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Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda

Marta Negri[1] | Enrico Cagno[1] | Claudia Colicchia[1] | Joseph Sarkis[2]

[1]Department of Management Economics and Industrial Engineering, Politecnico di Milano, Milan, Italy

[2]Foisie Business School, Worcester Polytechnic Institute, Worcester, Massachusetts, USA

Correspondence
Marta Negri, Department of Management Economics and Industrial Engineering, Politecnico di Milano, Via Lambruschini, 4/B, 20156 Milano MI, Italy.
Email: marta.negri@polimi.it

Abstract

Sustainability has emerged as an important industrial strategic outlook expanding beyond organizational boundaries to include the supply chain. Simultaneously, the industry has also been faced with supply chain resilience concerns. Research on the intersection of supply chain sustainability and resilience is nascent and is a consequence of their observed mutual influences. However, confusion about concepts, implementation methods, and measurements of sustainable and resilient supply chains remains. This study completes a systematic literature review that critically examines several major observations and directions. We find the concept of sustainable supply chains is more established, and general agreement on its theoretical foundations exists. Supply chain resilience is relatively less mature. The nexus and relationships between the two topics are often incoherent: there is confusion on sustainable and resilient supply chains establishment; there is no clarity on what practices could jointly advance both areas. A major conflict exists since sustainability generally focuses on efficiency, while resilience seeks effectiveness. We recommend studies to analyze implementation relationships and impact. We also observe that performance measurement systems should be developed to assess supply chain sustainability and resilience performance taking with explicit consideration time horizons considered in these measures.

KEYWORDS
resilience, supply chain, supply chain resilience, sustainability, sustainable supply chain

1 | INTRODUCTION

Supply chain sustainability garnered increased attention over the past few decades (Fahimnia et al., 2019), because of tighter regulations, increased competition and consumer pressures (Meixell & Luoma, 2015), globalization, outsourcing, challenging markets, uncertainty in demand, and a push toward economic competitiveness (Ansari & Kant, 2017; Grant et al., 2017). These recent trends, in addition to greater demand volatility, shortened product life cycles, and an increased innovation rate, have contributed to supply chain complexity vulnerability (Christopher, 2011). As a consequence, the need to investigate supply chain resilience has emerged, as a way to prepare, resist and recover from disruptions along the supply chain (Kamalahmadi & Parast, 2016).

Both sustainability and resilience are critical for supply chains (Fahimnia et al., 2019). Firstly, supply chains are asked to improve their sustainability performance along the triple bottom line (Ahi & Searcy, 2013); alternatively, they are required to address increasing vulnerability and uncertainty (Ali, Mahfouz, & Arisha, 2017).

Although a considerable number of journal papers and scientific contributions have been published on these two concepts, the research streams of sustainability and resilience have developed separately in the literature. The integration between sustainability and resilience in a supply chain context is still quite underexplored in extant literature.

However, empirical evidence shows that sustainability and resilience influence each other (Fahimnia et al., 2019). For instance, improving the firms' efficiency and sustainability by reducing stocks might reduce its capability to respond to disruptions in supply; investing in the relationship with suppliers to improve their sustainability performance might imply more rigidity when supply disruptions require firms to rapidly purchase from different sources. There are also cases in which sustainability and resilience do not result in trade-offs. One example is a strategy that depletes critical elements from the natural environment will likely reduce the resilience of the system (Perrings, 2006). Besides, some disruptions—including the Covid19 pandemic—may open opportunities for more sustainable development, as a resilient response to a crisis (Sarkis et al., 2020).

Studies have explored sustainability and resilience impact on supply chain and organizational performance. Some have recently claimed that incorporating sustainability into business operations can result in improved firm performance (Pinto, 2020). Similarly, resilience should be seen as a source of competitive advantage rather than a mere tool for risk reduction (Klibi et al., 2010).

Organizations increasingly appreciate the need to understand the relationship between these two concepts and seize emerging opportunities arising from a supply chain management sustainable and resilient approach.

This paper aims to study the inter-relationship between these two constructs, and understand whether they exist in trade-off environments or whether they are mutually reinforcing. The contribution of this finding occurs from a research and practical perspective. The findings may show a preponderance of one environment over another, understanding theoretically why one or the other exists can be important from a theoretical perspective to determine appropriate constructs and relationships. These constructs and relationships will provide insights into jointly managing these concerns for practitioners and managers.

The starting point will be a literature background (Section 2) on sustainability and resilience as separate concepts, which will serve as an initial reasoning to understand where the two concepts originated from and their evolution. The methodology is outlined in Section 3, and finally, the results from the systematic literature review will be presented and discussed in Sections 4 and 5. The conclusion appears in Section 6.

2 | BACKGROUND

Sustainability and resilience belong to rich research streams that have been explored mostly separately (Fahimnia et al., 2019). We now present main milestones related to the two streams of study.

2.1 | Sustainability

2.1.1 | General

The concept of Sustainable Development was first introduced by the United Nations Conference on the Human Environment (1972). However, increased attention to sustainability globally emerged after the Brundtland report, in 1987 (Klewitz & Hansen, 2014). The commission defined sustainable development as one that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development (WCED), 1987).

The operationalization of sustainability appeared as the triple bottom line (TBL) model, that described sustainability as the intersection and balance of economic, social and environmental concerns (Elkington, 1998; Trianni et al., 2017). The perspective of the TBL will be adopted in this paper, and sustainability will mean improving performance along one of the three pillars—economic, environmental, or social—without reducing performance in any other pillars.

The common traits present in these and similar definitions is the long-term perspective and the need to pose constraints on consumption. It is often stressed that sustainability should not be seen as a goal to strive for, but rather as an inherent characteristic of systems (Fiksel, 2003).

Although most studies define sustainability to include the three pillars of the Triple Bottom Line, some consider sustainability to encompass environmental sustainability alone (Azzone et al., 1996; Bansall & Roth, 2000; Barreto et al., 2010; Epstein, 2007; IPCC (Intergovernmental Panel on Climate Change), 2007; ISO 14001 (International Organization for Standardization), 2004; Korhonen & Seager, 2008; Maxwell et al., 1997; Ramos & de Melo, 2006; Rebitzer et al., 2004; Sharma & Henriques, 2005; Walton et al., 1998); social sustainability alone (Blair et al., 2004; Erickson & Gowdy, 2007; SA 8000, 2008), social and environmental sustainability (Amnesty International, 2004; Hunkeler & Rebitzer, 2005; International Council on Human Rights Policy, 2002; Jørgensen et al., 2008; Marteel et al., 2003; UN, 2000), or environmental and economic sustainability (ACBE (Advisory Committee on Business and the Environment), 1997; Azzone et al., 1996; Bianchi & Noci, 1998; Miles & Covin, 2000; Noci & Verganti, 1999; Rao & Holt, 2005; Rao et al., 2009; Simpson et al., 2004).

The intersection of the social and economic pillars in literature has also been explored as occupational health and safety (OHS), while the intersection between environmental and economic pillars as eco-efficiency (Neri et al., 2018; Tonelli et al., 2013).

2.1.2 | Supply chain sustainability

Sustainable supply chain management (SSCM) has been receiving increasing attention (Sajjad et al., 2020), as evidence showed that sustainability improvement can be more fully realized when considering concerns outside firm boundaries (Fahimnia et al., 2019).

Several literature reviews have sought to further understand and develop sustainable supply chain management (e.g. Ahi & Searcy, 2013; Ansari & Kant, 2017; Ashby et al., 2012; Hassini et al., 2012; Klewitz & Hansen, 2014; Martins & Pato, 2019; Touboulic & Walker, 2015), which is symptomatic of the great popularity of the topic.

The two mostly cited (Ahi & Searcy, 2013) SSCM definitions are: "The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements" (Seuring & Müller, 2008); and "The strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains" (Carter & Rogers, 2008).

Interestingly, the concepts of risk and resilience have been increasingly introduced in sustainable supply chain studies (e.g., Ahi & Searcy, 2013; Carter & Rogers, 2008; Closs et al., 2011). Besides, a long-term—strategic—perspective remains consistent in these definitions as well.

Yet there is a lack of consistency in the definitions of SSCM (Stindt, 2017); in fact, it is emblematic of essentially contested concepts. Table A1 summarizes a comprehensive set of SSCM definitions found in the literature, although the list is not meant to be exhaustive.

