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Knowledge mapping of resilience and human rights in supply chains: A roadmapping taxonomy for twin green and digital transition design

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Supply chain sustainability (SCS) has gone beyond the sustainability-performance approach, towards the increasing adoption of the sustainability-practice approach. The use of digital technologies in this approach can enhance resilience and human rights, particularly in the context of the green and digital twin transition post-COVID-19 pandemic. To enrich the sustainability-practice approach, this paper aims to produce a roadmapping taxonomy, based on knowledge mapping of a dataset collected in late December 2022 from the Web of Science Core Collection. As the knowledge map reveals the dimensions of resilience, human rights, and digital technologies, the proposed taxonomy highlights the importance of dynamic capabilities in facing supply chain disruptions, especially their ripple effects, along with the corresponding digital technologies to enhance human social dynamics in facing such disruptions. The proposed taxonomy provides a knowledge-based framework for professionals and researchers to enhance their understanding of supply chain resilience in designing and implementing digital solutions. The proposed roadmapping taxonomy features a people- and community-centric perspective and several managerial insights, contributing to the wider discussions on the green and digital transformation of the supply chain, by shaping actions and interactions in networked, digitized, and datafied forms to enhance supply chain sustainability.

KEYWORDS
supply chain resilience, ESG, CSR, digital transformation, socio-technical transitions, just transitions, industry 4.0, big data analytics

1 Introduction

Integrating supply and demand management across companies, supply chain management (SCM) usually consists of managing procurement, sourcing, logistics, and customer relationships, which requires coordination with channel partners and stakeholders such as intermediaries, suppliers, and third-party service providers. SCM is important, not only because it is one of the crucial competitive advantages in delivering goods and services (van Nunen et al., 2005; Pan et al., 2021), but also in relation to security (Furusho, 2021), sustainability (van Nunen et al., 2005), and human rights concerns (Nikkei staff writers, 2021). For instance, to shift supply chains from traditional linear product-service systems (PSS) to closed-loop circular ones is thus critical for business model innovations and supply chain circularity (Yang et al., 2018).

To ensure the sustainability dimensions, the concepts of supply chain sustainability (SCS) and sustainable product-service systems (de Jesus Pacheco et al., 2019; de Jesus Pacheco et al., 2022) thus highlight the demands for eco-design for the Fourth Industrial Revolution (Industry 4.0). As articulated by Director General of the United Nations Industrial Development Organization (UNIDO) at the World Eco-Design Conference (WEDC), such inclusive and sustainable industrial development can contribute to the global Sustainable Development Goals (SDGs), with implications for the Internet Eco-Design for Good (Liao, 2019; Ma, 2019), As the concept of industry 5.0 gains academic (e.g., Xu et al., 2021; Maddikunta et al., 2022) and political attention (e.g., European Commission, 2022), it is clear that the transition to a sustainable, resilient and human-centric production systems requires the study of sustainable supply chain and product-service systems.

SCS studies argued for a paradigm shift in SCM, beyond the sustainability-performance approach and toward the sustainability-practice approach (Silva and Figueiredo, 2020). The sustainability-performance approach includes reporting practices such as environmental, social, and governance (ESG) and Corporate Social Responsibility (CSR), to encourage companies in supply chains to take more socially responsible actions (Harwood et al., 2011). In contrast, as evidenced by a 4-year case study conducted in Brazil (Silva and Figueiredo, 2020), the sustainability-practice approach requires to focus on operating rather than on performance reporting. Both internal and supply chain operation practices can be improved through cooperation and by upgrading the underlying logic. The sustainability-practice approach can incorporate the repair, updates, and returns of products to add and recapture the values through the circular economy model of supply chains. To enhance companies' supply-chain proficiency, the notions of resilience and robustness were introduced (Edgeman et al., 2016). In synthesis, SCS studies suggested moving towards the sustainability-practice approach, focusing on improving operating practices and incorporating circular economy models, to achieve a more sustainable and resilient supply chain, based on the key notion of supply chain resilience (SCR).

1.1 SCR in the context of human rights and just transitions

International politics and policies (Clarke and Boersma, 2017; Lehr, 2020; Murphy and Elimä, 2021) and international laws (Nolan and Bott, 2018) have addressed human rights issues in global supply chain practices. Indeed, SCM is the key component of a business (social) impact assessment, including issues such as human rights, justice, resilience, community, culture, gender, and sustainable livelihoods, with important public and corporate policy implications (Esteves et al., 2012). Hence, it becomes important to explore how such eco- and for-good digital practices can be datafied and networked (Liao and Wang, 2020; Wang et al., 2020). To this respect, values such as sustainability, resilience, and human rights become increasingly relevant.

Resilient supply chains are essential to achieve just transitions that consider both environmental and labor impacts. A just transition is a framework to ensure an equitable and fair shift toward a more sustainable economy, taking into account the needs and interests of the workers and communities affected by the transition (Wilgosh et al., 2022). Thus, the supply chain becomes a main site for the observation of its impacts on workers and communities, including the distribution of wealth and energy (Biswas et al., 2022). Global supply chain traceability is expected to be increasingly important for low-carbon enterprises and investors, and related green technology transfer is also expected to create geopolitical tensions and trade disputes (Oxford Analytica, 2021).

In relation to human rights and just transitions, the human-centric perspective can be useful to contextualize the SCR in the wider contexts of smart manufacturing (Turner and Garn, 2022; Wang et al., 2022) and Adaptive Cognitive Manufacturing System paradigm (ElMaraghy et al., 2021).

1.2 SCR in the context of geopolitical tensions and the COVID-19 pandemic

The issues of SCR surfaced when the governments of Japan and the U.S. announced the objective to secure the global supply chain for the semiconductor sector (Furusho, 2021). To this respect, the combined effects of the COVID-19 pandemic and geopolitical tensions on manufacturing have been systematically examined, revealing the actions taken such as manufacturing and re-purposing for shifting consumption patterns, workforce, and workplace rearrangements for social distancing, and remote working for mandatory lockdown and closures (Ardolino et al., 2022). Multinational enterprises (MNEs) have made substantial investments in Industry 4.0 digital technologies to generate positive social impacts during and after the COVID-19 pandemic (Srinivasan and Eden, 2021).

Supply chain disruptions need innovative management strategies (Moosavi et al., 2022), and a community-based participatory approach may be of help (Charania and Tsuji, 2012). A literature review on supply chains under COVID-19-related disruptions showed that, while traditional mitigation actions such as redundancy and flexibility remained relevant, stronger pressures for digitalization and supply-based localization emerged (Pujawan and Bah, 2022). Similarly, another literature review and bibliometric network analysis on pandemic SCM indicated a shift from healthcare supply chains to food supply chains, when comparing past influenza and the more recent COVID-19 research (Swanson and Santamaria, 2021). Digital and data technologies also appear to enable a wider range of research methods such as simulation and modeling, which can also be integrated with the community-based participatory approach.

All these recent practices share a same consideration, i.e., that the use of digital technologies such as artificial intelligence (AI) should strengthen manufacturing and supply chain resilience, including facing complex geopolitical challenges in the risk management of global value chains. Indeed, the perspective of risk perception concerning trust is also instructive in the acceptance of COVID-19 case reduction measures (Siegrist et al., 2021). Thus, the relationship between digital capabilities and SCM raises several critical questions regarding digital practices (Wright, 2016): How can we identify critical data and design workflows that ultimately contribute to a working culture toward community resilience? How can we integrate both organizational and technical processes, so that the resulting learning-oriented model of resilience can manage complex environments (Sgobbi and Codara, 2022), thereby achieving the systemic potential for resilient performance (Hollnagel, 2022)?

