Chapter 1
An Overview of Advanced Technologies for the Management of Disruptive Supply Chains

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Abstract Supply chain management (SCM) is the process of planning, coordinating, and controlling the flow of materials, information, and services from the source to the customer. SCM faces many challenges and uncertainties due to various factors such as demand fluctuations, supply disruptions, environmental regulations, geopolitical risks, and technological changes. This book examines how advanced technologies such as artificial intelligence, blockchain, cloud computing, the internet of things, and robotics can enhance supply chain management (SCM) in the post-Covid era. It focuses on five global manufacturing sectors and covers various SCM functions and aspects. It reviews the current literature and practice, identifies the benefits, challenges, opportunities, and best practices of using these technologies in SCM, provides empirical evidence and case studies from different industries and contexts, and offers practical recommendations and guidelines for SCM stakeholders. The book aims to help SCM practitioners, policymakers, and researchers to manage disruptive supply chains and achieve resilience.

1.1 Introduction

Supply chain management (SCM) is the process of planning, coordinating, and controlling the flow of materials, information, and services from the source to the customer. SCM is essential for creating value, enhancing customer satisfaction, and gaining a competitive advantage in today's global and dynamic business environment

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(Lambert et al. 1998). However, SCM also faces many challenges and uncertainties due to various factors such as demand fluctuations, supply disruptions, environmental regulations, geopolitical risks, and technological changes. These factors can have significant impacts on the performance, efficiency, and resilience of supply chains, especially in times of crisis such as the COVID-19 pandemic (Ivanovet al. 2020).

To cope with these challenges and uncertainties, SCM needs to leverage advanced technologies that can enable more agile, responsive, and sustainable supply chain operations. Advanced technologies refer to the innovative applications of digital, physical, and biological systems that can transform the way supply chains are designed, executed, monitored, and optimized. Some examples of advanced technologies for SCM include:

- *Supply chain resilience*: The ability of a supply chain to recover from disruptions and maintain its functionality and performance. Supply chain resilience can be enhanced by using technologies such as predictive analytics, artificial intelligence (AI), blockchain, and control tower approach that can provide better visibility, coordination, risk management, and contingency planning across the supply chain network (Hohenstein et al. 2015; Wieland et al. 2017).
- *Smart manufacturing*: The integration of advanced manufacturing technologies such as robotics, automation, additive manufacturing (3D printing), internet of things (IoT), big data analytics, cloud computing, and fog computing that can enable more efficient, flexible, and customized production processes. Smart manufacturing can improve the quality, productivity, and sustainability of supply chain operations by reducing waste, energy consumption, emissions, and costs (Christopher et al. 2004; Sheffi et al. 2005).
- *Industry 4.0 and 5.0*: The concepts that describe the current and future trends of industrial transformation driven by advanced technologies. Industry 4.0 refers to the fourth industrial revolution that is characterized by the convergence of cyber-physical systems that can communicate and cooperate through IoT and AI. Industry 5.0 refers to the fifth industrial revolution that is characterized by the collaboration of humans and machines that can enhance the creativity, innovation, and personalization of products and services.
- *Digitalisation*: The process of using digital technologies to create new or modify existing business processes, models, capabilities, and value propositions. Digitalization can enable more transparent, connected, and intelligent supply chains that can deliver better customer experiences and outcomes. Digitalization can also facilitate the adoption of green supply chain management (GSCM) practices that aim to reduce the environmental impacts of supply chain activities.

The main theme of this book is to explore how these advanced technologies can help SCM to manage disruptive supply chains and achieve resilience in the post-Covid era. The book's objectives are to:

- Review the current state of the art and practice of SCM about these advanced technologies,

- Identify the benefits, challenges, opportunities, and best practices of applying these advanced technologies in SCM,
- Provide empirical evidence and case studies from various industries and contexts on how these advanced technologies can improve SCM performance and resilience, and
- Offer practical recommendations and guidelines for SCM practitioners, policymakers, and stakeholders on how to implement these advanced technologies effectively and efficiently.

The book's scope covers five global manufacturing sectors: automotive, electronics, food & beverages, apparel, and pharmaceutical. These sectors are selected because they represent different characteristics and challenges of SCM in terms of product complexity, demand variability, supply uncertainty, regulatory compliance, environmental impact, etc. The book also covers different aspects and functions of SCM such as procurement, production, distribution, inventory, and logistics.

The book is organized into eleven chapters as follows:

This chapter: Introduction—This chapter provides an overview of the book's main theme, objectives, scope, methodology, and chapter summaries.

Chapter 2: Smart Manufacturing: A Review Toward the Improvement of Supply Chain Efficiency, Productivity, and Sustainability—This chapter reviews how smart manufacturing systems can revolutionize SCM by monitoring and tracking production processes in real-time, providing valuable data that improve and optimize operations and reduce downtime, waste, and energy usage.

Chapter 3: Revolutionizing Supply Chain Management: A Bibliometric Analysis—This chapter uses a bibliometric analysis tool to identify key authors and publications in the field of SCM and advanced technologies, and to detect patterns and trends in the literature.