The most novel definitions of sustainable supply chain tend to encompass the three pillars of the triple bottom line definition. However, studies more fully embrace the environmental dimension of sustainability (Gimenez & Tachizawa, 2012; Martins & Pato, 2019; Winter & Knemeyer, 2013), in what is referred to as Green Supply Chain Management (GSCM). Papers on GSCM appear from the beginning of the 00s (Ahi & Searcy, 2013), while studies (Ashby et al., 2012) show that the first contributions to SSCM literature appeared after the year 2003 and have been increasing substantially after 2010 (Stindt, 2017). This might be explained by the fact that the first attempts of incorporating sustainability into supply chains began with the environmental dimension (Martins & Pato, 2019).

Consequently, some authors consider GSCM as a subset of SSCM (Stindt, 2017) and focus on SSCM as a natural continuation of the research stream of GSCM (Ahi & Searcy, 2013; Ashby et al., 2012; de Oliveira et al., 2018). On the other hand, some authors still explore GSCM and the environmental dimension alone (Min & Kim, 2012; Sarkis, 2012; Sarkis et al., 2011; Srivastava, 2007). Some researchers deem that the term sustainability is muddled and lessens attention to environmental concerns which are subsumed by the anthropocentric—social and economic—dimensions (Sarkis, 2007). A non-exhaustive list of definitions of GSCM is provided in Table A2.

The social dimension of sustainability, instead, is considered ambiguous (Ashby et al., 2012) and not necessarily directly linked to improved firm profitability (Yun et al., 2019). Even with an increasing uniform utilization of the term sustainability as a triple bottom line concept (Carter & Easton, 2011; Seuring, 2013), the social dimension is often absent from studies (Moreno-Camacho et al., 2019).

In a nutshell, the boundaries between sustainable supply chain management (SSCM) and other related paradigms, e.g. green supply chain management (GSCM) or corporate social responsibility (CSR), are still gray and polysemous (Ahi & Searcy, 2013; de Oliveira et al., 2018; Stindt, 2017). The lack of SSCM definitional consensus and the dispersion of literature (Touboulic & Walker, 2015) indicates the relative infancy of this field and that additional research is needed for clearer construct and theoretical development.

This study defines sustainable supply chain management as the planning, execution and control of corporate value creation processes along the whole supply chain by integrating economic, environmental, and social aspects into decision-making with the purpose of improving long-term performance and mitigating risks.

2.1.3 | Research streams

Maditati et al. (2018) perform a thorough literature review on GSCM—a subset of SSCM—and identify six research streams: conceptual development and sensemaking; GSCM impact on performance; SC integration (collaboration with customers and/or suppliers, reverse logistics); green supplier development; GSCM implementation drivers, practices, performance measure in GSCM; review and future research directions. Stindt (2017) divides the contribution on SSCM in a similar way, identifying the macro categories of theory development, decision-making, and performance measurement.

Building on the research stream categorization of Maditati et al. (2018) and Stindt (2017), SSCM studies may be divided into four categories:

- *Concepts*—Including definitional foundations and theory building.
- *Implementation*—including one or more of these factors: practices, pressures or drivers, decision-making, and barriers.
- Performance and measurement
- Future research agendas

Each of these streams is overviewed.

Concepts—includes studies that focus on SSCM foundational definitional, theoretical and conceptual development. This category has been further divided into *definitions* and *theory building*. Foundational definitions are provided in many studies; the most cited ones are by Srivastava (2007) for GSCM and by Carter and Rogers (2008) and Seuring and Müller (2008) for SSCM.

For theory building, several frameworks have been proposed to explain SSCM construct interrelationships. As examples, studies have investigated relationships between collaboration and performance (Kache & Seuring, 2014); or between implementing GSCM and business and operational performance (Abdallah & Al-Ghwayeen, 2019). Literature reviews have also been used to build a conceptual framework to link the constructs of SSCM (Seuring & Müller, 2008). Carter and Rogers (2008) provide guidance on how companies can achieve

sustainability and a competitive advantage, by stating that firms that can incorporate social and environmental resources are harder to imitate. Similar considerations are also suggested by others such as Touboulic and Walker (2015).

Implementation—this study stream includes the contributions understanding and building relationships within and between *practices*, *pressures/drivers*, *decision-making*, and *barriers*.

Practices studies include several classifications in the literature. Common organization environmental practices are Reduction, Reuse, Remanufacture, Recycle, and Disposal (Sarkis, 2003; Tseng et al., 2019). One popular approach is to consider supply chain position practices. For example, value chain processes would include early stages of product development, that is, sustainable product design, sustainable supply chain design, green design, eco-innovation and eco-design (Tseng et al., 2019). Upstream supply chain practices would include evaluation of supplier assessment, code of conduct and cooperation with suppliers, and sustainable procurement (Gimenez & Tachizawa, 2012; Tseng et al., 2019). Internal and downstream supply chain practices investigations include sustainable manufacturing, operations practices (Das, 2017), product stewardship, supply chain integration (Stindt, 2017), sustainable warehousing, sustainable logistics (Stindt, 2017) and industrial symbiosis (Tseng et al., 2019). There are also supporting tools and functions practices that support SSCM and include information management, practices identified are green information technology and systems, adoption of certifications, internal management (Tseng et al., 2019).

Studies have shown that sustainability practices are more likely to be adopted when they are connected to cost reduction—eco-efficiency perspectives (Marco-Ferreira & Jabbour, 2019). This may also explain some reasoning for social sustainability practices not being included in many studies or adoptions. Social practices are usually associated with an increase in costs, may require higher levels of coordination and control (Golini et al., 2017).

Many studies also conclude that supplier relationship management is fundamental for improving supply chain sustainability (Chen et al., 2018). More in general, all supply chain activities—procurement, production, warehousing, product design, and distribution—should be included in firms' sustainability strategies (Zhu & Sarkis, 2007). Other studies may define these breadth of practices in slightly different ways and may include practices such as green warehousing, green supplier collaboration, environment conservation, logistics optimization as drivers of sustainable supply chains (Dubey et al., 2017). These divergent and multiple practices identification and study further exemplify that SSCM is still an essentially contested concept.

The *pressures* and *drivers* in studies are typically viewed as antecedents, mediators or moderators to acceptance and implementation of practices. Some categorize these elements into internal and external dimensions (Tseng et al., 2019). Internal drivers include environmental commitment, senior management support, corporate history, resource availability, size, operational excellence, purchasing function capabilities, training, innovation capability, project leadership, quality management practices, performance measurement systems, and multifaceted CSR practices (Gimenez & Tachizawa, 2012).

External drivers and pressures include stakeholder—customers, governments and regulatory bodies—pressures (Meixell & Luoma, 2015; Seuring & Müller, 2008); transportation and information (Hassini et al., 2012); national culture; trust; technological developments; logistical integration; and competitive pressures (Gimenez & Tachizawa, 2012; Panigrahi et al., 2019; Tseng et al., 2019). Enablers have also been an investigatory direction (Ansari & Kant, 2017). The most common enablers identified are top management commitment, government regulations, and collaboration.

Decision making literature streams include identification of practices and SSCM elements such as product life cycle, operational life cycle, environmentally influential organizational practices as the foundations for decision-making tools (Sarkis, 2003). The modeling literature for SSCM is extensive with many works along this and similar lines (Brandenburg et al., 2014). Developing a green or sustainable supply chain usually implies shifting trade-offs or solving multi-criteria problems. Thus, methodologies are often applied (Seuring, 2013).

Barriers analysis implementation study dimensions for SSCM and GSCM are similar to enablers, pressures, and drivers with a quite lengthy and varied list. For example, Mathiyazhagan et al. (2013) identify lack of customer urgency and pressure on GSCM, disbelief in environmental benefits, poor supplier commitment and cooperation on information, lack of green system exposure to professionals as having the highest relevance. Golini et al. (2017) also mention the difficulty of fostering collaboration and the higher power held by industrial processors. Costs, lack of training, lack of top management commitment and inadequate supplier commitment are some of the most important barriers that occur in the implementation of SSCM (Ansari & Kant, 2017).

Performance and Measurement—studies argue that adequate metrics are essential to assess the level of supply chain sustainability (Panigrahi et al., 2019), and they are critical enablers to SSCM (Gimenez & Tachizawa, 2012).