1.3 SCR in the context of digital technologies

The potential of digital technologies in tackling human rights and sustainability issues has been thoroughly examined in literature, as illustrated by the digital practices of a Japanese company in the palm oil supply chain to identify and respond to human rights violations (Nikkei staff writers, 2021). Moreover, a case study of Zara and H&M (López et al., 2022) examined how the restructuring of the digital value chain in the fast-fashion sector transformed the labor processes. Similar questions can be formulated, such as: How can we ensure the protection of human rights and labor rights in the increasingly digital and complex global supply chains?

On the technology side, the advancement of information and communication technologies (ICTs) has helped companies' operations in managing the delivery of products and services throughout internal and SCM. The digital capabilities enabled by ICTs enhanced business resilience during the COVID-19 pandemic (Elgazzar et al., 2022), pointing to the broader potential of digital technologies in strengthening organizational resilience (Potrich et al., 2022) and climate resilience of human infrastructures (Argyroudis et al., 2022).

In relation to the wider topic of digital technologies and company performance practices, previous literature reviews explored the use of digital technologies. For instance, a literature review on the Internet of Things (IoT) and SCM revealed that the investigation of the impact of IoT has been limited to few analytical models and empirical studies, often focusing only on the food and manufacturing supply chains (Ben-Daya et al., 2019). Another literature review focused on the use of data mining and machine learning in the performance evaluation of a company for Sustainable Development Goals (Souza et al., 2019). Similarly, a survey of big data analytics for SCM has resulted in guidelines for industrial applications (Tiwari et al., 2018). A book chapter has also explored the ways in which digital technologies make supply chains smart and sustainable, as a necessary response to external drivers such as environmental regulations and customer requirements, arguing that sustainable supply chains are characterized by three P's: Profit (creation of economic value), People (creation of customer value), and Planet (minimization of natural resource consumption and waste; van Nunen et al., 2005).

How can SCM leverage digital capabilities to achieve relevant value objectives such as sustainability, resilience, and human rights? To the best of the authors' knowledge, there is currently no working taxonomy summarizing the role of the emerging values of resilience and human rights for supply chain knowledge, except for our preliminary knowledge mapping work published in a conference proceeding (Liao and Pan, 2021). Still, it lacks structured outcomes that can provide working framework and relevant managerial insights.

Given the need for a succinct organization of the guiding roles of resilience and human rights for the advancement of SCM, especially using digital technologies such as Industry 4.0, AI, blockchain, cloud computing, and big data analytics, this study aimed to examine the digital, resilience, and human labor aspects of SCM, so as to enrich the sustainability-practice approach (Silva and Figueiredo, 2020). This is an important research direction for SCM because of the green and digital twin transition research and policy agenda, supported by European (Bianchini et al., 2022; JRC, 2022) and Chinese institutions (Xinhua News Agency, 2022). Especially for SCM, evidence-based review on resilience and human rights considerations should advance the much-needed synthesized knowledge to support wider sustainability practices.

In short, how can digital technologies enhance such a sustainability-practice approach to improve resilience and human rights, especially as part of the green and digital twin transition after the COVID-19 pandemic? To answer this question, this study conducted a roadmapping exercise based on knowledge mapping, in order to build a taxonomy to organize the digital, resilience, and human labor considerations of the SCM sustainability-practice approach.

2 Methods and materials

This Section describes how roadmapping exercises can be supported and substantiated by bibliometric knowledge mapping, in line with previous research (Park et al., 2020; Liao et al., 2023).

Indeed, when well executed, science mapping based on bibliometric analysis can provide solid foundations for the advancement of a field in several meaningful directions, by enabling researchers and other professionals to gain an overview, identify knowledge gaps, derive innovative ideas for further investigation, and position their contributions to the knowledge domain. In fact, a review of 20 years of technology and strategic roadmapping research revealed the usefulness of bibliometrics and science mapping to cover the breadth of technology development, especially for 'bibliometrics-based roadmapping' that may include additional data such as workshop outcomes and expert opinions (Park et al., 2020).

2.1 Roadmapping questions

This study employed technology roadmapping (Phaal et al., 2004; Phaal, 2019; Gibbons, 2020; Hirose et al., 2021; 2022; Blümel et al., 2022; de Oliveira et al., 2022; Kerr and Phaal, 2022; Munro, 2022) to address the research question focusing on the potential of digital technologies for SCR. For the purposes of this research, the following roadmapping questions were raised to identify opportunities and challenges:

- What resources are needed to achieve SCR?
- Which digital technologies can be useful? What are their short-term and long-term impacts?
- In what ways can digital technologies enable trust and collaboration, which in turn enhance SCR?
- In what ways can the topic of human rights be relevant for the achievement of SCR?

TABLE 1 Basic description of the data set.

Bibliographic data source	Web of science core collection
Citation Index	Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI)
Number of Documents	342
Search query	TS = [("supply chain" AND ("resilience" OR "human rights" OR ESG OR CSR)) AND ("digital transformation" OR "information communication technolog*" OR "information technolog*" OR "social media" OR "social network" OR "internet platform" OR "artificial intelligence" OR "blockchain" OR "big data" OR "cloud computing")]
Timespan	2009-2022
Sources[a]	127
References	21,709
Average citations per document	26.92
Author's Keywords (DE)	1,091
Keywords Plus (ID)	762
Authors	1,019
Authors - Co-Authors per Doc	3.58

[a]Including journals, conferences, books, etc.

2.2 Knowledge mapping based on a bibliometric analysis of bibliographic data

Often used as a quantitative foundation for research assessment, bibliographic data can support research assessment, mainly when advanced technologies are applied (Kousha and Thelwall, 2022). These efforts can provide insights into roadmapping, a strategic approach for innovation and research management (Camarinha-Matos and Afsarmanesh, 2004; Hasse and Weingaertner, 2016), especially for issues such as climate change and carbon reduction (Urpelainen, 2017; Zhang et al., 2021), which require multi-disciplinary knowledge for system integration.

This study applied several strategies and conventions to ensure the usefulness of knowledge mapping outcomes for technology roadmapping; the detailed information is summarized in Table 1.

2.3 Building a roadmapping taxonomy

First, because the main purpose of this study was to build a taxonomy for roadmapping, the data collected from the Web of Science (WoS) Core Collection was limited to the leading journal citation indices, as shown in Table 1. On 28 December 2022, 342 bibliographic records were retrieved, based on the query shown in the third row of Table 1. The search query in the fourth row of Table 1 indicates the three-step strategy followed to filter the relevant research, which had to be related to: 1) "supply chain" as the main topic; 2) "resilience" and "human rights" as the main dimensions, along with associated reporting practices of ESG and CSR; and 3) various digital technologies such as digital transformation, information technologies, artificial intelligence, and cloud computing. Since these three conditions must be met, the Boolean logical operator AND was used to join these conditions.

Second, because knowledge mapping or science mapping (Cobo et al., 2011) can be used to visualize the knowledge structure (Aria and Cuccurullo, 2017) for practitioners, researchers, and policymakers, this study used VOSviewer (van Eck and Waltman, 2010; CWTS, 2020), Bibliometrix (Aria and Cuccurullo, 2017) and customized Python and R scripts to clean and analyze the dataset for better visualization of such structure, following the science and knowledge mapping conventions (Garfield, 2004; Rodrigues and Mendes, 2018; Wang et al., 2021; Liao et al., 2023). Since this study intended to build a taxonomy, a thesaurus file was needed (van Eck and Waltman, 2010; CWTS, 2020; Donthu et al., 2021) to clean the bibliometric data of authors' keywords, which was critical to ensure a meaningful visualization of the conceptual structure of knowledge. As shown in Table 1, the original authors' keywords (DE) had 1,091 distinct entries. However, since some terms may have spelling and terminology variants, such as "information communication technologies," "ICTs," and "ICT," which had to be treated as the same concept, the data were cleaned to ensure consistent semantic visualization. In this study, first, the collected authors' keywords were clustered using customized Python scripts leveraging the natural language processing capability offered by the Python packages, such as the Natural Language Toolkit (NLTK), resulting in 66 clusters of keywords. Then, the keyword data were inputted in the thesaurus coding processes to ensure meaningful visualization and analysis, resulting in a working thesaurus file that controlled vocabularies for meaningful taxonomy building.