Chapter 4: Supply chain resilience: A literature review and gap analysis—This chapter conducts a systematic literature review to examine the definitions, features, types, measures, theories, relationships, and effects of supply chain resilience strategies on SCM performance. It also identifies the research gaps and limitations in this field.

Chapter 5: Principal Lessons Learned from COVID-19: Prescriptive and Long-lasting Strategies for Sustainable Supply Chain Improvement—This chapter examines the lessons learned from the pandemic and proposes a long-lasting approach to address current SCM shortcomings. It suggests several prescriptive recommendations based on advanced technologies to enhance supply chain visibility, forecasting, risk management, traceability, and transparency.

Chapter 6: Impact of Digitalisation in Developing Procurement and Supply Chain Resilience in the Post-Pandemic Era—A Study of the Global Manufacturing Sector—This chapter investigates the impact of digitalization in developing procurement and supply chain resilience in the post-pandemic era within the context of the global manufacturing sector. It uses a qualitative approach based on interviews to gather and analyze data from different industries.

Chapter 7: Obstacles In Disruption and Adoption of Green Supply Chain Management (GSCM) Practices by Manufacturing Industries—This chapter explores the reasons that prevent the industrial sector of Karachi from adopting GSCM practices. It uses a literature review and the opinions of industry managers to identify the main obstacles and challenges.

Chapter 8: Improving Supply Chain Resilience with a Control Tower Approach Beyond Covid-19—This chapter analyzes the different types of supply chain control towers (CTs) and the challenges in implementing them. It presents interviews with four companies to tie the literature review to industry practice and discusses the results and implications.

Chapter 9: Phenomenological Study of Pharmaceutical Supply Chain in Pakistan: Innovative Approaches to Minimize Operational Inefficiencies—This chapter conducts a phenomenological study of the pharmaceutical supply chain in Pakistan, and identifies the innovative approaches to minimize operational inefficiencies. It uses an exploratory design and an in-depth interview method to collect and interpret data.

Chapter 10: Supply Chain Resilience during Pandemic Disruption: Evidence from the Healthcare Sector of Pakistan—This chapter investigates the impact of supply chain resilience in the healthcare supply chain of Pakistan when experiencing the COVID-19 pandemic disruption. It uses a qualitative approach based on interviews to collect and analyze data. It also identifies the key strategies of supply chain resilience in COVID-19 disruption.

Chapter 11: The readers of this chapter can expect to learn about, (i) the main contributions and implications of this book for SCM theory and practice, especially in the context of Covid-19 and its aftermath, (ii) the main limitations and challenges of using advanced technologies in SCM, such as standardization, interoperability, compatibility, skills, trust, security, privacy, ethics, regulation, governance, compliance, awareness, readiness, and willingness, (iii) the main directions and opportunities for future research on the relationship between advanced technologies and SCM, such as frameworks, models, standards, protocols, barriers, drivers, integration, adaptation, evaluation, and selection, and (iv) a conceptual model that illustrates the complex and dynamic relationship between advanced technologies and various aspects of SCM, such as integration, interoperability, compatibility, skills, roles, responsibilities, behaviors, ethical, legal, social, and environmental issues, effectiveness, efficiency, and return on investment.

1.2 Background

Supply chain management (SCM) has a long and rich history that can be traced back to the pre-industrial era when local and regional trade networks were established to exchange goods and services. However, the evolution and development of SCM as a distinct field of study and practice began in the twentieth century when several factors such as industrialization, globalization, technological innovation, and

market competition influenced the way supply chains were organized and operated. In general, SCM has gone through four main stages of evolution since the 1960s (Lambert et al. 1998):

Stage 1: Functional integration. This stage involved the consolidation of separate logistics functions such as procurement, production, distribution, inventory, and transportation into two main categories: materials management and physical distribution. The main objective was to reduce costs and improve efficiency by coordinating the flow of materials and products within the organization.

Stage 2: Internal integration. This stage involved the integration of logistics functions with other business functions such as marketing, finance, and operations. The main objective was to align the supply chain strategy with the corporate strategy and to create value for customers by meeting their needs and expectations.

Stage 3: External integration. This stage involved the integration of the organization's supply chain with its external partners such as suppliers, customers, intermediaries, and service providers. The main objective was to enhance collaboration, information sharing, and trust among supply chain partners and to achieve a competitive advantage by leveraging their core competencies and resources.

Stage 4: Network integration. This stage involved the integration of multiple supply chains into a network of interconnected and interdependent entities that can respond to dynamic and uncertain market conditions. The main objective was to achieve agility, resilience, and sustainability by adopting advanced technologies that can enable real-time visibility, communication, coordination, and optimization across the supply chain network.

However, despite the progress made in SCM over the years, there are still many challenges and opportunities that need to be addressed in the face of global disruptions. Disruptions refer to unexpected events or situations that can negatively affect the normal functioning and performance of supply chains. Examples of disruptions include natural disasters, pandemics, wars, terrorism, strikes, cyberattacks, trade wars, etc. Disruptions can cause various impacts on supply chains such as delays, shortages, quality issues, cost increases, demand changes, customer dissatisfaction, etc.