Reviews of this topic identify limitations such as the lack of context-based measurements, underrepresentation of key supply chain characteristics, and the fact that not all actors are included in the existing metrics (Ahi & Searcy, 2015). An explicit limitation in research was a lack of resilience metrics for SSCM (Ahi & Searcy, 2015). Most published metrics are based on supply chain environmental performance (Moreno-Camacho et al., 2019), evaluated in terms of resource consumption, life cycle assessment (LCA), and pollution emissions. Economic performance in the sustainability context is related to cost minimization, profit maximization, the difference between total income and total costs, and net present value maximization. The social dimension in the literature has primarily used work conditions, societal commitment, and customer issues performance dimensions (Mani et al., 2018; Moreno-Camacho et al., 2019).

Future research agendas—were a major element of several systematic literature reviews on SSCM, especially those after 2012 (Carter & Washispack, 2018). A criticism of the field is that literature reviews in SSCM have reached the saturation point (Carter & Washispack, 2018). Others argue that there is space for more literature reviews that investigate the interactions among constructs

(Meixell & Luoma, 2015) and that improve the rigor of existing systematic literature reviews (Carter & Washispack, 2018). Although duplication studies in this field are welcome, it is of particular importance to acknowledge the future research streams suggested by previous studies, in order to avoid too much duplication of research.

According to Carter and Easton (2011) the supply chain is still underrepresented as a unit of analysis in sustainability literature, and it is still unclear what types of relationships among the parties should be encouraged (Govindan et al., 2016). The systematic literature review by Tseng et al. (2019) studies the development of research and provides guidance for future research. Research still needs integration of social aspects into SSCM; on addressing inventory management and the customer-supplier relationship; on linking managerial practices to sustainability; on providing guidelines to SMEs and on implementing industry specific research (Panigrahi et al., 2019).

2.2 | Resilience

This section provides an overview of the resilience literature, with additional detail on supply chain resilience.

2.2.1 | General

The term resilience originated from engineering (Hollnagel et al., 2006). In material sciences it is "the property of material ability to return to their original shape after deformation and while not exceeding their elastic limit" (Rice & Caniato, 2003). Resilience has become wide-ranging (Ali, Mahfouz, & Arisha, 2017) and multidisciplinary (Ponomarov & Holcomb, 2009), with also psychological, ecological, disaster relief, and social science foundations (Ponomarov & Holcomb, 2009; Walker & Salt, 2012).

From an ecological and environmental perspective resilience is system persistence and its ability to "absorb change and disturbance while maintaining the same relationships between populations or state variables" (Holling, 1973).

Socially, resilience is the adaptation capability of a community to hazards, either resisting or moving till the level of functioning and structure are acceptable (UNISDR, 2005). Finally, from an organizational perspective it is the capability to cope with unanticipated shocks and learn after they become manifest (Bhamra et al., 2011; Horne, 1997; Weick et al., 2008).

2.2.2 | Supply chain resilience

Supply chain management views resilience in multiple ways, but is a fundamental capability of firms (Brusset & Teller, 2017; Fiksel, 2006; Rice & Caniato, 2003). Supply chain resilience (SCRes) is a relatively recent phenomenon that became popularized around 2003 (Ali, Mahfouz, & Arisha, 2017; Kamalahmadi & Parast, 2016). Rice and Caniato (2003), Christopher and Peck (2004) and Sheffi et al. (2003) constitute a foundational literature on SCRes (Ali, Mahfouz, & Arisha, 2017).

Despite being a relatively less established concept compared to SSCM, several literature reviews have attempted to consolidate SCRes concepts (e.g., Ali, Mahfouz, & Arisha, 2017; Bak et al., 2020; Sawyerr & Harrison, 2020) and metrics (Ham et al., 2020). It appears that SCRes has been studied mostly theoretically, and that a great number of definitions have been brought forward, although confusion on key terminology still exists (Ham et al., 2020). The lack of broad empirical research is also highlighted by other authors (Ali & Gölgeci, 2019).

SCRes with its multiple definitions includes: the adaptive capability to prepare (Ponomarov & Holcomb, 2009); react to an unforeseen disruption and restore regular activities (Rice & Caniato, 2003; Sheffi et al., 2003); or to move toward a different and more desirable state (Martin Christopher & Peck, 2004). It refers to the ability of a system to survive, adapt and grow (Pettit et al., 2010) while preserving its structure and function (Fiksel, 2006). Studies have proved and argued that it has positive impact on firm performance and is a source of competitive advantage (Rice & Caniato, 2003). Yet, there is still question on whether resilience should be considered a capability of the system, or a measure, a feature or a philosophy (Bhamra et al., 2011). Various definitions of SCRes are summarized in Table A3 (Ali, Mahfouz, & Arisha, 2017).

SCRes is closely related to supply chain risk and risk management concepts. Risk combines the probability of an event and its consequences (Pettit et al., 2010); or the effect of uncertainty on objectives (ISO/Guide 73:2009, 2009). Risk studies can be categorized into two groups (Wagner & Bode, 2008). The first group highlights the opportunity embedded in risks. Risk in this situation is defined as variation from expected outcomes (Jüttner et al., 2003). The second understanding of risk entails only a negative meaning to hurt the enterprise (Tang & Musa, 2011).

Supply chain risk management has as its core the protection of business from adverse events (Colicchia et al., 2010). The common elements present in risk management definitions include the potential losses if the risk is realised, the likelihood of the losses, the significance and consequences of the losses (Manuj & Mentzer, 2008).

Resilience takes on a significant supply chain risk management role (Elleuch et al., 2016; Ponomarov & Holcomb, 2009). Strategies to enhance supply chain security can either focus on preventing security breaches or on mitigating the consequences of disruptions and enabling prompt reaction (Sheffi et al., 2003). However, traditional risk identification is not always possible, statistical data might be absent and they are often based on an over-simplified understanding of the world (Fiksel et al., 2015); avoidance may also not be possible due to the unforeseen and unknown likelihood. In this sense, resilience may complement traditional risk management planning processes (Fiksel et al., 2015), but should be kept separated from it (Pettit et al., 2013).

Traditionally, there is a neglect of learning from crises that may lead to a different and potentially improved state of operations (Fiksel et al., 2015).

2.2.3 | Research streams

We use the SSCM research stream category to evaluate SCRes and risk research streams.

- *Concepts*—Including definitional foundations and theory building.
- *Implementation*—including one or more of these factors: practices, pressures or drivers, decision-making, and barriers.
- Performance measurement
- Future research agendas

Concepts—important *definitions* of SCRes summarized in Table A3 and include those by Christopher and Peck (2004), Fiksel (2006), Pettit et al. (2010), Ponomarov and Holcomb (2009), Rice and Caniato (2003), and Sheffi et al. (2003).

Theory building investigations focus on development and application of constructs. A review of the literature has identifies three constructs: the phases of resilience, the strategies to enhance SCRes and the capabilities needed to ensure SCRes (Ali, Mahfouz, & Arisha, 2017). Resilience phases consist of pre-disruption, during disruption and post-disruption (Ali, Mahfouz, & Arisha, 2017; Kamalahmadi & Parast, 2016; Sheffi et al., 2003). Some studies pointed out different supply chain resilience definitions according to the phase of resilience under consideration. For instance, Ponomarov and Holcomb's (2009) definition highlighted the preparedness dimension of disruptions (Ali, Mahfouz, & Arisha, 2017).

Similar to broader concepts as SSCM, there is lack of consensus among scholars for resilience constructs (Jüttner & Maklan, 2011). For instance, the term "strategies" (Ali, Mahfouz, & Arisha, 2017) will be used as a synonyms for "practices" in this paper, and will be detailed later in this section.

SCRes capabilities are also theoretically constructed. Some capabilities clusters include (Ali, Mahfouz, & Arisha, 2017): the ability to anticipate, change, react, recover, and learn; they are linked to the three resilience phases (Chowdhury & Quaddus, 2017). SCRes capabilities can be proactive and reactive (Chowdhury & Quaddus, 2017). The literature still shows disparity concerning the way the capabilities are classified.

Implementation—is a rich research stream. We define SCRes strategies as *practices* to implement in order to enhance the SCRes. There are proactive, concurrent, and reactive, based on disruption phase (Ali, Mahfouz, & Arisha, 2017).

Proactive practices refer to those anticipating disruptions. These practices include supply chain risk assessment, increasing collaboration and control (Rajesh, 2019a), increasing capabilities (Jüttner et al., 2003), supply chain design, supply chain visibility, infusing a resilience culture (Pettit et al., 2013), segmenting or regionalizing, avoiding to much centralization, and information and communication technology (ICT) adoption (Kamalahmadi & Parast, 2016).