Third, in order to go beyond a simple description of current research, the purpose of this study was to conduct a roadmapping exercise to advance the systematic improvement of the knowledge structure, following the "bibliometrics-based roadmapping" conventions (Park et al., 2020). Online workshops were held to map the expert opinions retrieved in literature onto a hierarchical taxonomy in a tree structure.

To summarize, the knowledge structure was expected to constitute the foundations on which the dimensions of resilience

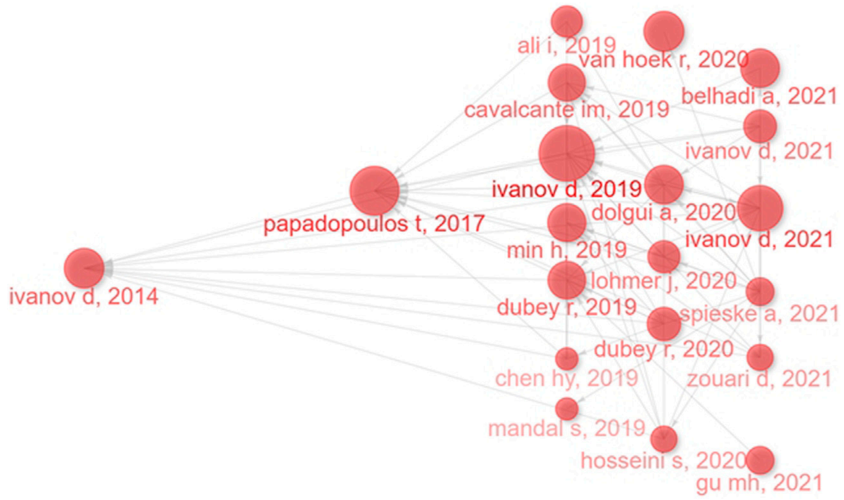

FIGURE 1
Historiograph: intellectual structure.

and human rights can be an integral part of the twin green and digital transition of supply chains, enabled by digital technologies. In other words, the knowledge mapping exercise must result in a taxonomy that can "frame" our collective cognitive map (Cukier et al., 2021) more consciously in the age of machine intelligence and automation, noting the blind spots and missing pieces during these socio-technical transitions toward sustainability (Geels, 2019).

3 Results: Empirical evidence of the knowledge structure for roadmapping

To provide evidence for roadmapping, knowledge mapping was performed, including the intellectual and conceptual structure of knowledge; the results are presented in the following Subsections.

3.1 Intellectual structure

To lay a solid foundation of the critical arguments and propositions, and of the authors behind them, this Subsection first shows the evolution of knowledge through a citation network of critical research works across time, using the historiographic network tool provided by Bibliometrix. Then, it presents the knowledge affinity network through a co-citation network, built using VOSviewer. In addition to the critical studies and their authors, brief descriptions of their key arguments and ideas are provided accordingly.

3.1.1 The historiographic network shows one single cluster

Historiographic mapping, also known as historical direct citation network, can provide a synthetic visualization of intellectual structure across time (Garfield, 2004; Aria and Cuccurullo, 2017). Since this study aimed to construct a roadmapping taxonomy, historiographic mapping was essential to obtain an overview of the intellectual history of the knowledge domain.

The results of historiographic network mapping performed using Bibliometrix software, shown in Figure 1, revealed 20 authors in a single cluster, suggesting a standard frame regarding an intellectual legacy and community among them. Looking at the *x*-axis representing the time dimension, an early period can be clearly observed from 2014 to 2017, as well as a later period from 2019 to 2021, which suggests a strong growth after the incubation period 2014–2017.

More details on the critical works are provided in Table 2, which presents information about the author, year, local citation score (LCS), global citation score (GCS), journal abbreviation, title, author keywords, and digital object identifier (doi) of each article. It is important to note that, while Figure 1 visualizes the direction of citations by using directed arrow links among the nodes, and the number of citations an article received by using the size of the nodes, Table 2 details such citation information by ranking each record based on the LCS values. LCS and GCS values, obtained using Bibliometrix, represent the number of citations an article received from the local data set considered in this study, and from the Web of Science database, respectively.

The information retrieved on the title and keywords of each article revealed the importance of keywords such as resilience, Industry 4.0, and COVID-19; in contrast, expressions such as "human rights" did not appear.

3.1.2 Earlier studies and their lasting impacts: The importance of two authors before 2017

Prominent in the network are the four articles by Ivanov and his co-authors, focusing on the issue of the ripple effects of SCR (Ivanov et al., 2014; Ivanov et al., 2019; Ivanov et al., 2021; Ivanov and Dolgui, 2021). As early as 2014, Ivanov et al. (2014)

TABLE 2 Detailed information of historiograph articles, ordered first by cluster and then by GCS.

Author	Year	LCS	GCS	Journal	Title	Author keywords	Doi
Ivanov, D.	2019	82	517	INT J PROD RES	The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics	Supply chain dynamics; supply chain risk management; supply chain resilience; supply chain design; supply chain engineering; Industry 4.0; additive manufacturing; blockchain; big data analytics; ripple effect	10.1080/00207543.2018.1488086
Papadopoulos, T.	2017	57	289	J CLEAN PROD	The role of big data in explaining disaster resilience in supply chains for sustainability	Resilience; big data; sustainability; disaster; exploratory factor analysis; confirmatory factor analysis	10.1016/j.jclepro.2016.03.059
Ivanov, D.	2021	46	314	PROD PLAN CONTROL	A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0	Supply chain; resilience; industry 4; 0; disruption risk; data analytics; digital twin	10.1080/09537287.2020.1768450
van Hoek, R.	2020	32	255	INT J OPER PROD MAN	Research opportunities for a more resilient post-Covid-19 supply chain - closing the gap between research findings and industry practice	Supply chain risk; supply chain resilience; COVID-19	10.1108/IJOPM-03-2020-0165
Ivanov, D.	2014	31	313	INT J PROD RES	The ripple effect in supply chains: trade-off 'efficiency-flexibility-resilience' in disruption management	Information technology; disruption management; quantitative analysis; resilience; ripple effect; event management; dynamics; robustness; supply chain; control	10.1080/00207543.2013.858836
Dolgui, A.	2020	29	149	INT J PROD RES	Reconfigurable supply chain: the x-network	Supply chain resilience; Industry 4.0; sustainable supply chain; ripple effect; digital twin; reconfigurable supply chain	10.1080/00207543.2020.1774679
Belhadi, A.	2021	29	208	TECHNOL FORECAST SOC	Manufacturing and service supply chain resilience to the COVID-19 outbreak: lessons learned from the automobile and airline industries	COVID-19; supply chain resilience; supply chain risk; airline; automobile; financial impact	10.1016/j.techfore.2020.120447
Min, H.	2019	28	247	BUS HORIZONS	Blockchain technology for enhancing check for updates supply chain resilience	Blockchain technology; supply chain risk management; cryptocurrency; blockchain; architecture; supply chain resilience	10.1016/j.bushor.2018.08.012
Dubey, R.	2019	27	128	IEEE T ENG MANAGE	Antecedents of resilient supply chains: an empirical study	Antecedents; relational view; resource-based view (RBV); supply chain resilience	10.1109/TEM.2017.2723042
Cavalcante, I.M.	2019	26	145	INT J INFORM MANAGE	A supervised machine learning approach to data-driven simulation of resilient supplier selection in digital manufacturing	Supplier selection; machine learning; simulation; digital supply chain; data-driven decision-making support; resilience; digital supply chain twin	10.1016/j.ijinfomgt.2019.03.004
Dubey, R.	2020	20	176	INT J PROD RES	Blockchain technology for enhancing swift-trust, collaboration and resilience within a humanitarian supply chain setting	Blockchain technology; distributed ledger technology; humanitarian supply chain management; humanitarian operations management; swift-trust; collaboration; supply chain resilience; operational supply chain transparency	10.1080/00207543.2020.1722860
Ivanov, D.	2021	19	136	INT J PROD RES	Researchers' perspectives on Industry 4.0: multi-disciplinary analysis and opportunities for operations management	Industry 4; 0; operations management; industrial engineering; data science; operations research; control	10.1080/00207543.2020.1798035
Lohmer, J.	2020	18	89	INT J PROD ECON	Analysis of resilience strategies and ripple effect in blockchain-coordinated supply chains: an agent-based simulation study	Blockchain technology; supply chain dynamics; supply chain resilience; simulation study; Industry 4.0; capacity sharing	10.1016/j.ijpe.2020.107882

