logistics

MDPI

Editorial

Supply Chain 4.0: New Generation of Supply Chain Management

Xue-Ming Yuan [1,*] and Anrong Xue [2]

[1] Singapore Institute of Manufacturing Technology, Agency for Science, Technology and Research (A*STAR), Singapore 138634, Singapore
[2] School of Computer Science and Communication Engineering, Jiangsu University, Zhenjiang 212013, China
* Correspondence: xmyuan@simtech.a-star.edu.sg

Industry 4.0 is the fourth industrial revolution, which began in the early years of this millennium with autonomous production using Cyber–Physical Systems (CPS), the Internet of Things (IoT) and the Internet of Services (IoS). Industry 4.0 has significantly influenced people's daily life in every aspect, from shopping to dining, from working to entertaining, from staying at home to overseas traveling, etc. It is changing and shaping people's lifestyles and living behaviors, even how people think and their mindset. Industry 4.0 has had a revolutionary impact to Supply Chain Management. With Industry 4.0 technologies, suppliers are intelligent, factories are autonomous, products are smart and customers are demanding all-round service and satisfaction. Industry 4.0 technologies enable the integration of processes and systems across companies and industrial sectors, creating new business models and value-generation opportunities. Enterprises and businesses are digitalized, profitable and sustainable. Manufacturing systems and services are real-time capable, interoperable, modular, decentralized, virtualized and service-oriented. Supply Chains are fully visible, connected and integrated. With the rapid growth of Industry 4.0 technologies, Supply Chain Management has been transforming to a new generation, Supply Chain 4.0.

Supply Chain 4.0 refers to a supply chain that is designed, planned, managed and optimized by using Industry 4.0 technologies. There are many research issues and challenges associated with Supply Chain 4.0, for example, how to leverage real-time Market Intelligence in order to model customer behaviors and more accurately predict future customer demand. How to use Data Analytics in relation to minimal stock inventory to maximize the customer service level? How to apply Machine Learning and Artificial Intelligent to allocate production capacity, schedule job orders and plan equipment maintenance to minimize the disruption of production lines? How to utilize Industry 4.0 technologies to select the right supplier for the right material at the right time? How to tap into Blockchain technology to share data and essential information between the parties across a supply chain? How to collaborate and coordinate the operations of supply chain partners in the environment of Industry 4.0?

Supply Chain 4.0 is a data-rich and complex system. From the available data, we can interpret what happened in the past, what is currently happening, what will happen in the future and what are the best actionable decisions. Data Analytics has become the backbone supporting supply chain performance evaluation, optimization and decision making, and driving the three typical flows: the material flow, financial flow and information flow of a supply chain. Based on the Data Analytics results, companies are able to achieve managerial insights and make optimal decisions to gain a competitive edge in their respective businesses. Data-driven supply chain analytics has been a research hotspot in the new generation of Supply Chain Management.

As it is beginning its journey, Supply Chain 4.0 research is currently being explored, defined and shaped. Literature reviews have connected Supply Chain 4.0 research to the

Citation: Yuan, X.-M.; Xue, A. Supply Chain 4.0: New Generation of Supply Chain Management. *Logistics* **2023**, *7*, 9. https://doi.org/10.3390/logistics7010009

Received: 18 January 2023
Revised: 19 January 2023
Accepted: 29 January 2023
Published: 1 February 2023

foundation of Supply Chain research, showing the linkages and continuation of Supply Chain Management, identifying the research gaps between conventional Supply Chain and Supply Chain 4.0 research and exploring the new research directions of Supply Chain 4.0. Industry applications and success cases demonstrate the applications and industrial value of Supply Chain 4.0 research. This Special Issue focuses on two streams of papers: review papers and case study papers. The Special Issue accepted eight papers that address various research and development issues and challenges facing Supply Chain 4.0 from both academic and industrial perspectives.

Inventory Management has been a very important topic in Supply Chain Management. By recognizing the role of inventory management in a supply chain and its importance, the review paper (8) contributed by Mashayekhy, Babaei, Yuan and Xue presents the impact of IoT technologies on inventory management in supply chains and conducts a comprehensive study to identify the research gap of applying IoT technologies to inventory management. The trend and potential opportunities of inventory management in the Industry 4.0 era are explored by analyzing the literature. The paper concludes that upgrading a supply chain into an integrated supply chain 4.0 is beneficial.

Logistics is the fundamental infrastructure to execute Supply Chain Management. The contribution (5) of Jafari, Azarian and Yu discusses the emerging concept that Industry 5.0 pushed forward the research frontier of the technology-focused Industry 4.0 to a smart and harmonious socio-economic transition driven by societies and technologies, where the role of the human in the technological transformation is the predominant focus. The contribution presents a comparative bibliometric analysis to show the connection and differences between Industry 4.0 and Industry 5.0 and their implications for smart logistics. A thorough content analysis is conducted to illustrate the features of smart logistics in Industry 5.0 concerning four areas, namely intelligent automation, intelligent devices, intelligent systems and intelligent materials. A research agenda is proposed for the purpose of identifying future research directions of smart logistics in Industry 5.0.

Additive manufacturing (AM) is bridging the digital and physical world as a 3D computer-aided manufacturing (CAM) method. The usage of AM has made supply chains simpler, more effective and more efficient. The contribution (1) of Debnath, Shakur, Tanjum, Rahman and Adnan summarizes the findings in the spare parts supply chain. It evaluates the potentiality and capability of AM in conceptualizing the entire supply chain and provides an overall view to make critical decisions on the spare parts supply chain design driven by Industry 4.0 technologies. The new-generation supply chain, Supply Chain 4.0, is able to remove the logistics barriers by reducing waste and improving capability and sustainability through implementing AM technologies.