During disruption practices include agility and responsiveness in supply chains, flexible supply chains (Rajesh, 2019a), excess capacity, additional inventory (Lücker & Seifert, 2017), increasing responsiveness, increasing flexibility, aggregate or pooling demand, building more customer accounts, postponement, strategic stock, operational mitigation, flexible supply bases, flexible transportation, dynamic assortment planning, economic supply incentives, silent product rollover, operational contingency, speculation, hedging, security, and avoidance (Jüttner et al., 2003).

Reactive practices include the ability to recover and the ability to learn, typically after a disruption. Therefore, practices include contingency planning, building social capital, market positioning, knowledge management (Ali, Mahfouz, & Arisha, 2017).

Flexibility and redundancy seem to be common practices with the greatest promise for building SCRes—even though there is no approach that fits all situations (Rice & Caniato, 2003). Designing for SCRes is seeing increasing emphasis in the literature (Sheffi et al., 2003). Information sharing is also considered critical in literature, as it facilitates the development of trust and the sharing of risks (Jain et al., 2017).

Pressures and drivers are typically studied as SCRes antecedents. Supply chain orientation, risk management culture, and orientation to learning are key organizational characteristics that foster SCRes (Ambulkar et al., 2015; Chowdhury & Quaddus, 2017); Trust, cooperation and visibility are relationally important drivers (Dubey et al., 2017). Visibility can improve decision-making, responsiveness, and supply chain performance, with a positive impact on robustness and resilience of supply chains.

The relational categories are typically non-industry specific and generalizable. But industry-specific drivers do come into play. Flexibility in contracts, diversification, better transport planning and safety stock, strategic and operational flexibility, switching suppliers, flexible supply bases, flexibility and redundancy, low inventories, and using ICT, are each drivers that have varying importance and relationships, depending on industrial sector (Ali, Nagalingam, & Gurd, 2017).

Another driver categorization includes proactive or reactive enablers (Ali, Mahfouz, & Arisha, 2017). Proactive drivers include business certifications—essential to ensure compliance; globalizations since it removes trade barriers; vertical integration; training and development; and quality management. Reactive elements enablers include: responsiveness to customer needs; responsiveness to competitors strategy; multi sourcing, and public-private collaboration. Jain et al. (2017) identify 13 enablers of resilience: adaptive capacity—accepting of change and creating a system capable of adapting to new system states; collaboration among players—two or more autonomous firms planning jointly and executing supply chain operations; trust among players—such as the willingness to rely on an exchange partner; supply chain sustainability, an important and underrepresented topic which we study in this paper.

Decision-making studies have also existed to help SCRes implementation. It was found that single actor decision-maker should have minimum levels of preparedness and capabilities to address unpredictability (Datta et al., 2007). Several studies identify firm decision-making that should be oriented toward a balanced SCRes, where the capabilities developed by the firms are able to mitigate

risks without eroding profits (Gualandris & Kalchschmidt, 2015; Pettit et al., 2013).

Failure in embracing resilience suggests a remaining presence of *barriers* (Ali, Nagalingam, & Gurd, 2017). Studies have identified lack of managerial autonomy, inadequate R&D investment, lack of ICT integration as major barriers—many times these barriers are the flip side of enablers.

Performance and measurement—few SCRes studies exist on this topic. Measuring SCRes is still unclear (Kamalahmadi & Parast, 2016). Multiple perspectives for performance evaluation and measurement have been proposed. These perspectives include: comparing suppliers resilience performance; applying performances criteria to measure resilience; and measuring ripple effects of supply chains (Elleuch et al., 2016).

Two critical measures of SCRes are generically defined as readiness and response recovery (Chowdhury & Quaddus, 2017). Traditionally resilience has focused on recovery time—implying it is a post-disruption phase measure (Ambulkar et al., 2015; Dubey et al., 2017). Specific metrics would include time to restore material flow, the recovery time till normal operating performance is restored, and the effort to return to the original status (Behzadi et al., 2020).

There are also operational capability factors that can serve as SCRes measures. Pettit et al. (2013) in their study included flexibility in sourcing and order fulfillment, anticipation, capacity, efficiency, visibility, financial strength, adaptability, recovery, collaboration, organization, market position, dispersion, and security.

Future research agenda issues in SCRes have been quite broad. For example, it is highlighted that few empirical studies exist when compared to theoretical ones (Ali, Mahfouz, & Arisha, 2017). This situation may result from the research topic's immaturity. Studies of models to overcome barriers and grounded research on quantitative methodologies have been proposed as fruitful future research directions (Ali, Nagalingam, & Gurd, 2017).

Another underrepresented SCRes research topic is the role of human and organizational behavior to mitigate and recover from disruptions (Dubey et al., 2017; Ivanov, 2018). Interestingly—and in the scope of our study—it has been proposed that resilience and sustainability should be combined and developed jointly, and further analyses on the trade-offs that arise are encouraged (Rajesh, 2019a). It is from this foundation that we now review the literature on the nexus of SSCM and SCRes.

3 | METHODOLOGY

A systematic literature review is the grounding of this paper. The process followed by the authors is exhibited in Figure 1 and described in the following paragraphs.

A systematic literature review should clearly state the process in order to ensure replicability and transparency (Denyer & Tranfield, 2009). The process should include (Thomé et al., 2016): planning and formulating the problem, searching the literature, data gathering and quality evaluation.

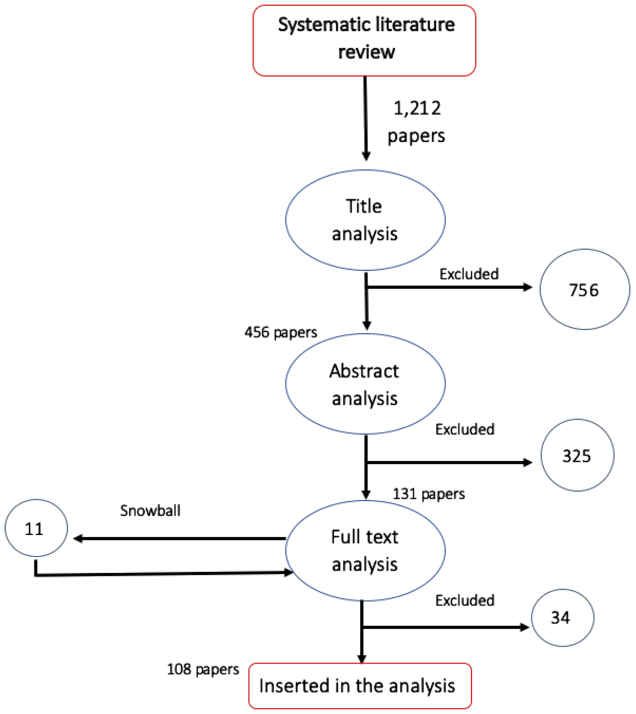

FIGURE 1 Summary of literature review process [Colour figure can be viewed at wileyonlinelibrary.com]

3.1 | Planning and formulating the problem

The research question and the scope of the review should be well established ex ante (Thomé et al., 2016 and the criteria for inclusion and exclusion of papers need to be clear (Shea et al., 2007).

The systematic literature review identifies contributions that reconcile resilience and sustainability concepts in supply chains; provide a state-of-the-art panorama of the research; identify research gaps; and propose a future research agenda. All related articles are included in the evaluation. Green supply chain management and risk management articles are included—the topics are closely related or elemental to the broad sustainable supply chain and resilience literature—provided that they contain resilience and sustainability aspects.

Exclusion criteria include non-affiliated fields (e.g., medicine) and papers not focusing on the intersection of sustainability and resilience. Additional papers have been excluded after an abstract or full text analysis and the paper is considered out-of-scope.

3.2 | Searching the literature

A systematic literature review should have broad enough keywords to ensure relevant contributions are not excluded (Thomé et al., 2016). The process of papers selection was stopped when no additional relevant contributions were found (Levy & Ellis, 2006).

The Scopus database is used to identify research articles. As mentioned, the keywords utilized are from a preliminary literature review. The keywords have then been evaluated by panel of experts in supply

chain, sustainability and resilience fields to help ensure completeness and accuracy. The search is summarized in Table 1.

The search (conducted in July 2020) initially results in 1212 publications. These results are analyzed independently by two reviewers to reduce the bias (Thomé et al., 2016). Each disagreement was discussed until consensus was reached.