(Continued on following page)

TABLE 2 (*Continued*) Detailed information of historiograph articles, ordered first by cluster and then by GCS.

Author	Year	LCS	GCS	Journal	Title	Author keywords	Doi
Ali, I.	2019	17	81	INT J PHYS DISTR LOG	Where is supply chain resilience research heading? A systematic and co-occurrence analysis	Supply chain resilience; literature review; VoSviewer	10.1108/IJPDLM-02-2019-0038
Gu, M.H.	2021	14	57	INT J PROD ECON	The impact of information technology usage on supply chain resilience and performance: an ambidexterous view	Information technology use; ambidexterity; supply chain resilience; supply chain performance; information processing theory	10.1016/j.ijpe.2020.107956
Spieske, A.	2021	14	53	COMPUT IND ENG	Improving supply chain resilience through Industry 4.0: a systematic literature review under the impressions of the COVID-19 pandemic	Industry 4.0; supply chain risk management; supply chain resilience; supply chain disruption; digital supply chain; literature review	10.1016/j.cie.2021.107452
Hosseini, S.	2020	13	79	EXPERT SYST APPL	Bayesian networks for supply chain risk, resilience and ripple effect analysis: a literature review	Supply chain management; supply chain resilience; bayesian network; machine learning; ripple effect	10.1016/ j.eswa.2020.113649
Zouari, D.	2021	13	53	INT J PHYS DISTR LOG	Does digitalising the supply chain contribute to its resilience?	Digital supply chain; supply chain resilience; digital maturity; digital tool adoption	10.1108/IJPDLM-01-2020-0038
Mandal, S.	2019	12	55	INFORM TECHNOL PEOPL	The influence of big data analytics management capabilities on supply chain preparedness, alertness and agility an empirical investigation	Business process management; supply chain management; resource-based view; business value of it	10.1108/ITP-11-2017-0386
Chen, H.Y.	2019	12	52	INT J INFORM MANAGE	Building resilience and managing post-disruption supply chain recovery: lessons from the information and communication technology industry	Supply chain; resilience; disruption management; risks; recovery; case-study; ICT	10.1016/ j.ijinfomgt.2019.06.002

[a]LCS (local citation score) and GCS (global citation score) indicators were calculated using the functions for historical direct citation network provided in the Bibliometrix package.

performed an analysis of the ripple effects in the supply chain, with the primary purpose to manage and control disruptions, making supply chains resilient and robust. Focusing on the ripple effects in the supply chain dynamics, this study classified research areas within quantitative methods, with the purpose to make supply chains more adaptable and robust for disruption management and recovery. In addition, focusing on resilience and robustness, this study built performance metrics from supply chain robustness and resilience using the contingent resource view.

This study had important implications at both theoretical and management level for the identification of robust and resilient approaches. As shown in Figure 1, the study of Ivanov et al. (2014) was cited by Papadopoulos et al. (2017), who proposed a theoretical framework to explain resilience in supply chain networks toward sustainability. This framework was based on unstructured big data, collected from news and social media sources, in conjunction with data from the humanitarian response to the 2015 Nepal Earthquake. This study applied both confirmatory factor analysis and content analysis to assess the importance of swift trust, information quality, information sharing, and public-private partnership in building resilient and sustainable supply chains.

As shown by the size of the two nodes in 2014 and 2017 in Figure 1, both these articles were instrumental in informing later research.

The study performed by Ivanov et al. (2019) has the highest LCS and GCS score in Table 2, as also shown in Figure 1. By examining the impact of digital technology and Industry 4.0 on supply chain ripple effects for risk analytics, this study focused on both the digitalization impact on SCM and the impact of SCM on the ripple effect control. By synthesizing various disciplinary perspectives of business, information, engineering, and analytics, it proposed an initial conceptual supply chain risk analytical framework anticipating a transition towards cyber-physical supply chains. Moreover, it provided answers regarding the relations between Industry 4.0, big data analytics, trace & tracking systems, additive manufacturing, and disruption risk management, so that digitalization efforts and extensions can enhance the ripple effect control and risk analytics.

The focus on the relationship between digital transformation and resilience continued, often under the umbrella term of Industry 4.0, with two papers published in 2021 (Ivanov and Dolgui, 2021; Ivanov et al., 2021). The first study, based on a literature analysis and a global survey of experts, introduced the concept of Industry 4.0 in operations management (Ivanov et al., 2021). The second study, aiming to further investigate the design and implementation of digital twins for managing disruption risks, proposed a combination of both model-based and data-driven approaches for digital supply chain twins, pointing to the need for digital twin mapping of supply chain networks to enhance predictive and reactive decisions, by using SCM risk data for risk management (Ivanov and Dolgui, 2021). In addition, this study discussed the impact of the COVID-19 pandemic in terms of supply chain shocks and adaptions, arguing for valid real-time data, historical disruption analysis, and visualization for visible and sustainable operations in global companies. This paper also cited the conceptual framework of Reconfigurable Supply Chain using digital twins (Dolgui et al., 2020).

3.1.3 Articles on the impact of the COVID-19 pandemic

The next most prominent article, presented in the fourth row of Table 2, is the work performed by van Hoek (2020) on research opportunities for a more resilient supply chain after COVID-19. Based on data including virtual roundtables with supply chain executives, interviews and public data, a lack of preparedness, and shortcomings of current response plans, the findings of this study revealed the supply, demand, and control aspects of supply chain risks experienced by the industrial leaders and, thus, the need for greater SCR. Furthermore, through empirical research, this study outlined the areas for future research to de-risk supply chains structurally. In addition, as part of the sustainability-practice approach (Silva and Figueiredo, 2020), this article assessed the practical implications of COVID-19 in the areas of global-nearshore-local sourcing balancing by using digital technologies, and of talent management in relation to SCM resilience. As for research, this study argued that COVID-19 has provided empirical and event-based research opportunities on several aspects including information availability, decision model design (especially considering the value of flexibility), shortening response time, expanding sources, supplier segmentation, and evaluation models. The goal of SCR has become central for closing the gap between SCR research and industrial practices, especially in the context of the COVID-19 pandemic.

