Guest editorial: Emerging trends in supply chain engineering towards global sustainability

The present state of affairs

The difficulties in getting the daily essentials to customers promptly during the COVID-19 pandemic have exposed major gaps and risks in the conventional supply chains. The crisis and the issues exposed, however, provided an opportunity for companies to reassess and remodel their supply chains by taking a more scientific and methodological approach (Queiroz *et al.*, 2020). Before COVID-19, the focus was mostly on supply chain optimization to reduce overall waste and increase overall operational efficiency. The COVID-19 crisis has now forced companies to work on building resilience, reducing risk, identifying shortages at the earliest during sudden spikes in demand and adopting sustainable strategies to ensure success in their supply chain operations (El Baz and Ruel, 2020).

Emerging advancements in technologies provide an opportunity to improve end-to-end supply chain performance (SCP) in response to situations such as COVID-19, and support organizations to increase supply chain resiliency, sustainability and agility (Ivanov and Dolgui, 2020). The supply chain risk indicators are more important in transforming a linear supply chain into a digital supply network (Manavalan *et al.*, 2020; Manavalan and Jayakrishna, 2019a, 2019b). It will allow organizations to improve the flow of information and collaborate easier than before. Supply chain engineering (SCE) is the use of mathematical models and methods to determine optimal strategies for managing the supply chain (Ravindran and Warsing, 2013). SCE intersects with multiple engineering specialties such as production engineering, industrial engineering, information systems engineering and software engineering (Goetschalckx, 2011). The methods followed in SCE practices are essential to build supply chain resiliency, collaboration and operational excellence. In addition, SCE enables optimally interconnecting IT, human resources, manufacturing centres, warehouses and logistics to achieve performance goals. One of the main sectors in the supply chain is the transportation sector. Heavy freight transportation and the efficient and strategic management of sea routes from an economic and environmental perspective has become a major concern (Jayakrishna *et al.*, 2022). Transportation is an important keystone in improving the supply chain resiliency. The most important qualities for supply chain resilience are responsiveness, readiness, flexibility and adaptability (Echefaj *et al.*, 2022). Also, commitment and communication are the highest maturity factors influencing resilience capabilities. With a proper hierarchical vision of capabilities and practices, the industries can increase the resilience. Strategic decision-making of management, accurate forecasting of demand, advanced manufacturing system in the organization and data integration tools are the critical drivers (Sathyan *et al.*, 2022). There is also the need to examine the environmental risks and benefits associated with any product or process so that improvements can be made during supply chain resilience (Vinodh and Jayakrishna, 2012). Supply chain resilience depends on sustainability of the product or process. Green SCM (GSCM) is one of the key concepts in sustainability. It was identified that "sustainable packaging" under the traits of GSCM had the best performance compared to other sustainability methods (Sahu *et al.*, 2022).

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The special issue

This special issue contains 13 articles pertaining to supply chain, sustainability, production and, supply chain resilience, supply chain engineering using mathematical models and approaches.

Contributions to the special issue

The articles published in this special issue set the tone by summarizing the extant literature on strategies to improve supply chain and supply chain engineering. The contribution of each section is presented in Table 1.

Echefaj *et al.* (2022) studied the supply chain resiliency during an unexpected disruption. The purpose of the study was to determine and rank the capabilities and practices necessary to maintain a resilient supply chain in the face of unforeseen disruptions. Key findings revealed that responsiveness, readiness, flexibility and adaptability were deemed the most crucial capabilities for ensuring supply chain resilience. Bandaranayake *et al.* (2022) developed a meta-model incorporating significant perspectives required for cross-border logistics (CBL) processes. The capacity of role activity diagrams (RADs) to depict all perspectives, including interactions in a single diagram, makes them particularly suitable for modelling CBL processes. RADs have been complemented with physical flow diagrams and methods to capture temporal dimension, enabling a comprehensive view of CBL processes and laying the foundation for insightful analysis.

Table 1. Accepted manuscripts and author

Manuscript title	Author
Application of AHP and G-TOPSIS for prioritizing capabilities and related practices for a mature and resilient supply chain during disruption	Echefaj *et al.* (2022)
Capturing cross-border logistics for analysis and improvement	Bandaranayake *et al.* (2022)
Modelling the drivers of responsiveness of automotive supply chain using an integrated fuzzy DEMATEL-ISM approach	Sathyan *et al.* (2022)
Can circular healthcare economy be achieved through implementation of sustainable healthcare supply chain practices? Empirical evidence from Indian healthcare sector	Vishwakarma *et al.* (2022)
Analysis of performance of COVID-19 vaccine supply chain in India	Nagarajan *et al.* (2022)
Improving the waste to energy supply chain through increased overall equipment effectiveness	Wijesinghe and Illankoon (2022)
Intertwining green SCM- and agile SCM-based decision-making framework for sustainability using GIVTFNs	Sahu *et al.* (2022)
The effect of supplier sustainability risk management strategies on supply chain performance	Silva *et al.* (2023)
Planning of a distribution network utilizing a heterogeneous fixed fleet with a balanced workload	Hettiarachchi *et al.* (2023)
Identifying the key influencing factors for the growth of air cargo demand	Karunathilake and Fernando (2023)
Artificial intelligence an enabler for sustainable engineering decision making in uncertain environment: a review and future propositions	Wankhede *et al.* (2023)
Achieving sustainability through multifaceted green functions in manufacturing	Rashid *et al.* (2024a, 2024b)
Role of information processing and digital supply chain in supply chain resilience through supply chain risk management	Rashid *et al.* (2024a, 2024b)

Sathyan *et al.* (2022) identified seventeen drivers for enhancing supply chain responsiveness and among them, the critical drivers are strategic decision-making, demand forecasting accuracy, advanced manufacturing systems and data integration tools. This integrated methodology will benefit the supply chain practitioners and automotive manufacturers to develop management strategies to improve responsiveness. Nagarajan *et al.* (2022) delved into the structure of the Indian vaccine supply chain during the Covid-19 pandemic. Through quartile and cluster analyses of secondary data, it was revealed that distinct responses among states during the pandemic waves, attributed to demographic variations and administrative efficiency affecting supply chain characteristics. The findings underscore the need for improved supply chain and last-mile delivery in large-scale vaccination efforts, offering vital insights for government and state-level initiatives.