A title analysis excludes 756 contributions, according to the criteria listed above. The resulting set of 456 papers were then subject to an abstract analysis, which led to an additional exclusion of 325 papers. The remaining 131 papers underwent a full text analysis. There were 34 additional exclusions. The snowball method (Thomé et al., 2016) investigated selected references from within the remaining 97. This resulted in 11 papers added to the list—since these articles provided additional useful insights on the topic.

The final data set of articles for this systematic literature review consists of 108 papers.

3.3 | Data gathering and quality evaluation

Internal and external validity evaluation is completed at this stage (Thomé et al., 2016). Internal validity means the research can deliver unbiased results. Internal validity is ensured by having two people analyze and select the manuscripts. External validity is used to evaluate generalizability of the outcomes. It is intrinsic to the research design, as the research was not confined to any particular industry or setting.

In the next section results of the preliminary search of literature on sustainability and resilience are presented.

TABLE 1 Keywords and criteria used for the papers selection

Criteria selection for the literature review		
Keywords	**Language**	**Publication type**
TITLE-ABS-KEY ("supply chain" OR "supply network") AND (TITLE-ABS-KEY (resilien*) OR TITLE-ABS-KEY (risk)) AND (TITLE-ABS-KEY (sustainab*) OR TITLE-ABS-KEY (green*))	English	Journals

4 | SUSTAINABLE AND RESILIENT SUPPLY CHAINS

The 108 papers selected from the systematic search have been analyzed and classified, according to the axes (concepts, implementation, performance measurement, future research agenda) used in the previous sections. In addition, whether papers focus on sustainable or green supply chain or if they focus on resilience or risk is highlighted.

First, most of the papers—roughly 60%—on sustainable and resilient supply chains are published after 2017—see Figure 2. This observation confirms that relationship between sustainability and resilience is in its early development (Fahimnia et al., 2019).

Concepts—many papers focus on definition and theory building, given the research area is nascent. In spite of this, however, initial attempts to integrate risk and green operations concepts appeared as early as 1995 (Shrivastava, 1995). This study pointed out that risk management should encompass environmentally sustainable practices, such as waste management and harmful products management.

Definitions: Carter and Rogers (2008) highlighted risk management as an additional sustainability element, even though it is not explicitly part of their definition. Initially, some authors acknowledged the presence of "sustainability risks" and "process risks" that could disrupt supply chains (Seuring & Müller, 2008). Subsequently the concept of risk evolved into resilience and it was explicitly included in some definitions of sustainability (e.g., Ahi & Searcy, 2013, 2015).

In this earlier interpretation of resilience and sustainability, resilience becomes a short- and long-term goal of sustainable

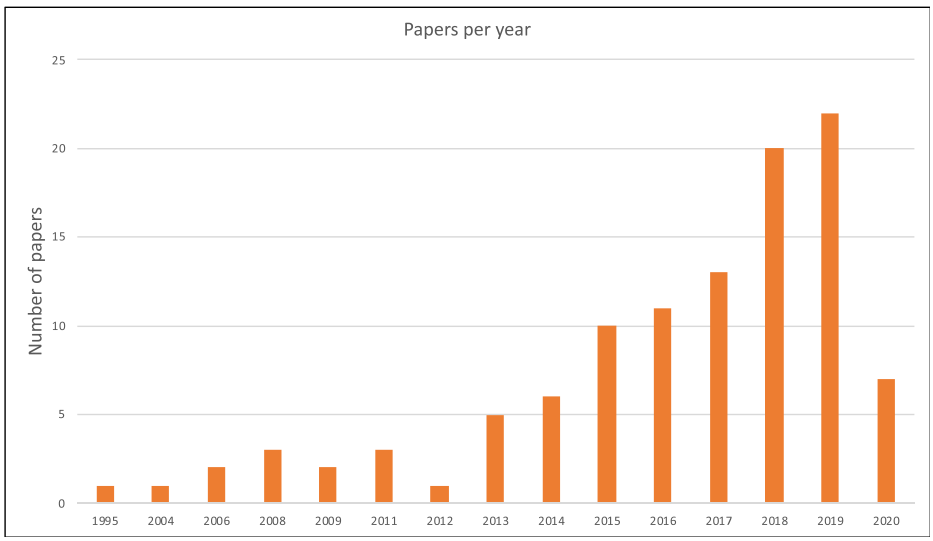

FIGURE 2 Annual distribution of the papers published (part of 2020 only) [Colour figure can be viewed at wileyonlinelibrary.com]

management and including risk reduction (Closs et al., 2011; Zhu et al., 2005). Besides these initial attempts to provide a definition by integrating the two concepts, there is still poor consensus among researchers on the definition of a sustainable and resilient supply chains.

Theoretical relationships and building (Theory): Several approaches to integrate sustainability and resilience have been introduced. In many cases, the traditional triple bottom line dimensions of sustainability have been broadened to other constructs that have been becoming increasingly important, such as risk and knowledge (Closs et al., 2011; Göçer et al., 2018, 2019). Nevertheless, more holistic approaches have been recommended given the complexity and urgency of sustainability (Fiksel, 2006). This holism is needed due to conflicting objectives and trade-offs.

Some studies argue that sustainability is a resiliency antecedent (Gouda & Saranga, 2018; Jain et al., 2017) and that sustainability practices may positively enhance resilience (Bag et al., 2019); other studies adopt the perspective that the two are strictly related but not necessarily correlated (Mäler, 2008). That is, strategies to improve one do not necessarily improve the other as well (Derissen et al., 2011; Edgeman & Wu, 2016; Ivanov, 2018; Perrings, 2006). Some studies have pointed out that disruption risk and environmental practices actually have a negative relationship (Kim & Chai, 2017). In this situation risks might be an obstacle to the implementation of green practices.

Some studies observe that risk or resilience are drivers for sustainability effort (Brinkley, 2018; Eltantawy, 2015; Lintukangas et al., 2016; Papadopoulos et al., 2017; Shin & Park, 2019). Others posit that sustainability should be addressed as a risk management issue (Anderson & Anderson, 2009), or that resilience is a "feature that describes sustainability", as it includes social and environmental dimensions (Higgins et al., 2010). It has also been argued that a sustainable supply chain should be able to properly assess and prepare to risk (Closs et al., 2011; Mangla et al., 2014a).

When integrating the two research streams, many studies now recognize the importance of integrating sustainability and resilience (Furman & Papavasiliou, 2018; Rajesh, 2018). However, several studies deal with sustainability and risk, rather than sustainability and resilience (Shahin et al., 2019). Sustainability risk studies have also drawn attention (Freise & Seuring, 2015; Li et al., 2015; Mani et al., 2017; Miemczyk & Luzzini, 2019; Shafiq et al., 2017; Song et al., 2017; Syed et al., 2019). Traditional risk management approaches typically do not include the risks that derive from social, ecological and ethical supply chain problems (Hofmann et al., 2014). Yet many organizations have suffered from damages related to unmanaged, or poorly managed, sustainability risks. Rostamzadeh et al. (2018) propose a framework to evaluate sustainability-related risks and observe that risk management practices and sustainability should be integrated to ensure resilient supply chains.

A relatively limited number of studies have analyzed the relationship between resilience and green supply chains (Azevedo et al., 2013; Cabral et al., 2012; Cruz, 2013) or have studied risk management in green supply chains (Cano & Ayala, 2019; Fahimnia, Tang, et al., 2015; Fernando et al., 2018; Mangla et al., 2016b).

A general observation is that confusion remains about the relationship between sustainability and resilience, additional studies are needed to further clarify and theorize relationships among these factors. There are numerous contingent and complex relationships between the two that can be theoretically investigated. Contingencies will likely require investigating a variety of moderating relationships and various mediational relationships given the lack of clarity in sequential relationships among the concepts.

Implementation—concerns on practices adoption, drivers and pressures, decision-making related to implementation, and barriers to implementation are four streams of research at the nexus of sustainable and resilient supply chains.

Practices: a big concern in the literature includes what practices can jointly enhance sustainability and resilience in the supply chain. Studies have argued that jointly maximizing sustainability and resilience are more likely to be better solutions than those that seek to optimize one of the two (Edgeman & Wu, 2016; Govindan et al., 2015).