Another empirical study was performed by Belhadi et al. (2021), summarizing lessons and insights learned from the impact of COVID-19 on the automobile and airline industries. Based on the integration of time-to-recovery financial impact analysis, survey, and interview data, the automobile industry identified Industry 4.0 and supply source localization as the main strategies. In contrast, the airline industry considered operations redefinition for business continuity and sustainability as the primary strategy. For both sectors, real-time information sharing and corresponding coordination among stakeholders in supply chains are critical.

The impact of the COVID-19 pandemic was further explored by a systematic literature review on the effective use of Industry 4.0 to improve SCR (Spieske and Birkel, 2021). By categorizing Industry 4.0 technologies in the context of SCR, this study proposed a framework of the relationship between the two, resulting in approaches to improve the stability of SCR using Industry 4.0, as illustrated in its application to an automotive COVID-19 use case. While big data analytics has been developed and has proved to be suitable enough for improving SCR, other enabling technologies, such as cyber-physical systems and additive manufacturing, still need further proof.

3.1.4 Other works on blockchain and digital twins

The use of blockchain digital technology to enhance SCR was discussed in several papers in the historiographic network (Min, 2019; Dubey et al., 2020; Lohmer et al., 2020). Min (2019) conceptualized the blockchain as a distributed peer-to-peer ledger information network that manages digital asset transaction records, and discussed how it may enhance SCR by mitigating risks.

Dubey et al. (2020) applied the organizational information processing theory to examine the use of blockchain technology in the humanitarian sector, specifically the development of blockchain-enabled swift-trust systems. This paper highlighted the importance of improving the traceability and transparency of relief supplies and information, by proposing and testing six hypotheses based on data including from the Coordinator for Humanitarian Affairs (OCHA) database. The findings confirmed all six hypotheses, arguing that collaboration and swift trust are significant predictors of SCR, and that blockchain contributes to quick trust and operational supply chain transparency. Overall, this study highlighted the instrumental role of collaboration in achieving SCR.

Lohmer et al. (2020) also examined the use of blockchain for SCR, using an agent-based simulation model of a complex supply network affected by disruptions. This study identified and analyzed risk-related scenarios for their impact on resilience strategies. Specifically, it highlighted the potential benefits of smart contracts for risk-related collaboration, which can reduce the adverse effects of disruption propagation, network recovery time, and total costs. Non-etheless, this study argued that the effectiveness of blockchain in enhancing supply chain resilience also depends on its efficiency.

Altogether, these three articles suggest that SCR can be enhanced by enabling trust and collaboration between supply chain partners, including the use of blockchain technology.

3.1.5 Articles adopting a resource-based view

The resource-based view (RBV) and relational view of supply chains continue to be relevant. Dubey et al. (2019) proposed a framework based on the RBV and the relational view to explore the implications of supply chain visibility, cooperation, trust, and behavioral uncertainty for SCR. These authors conducted a hierarchical moderated regression analysis on a sample of 250 manufacturing firms, to examine the relationships between these factors and SCR. In another study by Mandal. (2019), the RBV was used to investigate the influence of big data analytics on SCM. This study collected 249 complete responses from an online survey to explore the capabilities of big data analytics to enhance preparedness, alertness, and agility in SCM. It found that big data analytics can provide valuable insights and enhance the capabilities in responding to disruptions.

Overall, these studies suggest that traditional intellectual legacies, such as the RBV and the relational view of supply chains, continue to be relevant in the current supply chain literature, providing valuable insights into the factors that can enhance SCR. Additionally, they highlight the potential of emerging technologies such as big data analytics to provide valuable insights and enhance supply chain capabilities.

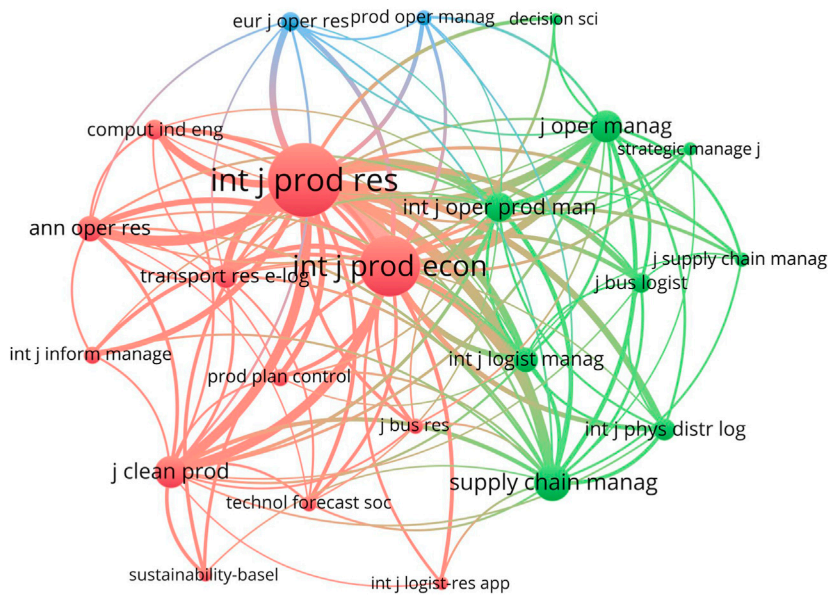

FIGURE 2
Source co-citation network: top 23 sources with more than 200 citations received from the local data set.

3.1.6 Source co-citation network and analysis: The cited journals

To elucidate the intellectual structure from the angle of the cited journals, the co-citation network of cited journals was divided in three clusters, as shown in Figure 2. The first cluster, in red color on the left side of Figure 2, includes the set of production, cleaner production, computer engineering, sustainability, and innovation research, and consists of journals such as the *International Journal of Production Research*, the *Journal of Cleaner Production*, and the *International Journal of Production Economics*. The second cluster, in green color on the right side of Figure 2, consists of journals such as the *Journal of Operations Management*, *Supply Chain Management*, and the *International Journal of Operations & Production Management*. The third cluster, in blue color at the top of Figure 2, consists of two journals: *Production and Operations Management*, and the *European Journal of Operational Research*.

In synthesis, the intellectual structure on which the primary work was built consists of production research, operations management, and sustainability research journals, with multiple implications for management, sustainability, and innovation practices.

3.2 Conceptual structure

To further reveal the conceptual structure, the second set of findings relies on the author's keywords as empirical evidence, as the basis to perform keyword co-occurrence network and thematic analysis. This Section describes these two network visualizations and summarizes the research findings concerning these concepts.

3.2.1 Conceptual structure: Keyword co-occurrence network

Used for knowledge mapping exercises, keyword co-occurrence networks (Garfield, 1994; Aria and Cuccurullo, 2017; Radhakrishnan et al., 2017; CWTS, 2020; Faraji et al., 2022) represent the knowledge structure in the form of networks, where a network node represents a keyword, and a link represents the co-occurrence of a pair of keywords.

The keyword co-occurrence network of the 31 top keywords is shown in Figure 3. The top keyword "resilience" was removed, resulting in five clusters of keyword concepts: 1) Industry 4.0 for sustainable and resilient supply chain; 2) big data analytics for SCM; 3) disruption management *via* supply chain network and social network; and 4) COVID-19, supply chain disruption, and risk management.

The dominance of concepts such as SCR, Industry 4.0, and AI, as shown by the first cluster in the lower part of Figure 3 in red, revealed the focus on Industry 4.0 on SCR. For instance, an article titled "Industry 4.0 enables supply chain resilience and supply chain performance" (Qader et al., 2022) analyzed cross-sectional data from 458 respondents in beverage, food, and pharmaceutical companies, confirming a significant impact of Industry 4.0 on supply chain performance.