Wijesinghe and Illankoon (2022) aimed to enhance the overall equipment effectiveness (OEE) of ABC Company's shredder operation, which supplies pre-processed industrial waste to a cement plant. Through a case study approach, the research identified availability and performance losses affecting the shredder system's OEE, using root cause analysis and Pareto analysis to pinpoint underlying issues. Three major loss factors were identified, and practical solutions were proposed to mitigate their effects, ultimately improving the machine's OEE and productivity. This OEE and productivity will have a direct impact on their supply chain engineering.

Sahu *et al.* (2022) developed a decision-support framework for identifying dominating measures in SCM. The degree of similarity approach and distance approach under the extent boundaries of GIVTFNs, are implicated in data analytics. The best performance score is identified by the "sustainable packaging" under the traits of GSCM. "Reutilization (recycling) and reprocessing" under GSCM in manufacturing and "Responsiveness and speed toward customers' needs" under ASCM are found difficult to attain. Silva *et al.* (2023) evaluated the adoption of four types of supplier sustainability risk management (SSRM) strategies, namely, risk avoidance (RA), risk acceptance (RAC), collaboration-based risk mitigation (CBM) and monitoring-based risk mitigation (MBM) in Sri Lankan apparel and retail industries, and to investigate their effect on SCP. Sri Lankan apparel and retail firms adopt RA and MBM strategies relatively more than CBM and RAC strategies, whereas there is no significant difference between the two industries in terms of the use of SSRM strategies.

Hettiarachchi *et al.* (2023) compared the performance of generic algorithms using a paired *t*-test, and results indicate that the GA outperforms in solution quality. Further scenarios are tested to explore alternative fleet compositions, with analysis conducted using ANOVA and Hsu's MCB methods, revealing that removing trucks with the lowest capacities improves average vehicle utilization and reduces travel distance. The adoption of metaheuristics, statistical analysis and scenario analysis offers significant methodological contributions to solving NP-hard distribution problems in supply chain engineering.

Karunathilake and Fernando (2023) pinpointed the factors influencing both passenger and cargo demand-driven networks, aiming to streamline the global supply chain. Using the analytical hierarchy process and regression analysis, a model was crafted using chosen variables to predict air cargo demand growth. Airport capacities and facilities are predominantly impacted by the air cargo transported by combi carriers. The model took into account variables such as the air connectivity index and air cargo demand at the destination.

Wankhede *et al.* (2023) analysed the current research trends to see the research collaboration between researchers and countries concerning the circular supply chain. Emerging research areas were identified by using structural topic modelling (STM). Rashid *et al.* (2024a, 2024b) findings illustrated that green supply chain practices positively

influence all used variables and provided a practical insight to practitioners to implement green practices in their supply chain networks for social, economic and environmental sustainability and compliance with SDG-12 and SDG-13. Rashid *et al.* (2024a, 2024b) also found that information processing capability and digital SC significantly and positively affect SC risk management and resilience. Also, supply chain risk management positively mediates the relationship between information processing capability and digital SC.

Thus, this special issue provides some valuable wisdom for supply chain researchers, practitioners and students by offering a narrow perspective of supply chain engineering, supply chain resilience and the importance of mathematical models in developing a resilient supply chain.

Concluding remarks

This special issue contributes to the sustainable supply chain literature by compiling a collection of interesting studies that describe the emerging trends in SCE towards global sustainability. Achieving resilience in supply chain management requires a multifaceted approach encompassing responsiveness, readiness, flexibility and adaptability. Furthermore, commitment and effective communication play pivotal roles in enhancing resilience capabilities, highlighting the importance of organizational culture and collaboration. Strategic decision-making, accurate demand forecasting, advanced manufacturing systems and data integration tools are identified as critical drivers by Sathyan *et al.* (2022), underlining the significance of proactive planning and technological integration.

Moreover, sustainability emerges as a fundamental aspect of supply chain resilience, with GSCM practices playing a crucial role. Sustainable packaging, in particular, is highlighted as a high-performing trait within GSCM, demonstrating the potential for environmentally conscious practices to enhance overall resilience. Integration of digital technologies into the supply chain is identified as another key factor in enhancing resilience, as it improves risk management and facilitates sustainability initiatives. Additionally, the impact of demographic variations and administrative efficiency during crises such as the COVID-19 pandemic underscores the need for adaptable and agile supply chain strategies. To address emerging challenges and optimize supply chain management, innovative analytical techniques such as STM and mathematical modelling are increasingly used. In essence, the convergence of responsiveness, sustainability, digital integration and operational efficiency forms the cornerstone of resilient supply chain management, enabling organizations to navigate uncertainties and disruptions while fostering long-term sustainability and competitiveness.

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About the Guest Editors

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