The literature's identified practices are roughly divided into supply, demand, product and information categories. Concerning the supply side, the most common practices are those investing in the long term supplier relationships (Azevedo et al., 2016; Mangla et al., 2018; Teuscher et al., 2006), investing in green purchasing (Hallikas et al., 2020), or having a multi-sourcing strategy (Ji, 2009), and information sharing (Carvalho et al., 2011). The level of implementation of practices in the supply side depends largely on the perceived losses and the available resources (Cousins et al., 2004).

Typical demand-side practices identified are customer relationship management (Azevedo et al., 2016; Beske & Seuring, 2014; Cruz, 2013; Mangla et al., 2018) and demand postponement (Ji, 2009). Product-related practices include product interchangeability and responsive pricing (Ji, 2009). Finally, information related practices include training and education (Mangla et al., 2018), information sharing, information systems flexibility (Ji, 2009).

Other identified practices include just-in-time (lean) practices, pull flows, and total quality management (Azevedo et al., 2016), top management commitment and the design of an effective reverse logistics system (Mangla et al., 2018), supply chain integration (Syed et al., 2019), supply chain re-design (Stiller & Gold, 2014). Lean practices seem to be antecedents of green and resilient supply chains (Ruiz-Benitez et al., 2017). Several authors point out that careful balance between practices is required, because of the inherent trade-offs among practices (Cabral et al., 2012).

Miemczyk and Luzzini (2019) highlight that practices are often deployed in silos, while they demonstrate the presence of mediating effects on a number of factors. For example, environmental and social supply chain practices are found to have no direct effects on economic performance of firms. They do find that social supply chain practices are related to risk assessment and therefore have an indirect effect on economic performance. In addition, introducing risk assessment practices is associated with cost reduction. Fahimnia et al. (2018) find interesting insights on the simultaneous

implementation of sustainability and resilience: designing a robust and green supply chain might imply considerably higher costs. However, an already robust supply chain might be more likely to "go green," compared to a low-robustness supply chain. In this sense, resilience might facilitate the improvement of green performance. Besides, according to the authors there seems to be more incentives to invest for business continuity in case of a green supply chain. Interestingly, Rajesh (2018) suggests that sustainability-oriented strategies should be implemented upstream in the supply chain, while downstream activities are more suitable for resilience-oriented practices. This is one of the few studies to investigate this phenomenon and is clearly an important area for additional research given the very different and separable focus of practices depending on location within the supply chain.*Pressures and Drivers:* The literature review shows a paucity of studies on supply chain sustainability and resilience drivers. Shin and Park (2019) demonstrate that resilience practices improve sustainability in the supply chain and ultimately contribute to achieving a competitive advantage. They find redundancy as a key driver for resilience practices. It is somewhat surprising that redundancy was a key driver for resilience to improve sustainability given that redundancy may generate waste and use greater amounts of resources. The nuances of redundancy need to be investigated, such as whether there are differences in drivers for durable versus perishable goods.

Some studies have identified sustainability as an enabler of resilience (Jain et al., 2017), since sustainability can support better decision-making and contributes to risk reduction. Stakeholder and legal pressures are main drivers for sustainability risk management (Freise & Seuring, 2015; Harms et al., 2013; Rajesh, 2019b); internal orientation, competitiveness and risk exposure are also identified as antecedent drivers. Other authors identify the uncertainty that characterizes markets as an antecedent to building more resilient and sustainable supply chains (Abrahamsson et al., 2015).*Decision-making*: a good decision-making process should start from a deep understanding of the system (Perrings, 2006). Cabral et al. (2012) propose a decision-making tool to help managers prioritize the best factors among leanness, agility, resilience and greenness. The model begins with the goal to be pursued, lists the criteria to assess the supply chain performance (in terms of cost, service, time and quality) and it establishes key performance indicators (KPIs) to measure the criteria and alternatives are identified and assessed —these multistage and multifactor approaches are representative of more recent developments. A decision framework suggested by Eltantawy (2015) presents two types of resilience, one focusing on performance maintenance—engineering resilience—and the other on transforming to maintain supply chain long-term operations—ecologic resilience. The two work together to make the supply chain sustainable and meeting sustainability goals. Brandenburg (2017) states that uncertainties might influence the supply chain configuration decisions, and several other studies propose indicators to guide the decision-making process within supply chains (Fahimnia & Jabbarzadeh, 2016; Mari et al., 2016; Qiu et al., 2019; Zahiri et al., 2017). Darom et al. (2018) suggest that including sustainability into recovery plan evaluation might result in better optimization of resources and environmental impact. Indeed, when sustainability and resilience are optimized separately, sustainability objectives may be overlooked during disruptions (Mari et al., 2014). Some explore the topic of sustainability risk and how to manage them (Bag et al., 2019; Giannakis & Papadopoulos, 2016; Mangla et al., 2015a; Mangla et al., 2015b; Song et al., 2017). Rajesh (2018) analyzes different cases of networks with different balances between agility and leanness—antecedents of resilience and sustainability. Several methods to solve or shift trade-offs are also proposed (e.g., Suifan et al., 2019). In particular, an excessive focus on efficiency may lower resilience performance (de Souza et al., 2019a).

Decision models to integrate lean, green and resilience are common in literature (Das, 2019).

The most common goal for decision-making is cost minimization while ensuring environmental performance of the supply chain and robustness or under disruption scenarios (Fahimnia et al., 2018; Mohammed et al., 2019).

The decision-making tools in the literature typically aim at either the design and planning of resilient and sustainable supply chains (Asokan et al., 2017; de Souza et al., 2019a; Fazli-Khalaf et al., 2017; He et al., 2020; Jabbarzadeh et al., 2018; Mangla et al., 2014b; Mari et al., 2016; Zahiri et al., 2017); or at the selection of suppliers to ensure the supply network sustainability and resilience. This latter research stream is particularly rich (see, e.g., Foroozesh et al., 2018; Harms et al., 2013; Kaur et al., 2020; Kellner et al., 2019; Leppelt et al., 2013; Shafiq et al., 2017). *Barriers*: Sustainable and resilient supply chain implementation barriers are relatively inadequately explored. Studies on barriers to resilient supply chains or sustainable supply chains have typically been investigated separately. Fiksel (2003) mentions barriers to practical sustainable development principles, namely that protecting future generations seems remote. He argues that sustainability is represented as a constraint rather than as an innovation opportunity. Another barrier is the perception is that the triple-bottom-line concept suggests that profits should be shared with environmental and social performance. A final barrier is that sustainability is often seen as a goal to reach rather than a characteristic.

Beske and Seuring (2014) identify a lack of trust and a lack of sharing information as important barriers to sustainable and low-risk supply chain implementation. They further argue that by engaging in long-term relationships, firms in supply chains also can reduce the risk and improve their overall sustainability. These are also good practice recommendations for traditional supply chains.

Additional barriers refer to the facts that while economic sustainability can rely on relatively established KPIs, social and environmental sustainability and resilience typically have varying standards across different regions and industries (Juettner et al., 2020).

Performance Measurement: selecting adequate metrics to measure both the sustainable and resilient performance can be complex (Ruiz-Benitez et al., 2017). Performance measurement in literature is divided between those who attempt to jointly measure sustainability and resilience, by developing adequate indicators (Azevedo et al., 2016, 2013; Malek et al., 2017; Ramezankhani et al., 2018; Ruiz-Benitez et al., 2019) and those who focus on either risk assessment of green supply chains—mostly focusing on environmental

sustainability—or on greenness assessment under uncertainty (Chavan et al., 2018; Chung & Chu, 2016; Ji, 2009; Mangla et al., 2016b, 2018); or on sustainable supply chain risk assessment (Abdel-Basset & Mohamed, 2020; Mangla et al., 2015c; Rostamzadeh et al., 2018; Xu et al., 2019). In some cases, sustainability assessment is carried out so to keep risk levels under control (Almeida et al., 2016).

Azevedo et al. (2013) propose an *ecosilient* index to monitor supply chain greenness and resilience. The index initially assesses green behavior and resilient behavior separately. These two indices are ultimately combined to compute an *ecosilient* indicator. A similar combination methodology is uses by Azevedo et al. (2016) a leanness, agility, resilience and greenness indicator; by Mohammed (2020) when evaluating supplier *greesilience*; and by Sen et al. (2018), who build on the methodology used by Azevedo et al. (2013), developing an index to identify poor performances in the supply chain. It is widely accepted that performance measurement should preferably encompass the entire supply chain (Carvalho et al., 2011).

