuzzy Systems, INFUS2025. 29-30 July 2025, Istanbul, Turkey, ***[Accepté]***.

[6] **Saidi**, **C.,** Hamani, N., Benaissa, M., Rolf, B., Reggelin, T., Lang, S. (2025). Towards Intelligent Supply Chain Reconfiguration: A Framework Integrating Dynamic Knowledge Graph and AI-Driven Optimization, 10th Changeable, Agile, Reconfigurable and Virtual Production Conference, CARV2025. 9-12 September 2025, Siegen, Germany, ***[Accepté]***.

[7] **Saidi**, **C.,** Yaddaden, A., Hamani, N., Benaissa, M. (2025). Machine Learning and Dynamic Knowledge Graph for Intelligent Supply Chain Reconfiguration: Graph Neural Networks Application, International Journal of Production Research, Taylor and Frencis, 2025, **IF = 8.3**, ***[En cours]***.