To cope with disruptions, SCM needs to adopt two complementary capabilities: resilience and innovation. Resilience refers to the ability of a supply chain to recover from disruptions and maintain or restore its functionality and performance. Innovation refers to the ability of a supply chain to create or adopt new solutions that can improve its functionality and performance or prevent or mitigate disruptions. Several studies have explored the concepts and practices of supply chain resilience and innovation from different perspectives and contexts. For example:

- Christopher et al. (2004) proposed a framework for building agile supply chains that can cope with volatile demand by using strategies such as postponement, mass customization, and collaborative relationships.
- Sheffi et al. (2005) identified four types of resilience strategies: redundancy, flexibility, security, and collaboration, and discussed how they can be applied in different scenarios.
- Hohenstein et al. (2015) conducted a systematic literature review on supply chain risk management and proposed a classification scheme based on four dimensions: sources, outcomes, mitigation strategies, and performance effects of supply chain risks.
- Wieland et al. (2017) developed a conceptual model of supply chain innovation and suggested that it can be driven by three factors: opportunity recognition, knowledge access, and mobilization.
- Ivanov et al. (2020) examined the impact of the COVID-19 pandemic on global supply chains and proposed a framework for structural dynamics analysis and control to assess and mitigate the ripple effects of disruptions.

However, there are still some research gaps and limitations that this book aims to address. Some of them are:

- The lack of comprehensive and holistic approaches that can integrate different aspects and functions of SCM with advanced technologies to create value and competitive advantage.
- The lack of empirical evidence and case studies on how advanced technologies can enhance supply chain resilience and innovation in different industries and contexts.
- The lack of practical recommendations and guidelines for SCM practitioners, policymakers, and stakeholders on how to implement advanced technologies effectively and efficiently in their supply chains.

Therefore, this book intends to fill these gaps by providing a state-of-the-art review and analysis of advanced technologies for the management of disruptive supply chains and achieving resilience in the post-Covid era.

1.3   Methodology

In our call for contributions to this volume on "**Advanced Technologies for the Management of Disruptive Supply Chains: Achieving Resilience in Supply Chains for Post-Covid Era**," we went through various email lists of professional associations. Personal invitations were also sent to target researchers and scholars as well. We received a total of fifteen "two-page" long abstracts as the expression of interests. Based on the initial screening by our review panel, the authors of thirteen chapters were invited to submit the complete chapters. We received twelve chapters from the contributors that went through a double-blind review process. The reports

from the independent reviewers were sent to the authors to address the issues and incorporate the suggestions made by the reviewers. Only nine chapters made it to the final stage of acceptance. The final versions of these nine chapters have been edited and included in this volume.

1.4 Research Categories

The chapters thus compiled are classified into five categories following the structure of the book. The first category, the current one, "*An Overview of Advanced Technologies for the Management of Disruptive Supply Chains*," presents the introduction and preview of this book. The second category examines the Theoretical Models for Building Resilient Supply Chains. Four state-of-the-art chapters on this theme include (i) *Smart Manufacturing: A Review Toward the Improvement of Supply Chain Efficiency, Productivity, and Sustainability*, (ii) *Revolutionizing Supply Chain Management: A Bibliometric Analysis of Industry 4.0 and 5.0*, (iii) *Supply Chain Resilience: A Literature Review and gap analysis*, and (iv) *Principal Lessons Learned from COVID-19: Prescriptive and Long-lasting Strategies for Sustainable Supply Chain Improvement*. The third category showcases five unique contributions demonstrating the use of advanced technologies in building sustainable supply chains: (i) *Impact of Digitalisation in developing Procurement and Supply Chain Resilience in the Post-Pandemic Era—A study of the Global Manufacturing Secto*r, (ii) *Obstacles in Disruption and Adoption of Green Supply Chain Management (GSCM) Practices by Manufacturing Industries*, (iii) *Improving Supply Chain Resilience with a Control Tower Approach Beyond Covid-19*, (iv) *Phenomenological Study of Pharmaceutical Supply Chain in Pakistan: Innovative Approaches to Minimize Operational Inefficiencies*, and (**v**) *Supply Chain Resilience during Pandemic Disruption: Evidence from the Healthcare Sector of Pakista*n.

The final category, Conclusions, and Future Research Directions, overviews the key insights and learning points as well as the future research avenues contained in this book.

1.5 Conclusion

This book has explored the topic of advanced technologies for the management of disruptive supply chains and achieving resilience in the post-Covid era. The book has provided a comprehensive and holistic review and analysis of the current state of the art and practice of SCM and advanced technologies, as well as empirical evidence and case studies from various industries and contexts. The book has also offered practical recommendations and guidelines for SCM practitioners, policymakers, and stakeholders on how to implement advanced technologies effectively and efficiently to build resilience in their supply chains.

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