Other studies—such as (Chavan et al., 2018; Mangla et al., 2016b)—develop methodologies to assess the risk level of green supply chains.

Similar to the decision-making category, a rich stream of literature focuses on supplier performance assessment with several joint sustainability and risk indicators (for example, Akcan & Taş, 2019; Almasi et al., 2019; Arabsheybani et al., 2018; Awasthi et al., 2018; Hosseini & Barker, 2016; Kaur et al., 2020; Mohammed, 2020; Torres-Ruiz & Ravindran, 2018; Wei et al., 2017).

Future research agenda: There are studies that sought to summarize existing research and propose a future research agenda. However, compared to reviews about sustainable supply chain management (Carter & Washispack, 2018), relatively few reviews exist. Fahimnia et al. (2019) call for additional studies on the intersection of sustainability and resilience in supply chains; while Swanson et al. (2018) identify sustainability and resilience as the most rapidly growing supply chain research streams. Some authors call for more research on sustainability and risk assessment of suppliers (Cano & Ayala, 2019; Wetzstein et al., 2019), or explorations at the operational and tactical level—besides the strategic one—to find more specific impacts (Fahimnia et al., 2018).

Detailed guidance on future research at the intersection of sustainable and resilient supply chains is lacking.

Having considered literature, a novel definition of sustainable and resilient supply chains is proposed: The management of coordinated supply chains integrating economic, environmental and social considerations in the business system, while dynamically preparing, adapting and reacting to unexpected disruptions, in order to meet the stakeholder requirements and improve firm profitability and competitiveness in the short and long term.

5 | DISCUSSION

We now provide a summary discussion from the various observations and knowledge obtained from the literature review.

5.1 | Concepts

The conceptual development of sustainable supply chains sees a relative consensus in definitions although some slight differences exist. Researchers seem to have some general agreement on the theoretical foundations of sustainability in supply chains with the triple-bottom-line and intergenerational definitions (Ahi & Searcy, 2013). Alternatively, SCRes has not gelled as well with limited, if any, consensus on the terminology used (Ham et al., 2020). For example, the phases of resilience slightly overlap with the strategies and practices, or with the capabilities required to enhance resilience. Supply chain resilience has existed in some form, as has sustainability, for an appreciable length of time. Yet, the greater growth in sustainability research has allowed it to mature relatively quickly, while resilience is in its relative infancy.

The joint sustainability and resilience in supply chains research has shown that the relationship between the two concepts remains ambiguous and inchoate (Fahimnia et al., 2019). Little is known, with significant confusion, on the capabilities required to jointly build sustainable and resilient supply chains (Ivanov, 2018). Clearly, this is an important avenue of foundational research study. As Table 2 shows, extant literature has somewhat explored the concepts of green supply chains as linked to risk management (e.g., Fahimnia, Sarkis, & Davarzani, 2015; Ji, 2009). In more recent years, instead, the discussion has shifted toward sustainability and resilience (e.g., Kaur et al., 2020). Although the two concepts are increasingly discussed jointly, more research is needed to establish the theoretical building blocks of sustainable and resilient supply chains. A clear definition was required and has been provided in this paper. A deeper understanding of the joint capabilities, supported by empirical evidence, is advisable.

5.2 | Implementation

The main findings from the literature about sustainable supply chain management showed that (1) the practices are usually connected to cost reduction and therefore contribute to improved firms' profitability (Golini et al., 2017). Alternatively, SCRes literature emphasizes strategies rather than practices. The main focus is on improving flexibility and redundancy rather than on efficiency (Rice & Caniato, 2003). As a consequence, improved SCRes is often results in higher cost. There is still lack of knowledge on practices that can simultaneously improve supply chain sustainability and resilience. Although some practices such as sustainable use of resources relates to building supply chain resilience—these win-win opportunities require further investigation (Edgeman & Wu, 2016).

Second, (2) in improving sustainability the supply chain perspective is extremely relevant, and there is a strong interest on improving and assessing the performance of suppliers (Tseng et al., 2019). Resilience focus is slightly shifted toward network design (suppliers and customers) and information sharing among network partners. In this sense, the focus seems to be more on the focal company rather than

TABLE 2 Summary of the analysis of literature

Reference	Research stream								Approach to sustainability and resilience
	Concepts		Implementation				Performance/ measurement	Future research agenda	
	Definition	Theory building	Practices	Pressures/ drivers	Decisions making	Barriers			
Shrivastava, 1995		✓							
Cousins et al., 2004			✓						
Perrings, 2006		✓							
Teuscher et al., 2006			✓						
Carter & Rogers, 2008	✓								
Mäler, 2008		✓							
Seuring & Müller, 2008	✓								
Anderson & Anderson, 2009		✓						✓	
Ji, 2009			✓				✓		
Higgins et al., 2010		✓						✓	
Closs et al., 2011	✓	✓							
Carvalho et al., 2011			✓				✓		
Derissen et al., 2011		✓							
Cabral et al., 2012			✓		✓				
Azevedo et al., 2013							✓		
Ahi & Searcy, 2013	✓								
Cruz, 2013			✓						
Harms et al., 2013				✓	✓				
Leppelt et al., 2013					✓				
Beske & Seuring, 2014			✓			✓			
Hofmann et al., 2014		✓							
Mari et al., 2014					✓				
Mangla et al., 2014		✓							
Mangla et al., 2014b					✓				
Stiller & Gold, 2014			✓						
Ahi & Searcy, 2015	✓								
Abrahamsson et al., 2015				✓					
Eltantawy, 2015		✓			✓				
Fahimnia, Tang, et al., 2015								✓	
Freise & Seuring, 2015		✓		✓					
Govindan et al., 2015			✓						
Li et al., 2015		✓							
Mangla et al., 2015a					✓				
Mangla et al., 2015b							✓		
Mangla et al., 2015c					✓				
Almeida et al., 2016							✓		
Azevedo et al., 2016			✓				✓		
Chung & Chu, 2016							✓		
Edgeman & Wu, 2016		✓	✓						
Fahimnia & Jabbarzadeh, 2016					✓				

(Continues)

TABLE 2 (Continued)

Reference	Research stream								
	Concepts		Implementation						
	Definition	Theory building	Practices	Pressures/ drivers	Decisions making	Barriers	Performance/ measurement	Future research agenda	Approach to sustainability and resilience
Giannakis & Papadopoulos, 2016					✓				
Hosseini & Barker, 2016							✓		
Lintukangas et al., 2016		✓							
Mangla et al., 2016a							✓		
Mangla et al., 2016b		✓							
Mari et al., 2016					✓				
Asokan et al., 2017					✓				
Brandenburg, 2017					✓				
Jain et al., 2017		✓		✓					
Fazli-Khalaf et al., 2017					✓				
Kim & Chai, 2017		✓							
Malek et al., 2017							✓		
Mani et al., 2017		✓							
Papadopoulos et al., 2017		✓							
Ruiz-Benitez et al., 2017			✓				✓		
Shafiq et al., 2017		✓							
Song et al., 2017		✓			✓				
Wei et al., 2017							✓		
Zahiri et al., 2017					✓				
Arabsheybani et al., 2018							✓		
Awasthi et al., 2018							✓		
Chavan et al., 2018							✓		
Darom et al., 2018					✓				
Fahimnia et al., 2018			✓		✓			✓	
Fernando et al., 2018		✓							
Foroozesh et al., 2018					✓				
Göçer et al., 2018		✓							
Gouda & Saranga, 2018		✓							
Ivanov, 2018		✓							
Jabbarzadeh et al., 2018					✓				
Mangla et al., 2018			✓				✓		
Rajesh, 2018		✓			✓				
Ramezankhani et al., 2018							✓		
Rostamzadeh et al., 2018							✓		
Sen et al., 2018							✓		

TABLE 2 (Continued)

Reference	Research stream								Approach to sustainability and resilience
	Concepts		Implementation						
	Definition	Theory building	Practices	Pressures/ drivers	Decisions making	Barriers	Performance/ measurement	Future research agenda	
Swanson et al., 2018								✓	
Torres-Ruiz & Ravindran, 2018							✓		
Brinkley, 2018		✓							
Furman & Papavasiliou, 2018		✓							
Fahimnia et al., 2019								✓	
Almasi et al., 2019							✓		
Akcan & Taş, 2019							✓		
Bag et al., 2019		✓			✓				
Cano & Ayala, 2019								✓	
Das, 2019					✓				
de Souza et al., 2019b					✓				
de Souza et al., 2019a					✓				
Kaur & Singh, 2019					✓				
Göçer et al., 2019		✓							
Mohammed et al., 2019					✓				
Kellner et al., 2019					✓				
Miemczyk & Luzzini, 2019		✓	✓						
Qiu et al., 2019					✓				
Rajesh, 2019				✓					
Shahin et al., 2019		✓							
Shin & Park, 2019		✓		✓					
Suifan et al., 2019					✓				
Ruiz-Benitez et al., 2019							✓		
Syed et al., 2019		✓	✓						
Wetzstein et al., 2019								✓	
Xu et al., 2019							✓		
Abdel-Basset & Mohamed, 2020							✓		
Juettner et al., 2020						✓			
Kaur et al., 2020							✓		
Mohammed, 2020							✓		
He et al., 2020					✓				
Hallikas et al., 2020			✓						
Mohammed et al., 2020							✓		

Note: Approach to sustainability and resilience.