The upper part of Figure 3 shows a cluster in green color, highlighting the significance of big data analytics, SCM, and of blockchain in SCM. Several studies (Choi et al., 2018; Tiwari et al., 2018; Cavalcante et al., 2019; Mandal, 2019) demonstrated the use of big data analytics for SCM and operations management. Choi et al. (2018) reviewed the importance of big data analytics for various areas including inventory, revenue, marketing, logistics, forecasting, and SCM. Cavalcante et al. (2019) proposed a new approach to capture the risk profiles of the suppliers using data-driven decision-

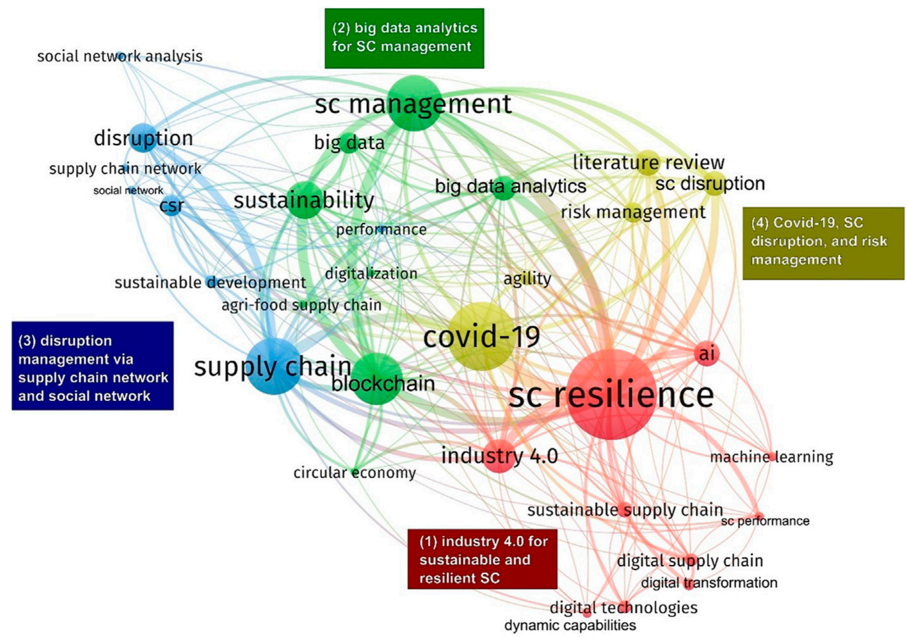

FIGURE 3
Keyword co-occurrence network: top 31 keywords in 4 clusters (the top keyword "resilience" was removed from visualization).

making for supplier selection, which can enhance resilient performance in the supply chain. This study also aimed to advance data analytics for digital manufacturing.

The third keyword cluster, depicted in blue on the left side of Figure 3, focuses on the relationship between disruptions, social networks, CSR, and supply chain networks. Several articles discussed the importance of social networks (Cabras and Mount, 2016; Luthe and Wyss, 2016; Graça and Camarinha-Matos, 2017; Liu et al., 2021; Margherita and Heikkilä, 2021).

The dominance of COVID-19 is illustrated in the fourth cluster in yellow on the right side of Figure 3, revealing the importance of risk management and supply chain disruption.

The keyword co-occurrence network offered a categorized view of concepts into four clusters, and also showed the relative importance (as demonstrated by the size of the nodes) and the strength of the relationship between keywords (as demonstrated by the width of the edges). The keyword COVID-19, for instance, has a significant presence in the whole network, with multiple links to other groups. This indicates that the COVID-19 pandemic event has had lasting impacts not only on the supply chain operation practices, but also on SCR knowledge.

3.2.2 Conceptual structure: Thematic mapping analysis

Thematic maps help researchers by grouping key concepts based on their importance and how they connect in the keyword network. Researchers can then use them as strategy maps for further research and development. The results of the thematic mapping analysis, presented in Figure 4 allows to identify four distinct groups of themes can be identified based on their network centrality and density scores (Cobo et al., 2011):

- "Motor themes" are well-developed and pertinent themes that provide the structure for the domain knowledge. These themes appear in the upper right quadrant of the strategy map in Figure 4.
- "Niche themes" are developed, but less significant (i.e., more peripheral) to the overall domain knowledge. They are depicted the upper left quadrant of the strategy map.
- "Emerging or declining themes" are not well-developed (low density) and not as relevant (low centrality). These themes appear in the lower left quadrant of the strategy map.
- "Basic themes" are necessary, but not yet well-developed. These themes are located in the lower right corner of the strategy map, and are often fundamental to the domain knowledge.

The main "motor themes" of the literature data reveal the importance of CSR, sustainable development, and social network for SCM, confirming the prominence of the sustainability-performance approach. A study examined the incongruence between CSR orientation and supply chain partnership performance, by using a network perspective; its findings suggest that a firm's relationship performance may be negatively affected by incongruent levels of CSR orientation between itself and its supply partner, especially when the firm occupies a central network position (Liu et al., 2021). Also, another study examined the impact of sustainable SCM organizational performance on SCR, with a focus on the mediating role of big data analytical capabilities, finding a positive impact and suggesting an important mediating role of big data analytical capabilities (Zhu et al., 2022). Finally, a study of fashion supply chains and branding proposed the use of blockchain technology to improve brands' CSR commitment (Chan

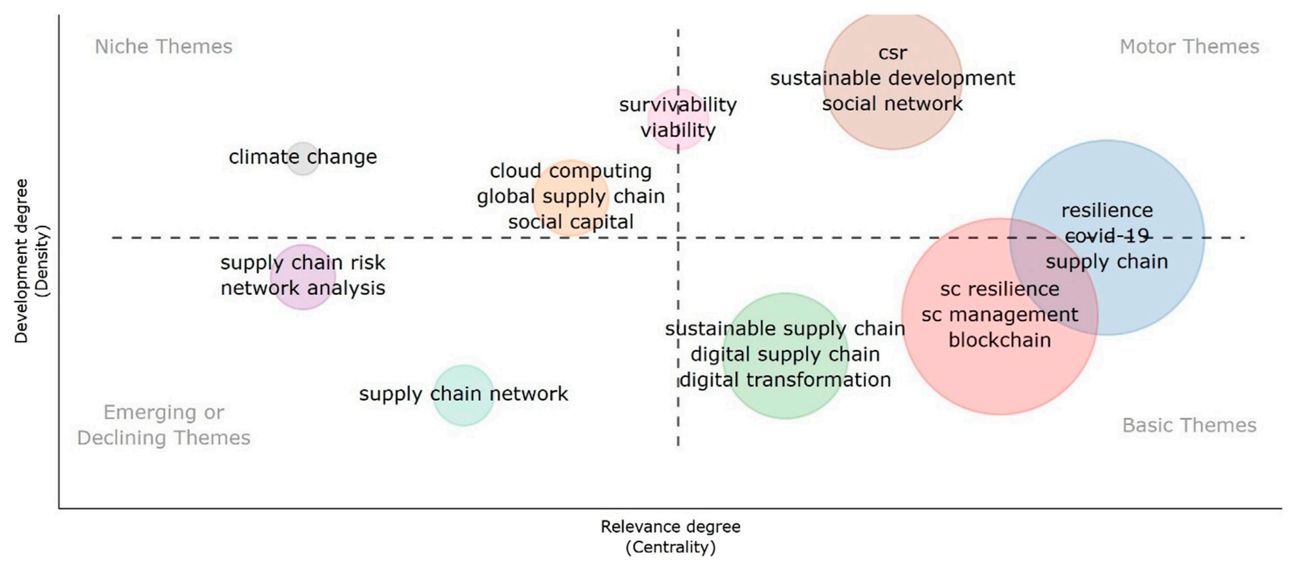

FIGURE 4
Conceptual structure using thematic mapping analysis.

et al., 2020). In summary, digital technologies such as networks, data analytics, and blockchain appear to move the sustainability-performance approach toward the sustainability-practice approach.