In the context of Supply Chain 4.0, supply chain relationship management becomes one of the central enablers in improving supply chain performance. While the influences of globalization and digitalization on the supply chains are increasing, the power allocation within several markets is centralized to a small number of companies. The contribution (3) from Brinker and Haasis investigates the research gap concerning the impact of power asymmetries on the supply chain, in addition to digitalization trends. The contribution provides a comprehensive definition of the concept of power and develops a definition of Power in Supply Chain Management in general. The research gap is elaborated between power allocations and the digitalization of the supply chain.

Industry 5.0 is in an embryonic and ideal stage, and its technologies are entering the technology development roadmap. The contribution (2) by Frederico links the current knowledge to this new development and evidences the gap related to Industry 5.0 approaches for supply chain management. This contribution presents the four constructs of Industry 5.0: Industry Strategy, Innovation and Technologies, Society and Sustainability and Transition Issues. An alignment with the supply chain context is proposed, being the basis for the incipient Supply Chain 5.0 framework and its research agenda. The contribution provides insightful and novel concepts related to Industry 5.0 in the supply chain context and adds valuable insights to researchers and practitioners by approaching

the newest and revolutionary concept of the Industry 5.0 phenomenon in the supply chain context, which is an unexplored theme.

There are not many industry cases at the beginning of Supply Chain 4.0 research and development. Pleasantly, this Special Issue accepts three practical application papers on Supply Chain 4.0. The practical application paper (4) contributed by Shqair and Altarazi evaluates the status of small and medium enterprises (SMEs) concerning Industry 4.0 in Jordan. Four criteria are assessed, including Industry 4.0 readiness, maturity, drivers and barriers. It was concluded that Jordan needs country-scale initiatives for the implementation of groundbreaking Industry 4.0 technologies, incorporating government agencies, industrial parties and experts, relying on Industry 4.0 readiness and practice status as a starting point, and considering the influential drivers and barriers to steer the development process.

The Food Supply Chain is essentially important, especially during and after the COVID-19 pandemic. Food supplies and security are paramount to everyone. There are a lot of operational challenges and issues related to the food supply chain, in particular, for those products with a very short shelf life. The contribution (7) from Binsfeld and Gerlach investigates the impact of digital supply chain twins on the food supply chain by an extensive simulation study of a constructed organic food supply chain, quantifies the benefits of using a digital supply chain twin in the organic food supply chain and demonstrates an exemplary application of digital supply chain twins in the context of an organic food supply chain.

The Vegetable Supply Chain is one of the most fragile and volatile food supply chains. Industry 4.0 technologies are playing a very important role in digitizing the vegetable supply chain. The contribution (6) by Abbas, Amran, Hussain and Ma proposes a novel approach and a complete scientific classification of vegetable supply chain concerns relating to soft computing, presents a view of three delegate supply chains: cruciferous vegetables, dark green leafy vegetables and tomatoes, and assembles the scientific type in light of different parts to arrange vegetable supply chain issues as per how they can be demonstrated utilizing soft computing methodologies.

In Supply Chain 4.0, digitalization, visibility, connectivity and interoperability are integrated within all parties of the supply chain. The operational, tactical and strategic plans across the supply chain are digitally interlinked and real-time synchronized with a 360-degree view. The win–win partnerships are dynamic and sustainable, with agility, flexibility and responsiveness to uncertain business environments. New models and methods are advocated to implement Supply Chain 4.0 research and development. With the progress and implementation of Industry 4.0 technologies, it is anticipated that there will be more and more breakthroughs in models and methods of Supply Chain 4.0. Hopefully, this Supply Chain 4.0 Special Issue will serve as a helpful reference for Supply Chain 4.0 researchers and practitioners.

The contribution list of the Special Issue:

(1) Binoy Debnath, Md Shihab Shakur, Fahmida Tanjum, M. Azizur Rahman and Ziaul Haq Adnan, Impact of Additive Manufacturing on the Supply Chain of Aerospace Spare Parts Industry—A Review

(2) Guilherme F. Frederico, From Supply Chain 4.0 to Supply Chain 5.0: Findings from a Systematic Literature Review and Research Directions

(3) Janosch Brinker and Hans-Dietrich Haasis, Power in the Context of SCM and Supply Chain Digitalization: An Overview from a Literature Review

(4) Maram I. Shqair and Safwan A. Altarazi, Evaluating the Status of SMEs in Jordan with Respect to Industry 4.0: A Pilot Study

(5) Niloofar Jafari, Mohammad Azarian and Hao Yu, Moving from Industry 4.0 to Industry 5.0: What Are the Implications for Smart Logistics?

(6) Rizwan Abbas, Gehad Abdullah Amran, Irshad Hussain and Shengjun Ma, A Soft Computing View for the Scientific Categorization of Vegetable Supply Chain Issues

(7) Tom Binsfeld and Benno Gerlach, Quantifying the Benefits of Digital Supply Chain Twins—A Simulation Study in Organic Food Supply Chains

(8) Yasaman Mashayekhy, Amir Babaei, Xue-Ming Yuan and Anrong Xue, Impact of Internet of Things (IoT) on Inventory Management: A Literature Survey

Author Contributions: Conceptualization, X.-M.Y. and A.X.; methodology, X.-M.Y. and A.X.; writing—original draft preparation, X.-M.Y.; writing—review and editing, A.X. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.