The right side of Figure 4 shows that the set of resilience, COVID-19, and supply chain themes as the most relevant (see the centrality scores along the *x*-axis), as discussed earlier in Section 3.1.3 on the impact of COVID-19. The top of Figure 4 reveals the niche cluster of survivability and viability as among the most developed themes (see the density scores along the *y*-axis), with a shared research agenda on how and which businesses can survive facing supply chain disruptions (Sheng and Saide, 2021; Lerch et al., 2022; Sharma et al., 2022). Sharma et al. (2022) developed a framework aimed at improving survivability during and after the COVID-19 pandemic. Moreover, Sheng & Saide (2021) adopted a viable system perspective to investigate the survivability of sustainable supply chains. Finally, an empirical study on German manufacturing sector during the COVID-19 pandemic suggested that AI-enabled production can increase a firm's production resilience (Lerch et al., 2022).

The niche themes of Figure 4 are summarized as follows. In relation to the set of themes of cloud computing, global supply chain, and social capital, the use of cloud computing was examined by several studies (Arsovski et al., 2015; Subramanian and Abdulrahman, 2017; Akhtar et al., 2022). More in detail, by examining the role of cloud computing for corporate organizational resilience, a study compared the modeling outcomes of a non-cloud enterprise versus a cloud-based enterprise in a supply chain, thereby providing a benchmarking starting point for both research and practice (Arsovski et al., 2015). Another study explored the potential benefits of cloud computing services in logistics, specifically examining the cooperation between logistics companies and cloud computing service providers (Subramanian and Abdulrahman, 2017). The findings of this study suggest that Chinese logistics companies perceive security impediments as a significant factor affecting cooperative resilience between logistics and cloud computing service providers. Looking at the use of real-time information in the wider digital and information perspectives for supply chain resilience, another study found that the use of real-time information is significantly associated with SCR and operational agility (Akhtar et al., 2022). All these studies point to the effective use of digital technologies, such as cloud computing, to improve the relationship among stakeholders with the critical information they need for cooperative resilience.

Finally, in relation to the remaining two basic themes shown in Figure 4, first, the implications of blockchain for SCM and SCR have been introduced and described above in Section 3.1.4. Second, the notion of sustainable supply chains is clustered with digital supply chains and digital transformation (Ebinger and Omondi, 2020; Bui et al., 2021; Sharma et al., 2022; Zhu et al., 2022). With the purpose to explore how digital technologies improve transparency in sustainable supply chains, a conceptual paper discussed the growing accountability of companies for environmental, social, and human rights impacts associated with their suppliers and sub-suppliers. This study also identified data-driven digital approaches for achieving potential for sustainable supply chain transparency (Ebinger and Omondi, 2020). In addition, a data-driven literature review of SCM analyses identified important indicators such as supply chain agility, coordination, finance, flexibility, resilience, and sustainability, in facing the challenge of balancing between SCS and disruptions (Bui et al., 2021). These two sets of themes reveal the need for advanced research and practices in the use of blockchain and digital technologies for SCR, SCM, and sustainable supply chains.

3.2.3 Conceptual structure: Human rights as a missing piece?

Since the keyword "human rights" did not appear prominently in the abovementioned findings, this study further examined the related literature (Chae, 2015; Posner, 2016; Ebinger and Omondi, 2020; Mercuri et al., 2021; Upadhyay et al., 2021; Coco et al., 2022) in the dataset.

The use of social media platforms has become important to gather insights, also in relation to supply chain practices. Chae (2015) conducted a ground-breaking study that analyzed Twitter data using the hashtag #supplychain; One of its key findings was the prominence of human rights issues within the public perception and trust around SCM. Drawing on the author's experience as both a human rights advocate and a U.S. labor rights official, Posner (2016) identified the following critical areas for a business to seriously consider human rights: labor rights in supply chains, security-related extractive industry, information technology, freedom of expression, agriculture, child/forced labor, and socially responsible investment. This article, published in the *Accounting Auditing & Accountability Journal*, highlighted the interconnectedness of human rights issues in business operations, especially of labor rights in supply chains. Another study discussed the relevance of preserving the integrity of IT supply chains regarding a hacking incident (Coco et al., 2022). Furthermore, a recent study (Upadhyay et al., 2021) showed that blockchain technology can improve supply chain performance and communication in the circular economy, which could have positive effects on human rights protection and patient confidentiality, as well as on reducing carbon emissions. However, the application of digital technologies such as blockchain will entail challenges in cost, trust, legislation, and public policies. Fortunately, a case study of a start-up in the agri-food sector (Mercuri et al., 2021) demonstrated how blockchain technology can provide transparency along supply chains. This can address issues of security, traceability, and non-manipulability of information, which can help fight pollution, human rights abuses, and frauds.

Overall, the results of the knowledge mapping exercise based on bibliographic data showed that digital technologies can improve the transparency and traceability of critical information in supply chains, thereby building a trustworthy and sustainable supply chain for the future.

4 Discussion

It becomes clear that the COVID-19 pandemic has had lasting impacts not only on supply chain operation practices but also on SCR knowledge. In contrast, the supply chain knowledge of human rights is relatively underdeveloped.

Several efforts have been made to make supply chains sustainable and intelligent at both theoretical and practical level, to coordinate SCM practices with a better understanding of the organizational impacts on the people and the planet. Although the science mapping exercise conducted in the present study did not entail a full systematic review, it provided a succinct summary of the considerations of resilience and human rights, as follows:

- The historiographic findings, based on data on citations and most-cited works, highlighted the importance of the ripple effects, robustness, and resilience of SCM, as well as of the rise of big data analytics and social networks to improve the theories and practices of SCM.
- The keyword co-occurrence network analysis revealed four clusters of keyword concepts: 1) Industry 4.0 for sustainable and resilient supply chains; 2) Big data analytics for SCM; 3) Disruption management *via* supply chain network and social network; and 4) COVID-19, supply chain disruption and risk management.
- The findings of the thematic mapping showed that the "motor themes" driving current research consist of big data analytics, sustainability, and flexibility. In contrast, the research themes that require more development and practice include predictive analytics, dynamic capabilities, performance, impact, and resilience.

4.1 A roadmapping taxonomy from a people- and community-centric perspective

Figure 5 summarizes the proposed roadmapping taxonomy for an intelligent, sustainable supply chain. This taxonomy adopts a people- and community-centric perspective, with the main related concepts of approach, dynamics, trust, visibility (transparency), cooperation, and sharing as the first-level components. The category of approach clearly distinguishes the practice-based approach of focusing on the green digital transformation of operations management, from the mere performance-based CSR/ESG reporting. While not diminishing the importance of CSR/ESG reporting as an essential aspect for companies to engage their investors and stakeholders in the general public, it requires such reporting to be based on actual operations data, especially about supply chains. Then, in relation to the dynamics component, the proposed taxonomy assumes that resilience is the outcome of action and reaction dynamics from the disruptions and networks.

Thus, supply chain disruptions, and especially their ripple effects, must be examined and analyzed with dynamics capabilities and disruption management skills, and both supply chain networks and social networks should be considered in the overall system dynamics and system capabilities. The inclusion of both such networks is related to the other four first-level components, i.e., trust, visibility, cooperation, and sharing, which highlight the essence of human social dynamics in supply chain building, be it for market mechanisms or for humanitarian efforts. The corresponding digital technologies, such as blockchain, big data analytics, Industry 4.0, etc. need to serve such fabrics of human social dynamics when organizing, managing, and distributing the information, resource, and capacity to face disruptions such as COVID-19 and climate change.

4.2 Managerial insights

In response to the managerial questions such as how companies can address the SDGs by introducing technologies and designs into their production systems and supply chains, several suggestions can be made based on the findings and discussions. The innovative

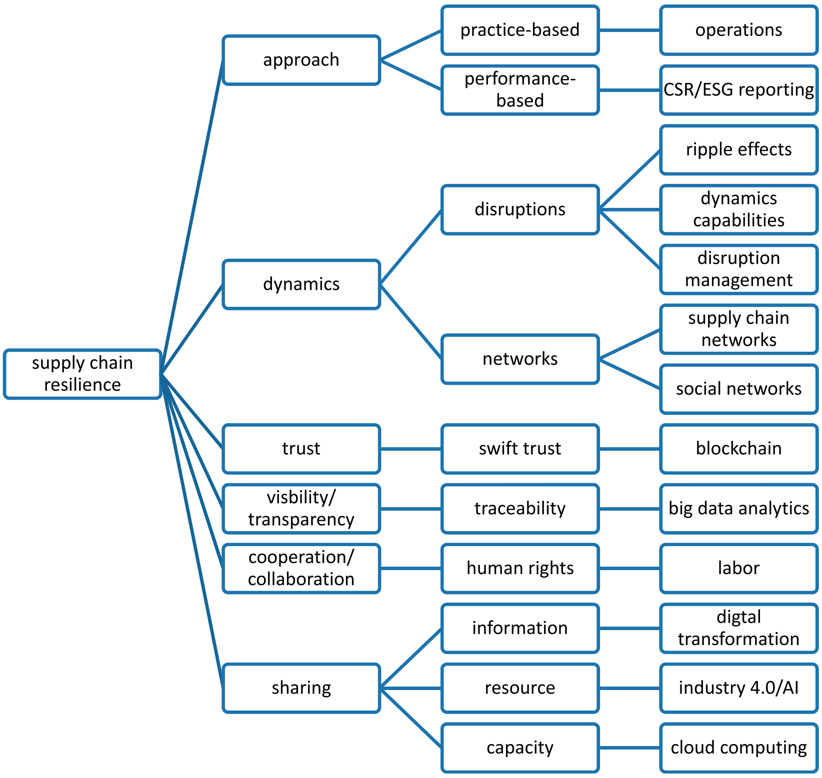

FIGURE 5
A roadmapping taxonomy for the twin green and digital transition for smart sustainable supply chains.

system integration of green and digital technologies in SCM entails the following managerial insights:

- Sharing information is fundamental, and is critical to coordinate best practices among stakeholders.
- The traceability of meaningful information improves supply chain visibility and transparency, which can enable, and be enabled by, big data analytics.
- Trust in SCM-related information can be valuable when facing disruptions, by employing the swift trust theory to assemble teams to work on time-sensitive projects, in an open, collaborative, transparent fashion. This can enable, and be enabled by, the use of blockchain technologies.
- The human-centric approach is compatible with the sustainability-practice approach of SCM in managing both resilience and labor/human rights dimensions, which can enable, and be enabled by, advanced data analytics practices such as the human-in-the-loop (ElMaraghy et al., 2021; Turner and Garn, 2022) modeling and simulation of supply chain dynamics and disruptions.

In synthesis, by adopting sustainable and digital technologies that consider people in supply chains, companies can better prepare for supply chain disruptions, facing events such as natural disasters, climate change, pandemics, and geopolitical conflicts.

5 Conclusion

The sustainability-practice approach (Silva and Figueiredo, 2020) to SCM is essential to reduce environmental impacts, promote socially responsible practices, ensure regulatory compliance, and gain competitive advantages. Through the mapping of related knowledge on resilience and human rights, this study advanced the sustainability-practice approach by providing a succinct summary and taxonomy for SCM based on a roadmapping exercise with knowledge mapping findings.

In response to the European Union's (European Commission, 2020) and Chinese (Xinhua News Agency, 2022) green and digital transformation agenda, the smart design of the twin green and digital transition of SCM is an important trend that is transforming the way companies operate. By adopting sustainable and digital technologies, companies can improve efficiency, reduce environmental impacts, and increase resilience, while also meeting the demands of customers who are increasingly focused on sustainability. This includes ensuring that workers are treated fairly, and that suppliers adhere to ethical and responsible business practices.

For more fruitful discussions on the green and digital transformation of the supply chain, the considerations of resilience and human rights in SCM require further practice and research, so as to provide practical details for more substantial CSR and ESG performance reporting of social and environmental impacts. In particular, these details and impacts should be digitized, datafied, and networked as meaningful digital transformational forces that reshape the production and consumption patterns of products and services, thus ensuring that these impactful values can be embedded in the forward and backward integration of the supply chain. In other words, the impact performance can, and should, be backed up by practice or real-time operations data, and digital technologies, such as Industry 4.0, artificial intelligence, blockchain, cloud computing, and big data analytics should enable those practices that can bring positive impacts in shifting production and consumption patterns toward sustainability.

5.1 A taxonomy based on the intellectual and conceptual structures

The conceptual and empirical review performed by the present study provides the basis for further development to enhance supply chain resilience, operations resilience and, thus, social resilience. The roadmapping taxonomy proposed in this study, supported by the findings of the knowledge mapping exercise based on the critical work, provides a succinct guideline for further discussion of the green digital transformation of SCM, with a more comprehensive inclusion of topics such as resilience and human rights, as essential supplementary contributions to the existing SCM digital practices, as part of the wider trends in the market demands towards more substantial CSR. Future work should also explore the implications of SCM practices of trust, transparency, cooperation, sharing, etc., to tackle the emerging issues of carbon neutrality, human rights, labor rights, and environmental impacts.

5.2 Limitations and future research directions

The authors acknowledge that this study has the following limitations:

1. The focus on the prominent authors and concepts meant that the roadmapping exercise may have overlooked other aspects of the current knowledge landscape, such as major institutions and countries.
2. Although 342 bibliographic records were collected, this study did not examine all of them, focusing only on the prominent authors and concepts revealed through the knowledge mapping and the specific literature on human rights.
3. The discussion of managerial insights was largely limited to the authors' worldviews and understanding of the limited literature investigated. In general, the knowledge mapping method for taxonomy building cannot replace a thorough and systematic literature review, leaving contributions by other scholars undiscussed.

Nevertheless, with the clear intention to develop a working taxonomy for mapping digital technologies and SCR, this study provided an elegant, practical, and roadmapping taxonomy that integrates relevant digital technologies into the intellectual and conceptual structure of knowledge, which can be used as a rough technology roadmap for practitioners and researchers to reflect on their supply chain knowledge, to innovate and design supply chain solutions for twin green and digital transition. This study succinctly visualized the key aspects of SCR and human rights to enable a carbon-neutral future.

Future research and innovation in the field should expand the investigation of the role of human rights in SCR in the context of geopolitical tensions and the pandemic. Also, additional managerial insights are needed to address the impact of geopolitical tensions on companies' implementations of the SDGs, as performed in production systems and supply chains, especially in the emerging discourses on "friendshoring," a related concept to "reshoring" and "nearshoring," which refers to the practices of supply chain network relocation and reconfiguration based on political considerations and pressures. This expansion should cover also the role of digital technologies, including their relationship with human rights, exploring the ways in which digital technologies can facilitate just transitions. To this respect, human-centric design thinking is central to ensure SCR as an instrumental component for the twin green and digital transition of human societies.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

Conceptualization, H-TL, and C-LP; Methodology, C-LP; Data curation: H-TL and C-LP; Writing—original draft preparation, H-TL, and C-LP; Writing—review and editing, H-TL, C-LP, and YZ; Visualization, H-TL and C-LP; Project administration, C-LP; Funding acquisition, YZ and H-TL. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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