Sustainability and resilience;
Sustainability and risk
Green and resilience
Risk and green

on supplier resilience. The SCRes literature can learn from the sustainable supply chain literature and can advance in the directions of sustainability research.

Similarly, (3) the decision-making for sustainable supply chain management can cover the entire life cycle of products. It can involve the entire supply chain (e.g. Das, 2018; Stindt, 2017; Tseng et al., 2019). Literature on SCRes decision-making typically refers to single actors. The decision-making for joint topics is characterized by solving trade-offs and conflicting objectives (Korhonen & Seager, 2008). However, more support tools for decision-making should be developed, and synergies should be emphasized as well as trade-offs. We also identified greater ambiguities and uncertainty with multiple additional measures adding to the complexity. In this environment, we recommend soft computing methods such as fuzzy and rough set theoretical perspectives in a multiple criteria environment.

Fourth, (4) pressures for sustainable supply chain management derive from both internal and external stakeholders (e.g., Meixell & Luoma, 2015). Resilience study is concentrated on enablers and antecedents, such as trust, cooperation, information sharing and visibility (e.g., Chowdhury & Quaddus, 2017). At the intersection of the concepts, there is a gap in literature in highlighting the drivers for sustainable and resilient supply chains. A direction of research along this avenue is to accumulating the multiplicity of antecedents from both fields and identify the most promising in terms of both adoption and outcomes for joint sustainable and resilient supply chains.

Finally, (5) implementing supply chain sustainability requires multi-criteria consideration (Seuring, 2013). A substantial part of this literature is focused on examining the sustainable supply chain management barriers (e.g., Ansari & Kant, 2017). The lack of awareness, commitment and expertise are recognized as the most common barriers. For SCRes the barriers identified in studies include poor integration and decisional autonomy (Ali, Nagalingam, & Gurd, 2017). There is little investigation on the barriers for jointly implementing sustainability and resilient in supply chains. The research in this area can investigate which barriers play a larger role in the joint situation. Given the breadth and differences in identified barriers it would be interesting to determine which dominate for the joint concept environment.

5.3 | Performance measurement

Performance measurement for sustainable supply chain management studies are mostly focused on the effects of the environmental dimension on performance, while the social pillar relatively neglected (Mani et al., 2018); economic sustainability is a baseline issue in most cases (Moreno-Camacho et al., 2019). Research remains for expanding measurements and performance considerations to simultaneously incorporate all three pillars of sustainability. Additional research on performance indicators of SCRes are also required (Kamalahmadi & Parast, 2016). Therefore, it could be stated that performance measurement research is needed to integrate and monitor the intersection of sustainability and resilience. These studies should focus both on the short- and on the long-term, in order to highlight how the relative importance of the sustainability pillars and of resilience may change as the time horizon lengthens. Another important aspect is that the fields are lacking separately and together in effective maturity matrices. This is especially true for SCRes which can have both practical and research significance. An integrated maturity matrix for both resilient and sustainable supply chains will require careful development to not become overly complex and difficult to use. But some initial efforts can prove extremely beneficial as a foundation for future study.

5.4 | Future research agenda

In the previous sections we have identified a number of research questions and directions for research. We now summarize and add a few more possibilities. Overall, we believe that this joint field is primed for significant research and knowledge advancement.

The future research suggested for sustainable supply chain management concerns the improvement in the use of the supply chain as a unit of analysis, rather than the single firm (Carter & Easton, 2011). Additionally, more studies are often requested on the integration of the social pillar into the evaluations (Mani et al., 2018). Finally, more guideline for SMEs might be useful, in order to facilitate the adoption of practices (Panigrahi et al., 2019).

Concerning SCRes, there is lack of empirical studies on the practices implemented by firms and on their impacts on performance (Ali, Mahfouz, & Arisha, 2017). Additionally, there should be more focus on human and organizational behavior factors to facilitate the adoption of practices (Dubey et al., 2017; Ivanov, 2018).

At the intersection, there are still very few reviews on the integration of sustainability and resilience in supply chains (Fahimnia et al., 2019). Additional effort in this sense might help clarify the concepts and establish a common ground on which to build future research. Empirical research is still scarce, despite being extremely relevant and useful; the difficulty is that few organizations may be focusing and implementing both practices simultaneously. More studies could be conducted in firms in order to understand better their perspectives on sustainable and resilient supply chains, what joint practices are already in use and what the measurements are adopted. Exemplary case studies will be necessary in this circumstance to identify best practices and exploratory directions for further research.

5.5 | Research gaps

To help set some general foundation for a research agenda, we use this review to identify several gaps.

1. Many studies have a difficult time integrating resilience and sustainability as more complete topics. Much of the focus for

supply chain research still appears to be on environmental sustainability rather than the broader triple bottom line dimensions of sustainability. Also, the concept of risk is utilized instead of the different perspective offered by resilience.

2. Overall, given the arguable importance of sustainability and resilience integration, extremely few studies have been exploring this research area (Jabbarzadeh et al., 2018). More studies considering the multiplicity of nuances are needed to develop a solid knowledge base. For example there is still a need to more completely understand what trade-offs and synergies exist between resilience and sustainability, and the impact of coordination, information sharing, vulnerability outsourcing and vertical integration (Fahimnia et al., 2019). Essentially, the nexus of these two topics is critical since organizations and supply chains are struggling with both concepts. If organizations can effectively understand how the integration of both practices and concepts will affect supply chains, then managers can plan and invest more wisely.
3. There is limited indication of what practices could joint improve sustainability and resilience in supply chains. KPIs and performance metric development, both for practice and research, are needed to more completely assess the integrative and complementary relationships and outcomes.
4. Given the complexity of the topic, analytical decision-support tools can be developed to help decision-makers evaluate alternative sustainable and resilient supply chain solutions (Fiksel, 2006). The complexity, ambiguity, and uncertainty of this management environment leaves substantial opportunity for *soft* computing methodologies to aid in decision support development.
5. Industry characteristics may mean different antecedents, practices, and outcomes. Given these potentially heterogenous impacts on sustainability and resilience inter- and intra-sectoral investigations are needed (Azevedo et al., 2016; Brandenburg et al., 2014).
6. Given the complexity of the relationships, it is unclear if a single and clear explanatory theory can capture the full understanding of the sustainable and resilient supply chains. What constructs, concepts, and theories emerge need testing. The field and understanding have been typically ahead of practice, especially sustainability. These theoretical concepts require actual practice, empirical evidence and applications in industries (Rajesh, 2019a).

6 | CONCLUSIONS

This systematic literature review stressed the importance of integrating sustainability and resilience in supply chains. Indeed, on the one hand supply chain management is more complex and the effects of disruptions could have severe consequences on the capability of supply chains to deliver value to customers. On the other hand, supply chains are under stakeholders' pressure to improve their sustainability performance. Despite the fact that some studies have addressed this issue, there is still very little investigation around the integration of the two concepts.

This review represents an important starting point—foundation—for research into sustainable, resilient supply chains. We suggest that there is ample space for new research on the topic. In particular, starting from the literature review, clarifications should be made about the integration of the two concepts, about the practices that will improve both sustainability and resilience, and about the metrics to measure them. Finally, more applications to real case studies should be developed.

We should also highlight some study limitations. First, our focus prioritized scientific journals, but the scope of the research could be broadened and encompass alternative sources. Besides, more specific research topics should be investigated to complete the overview on sustainable/green and resilience/risk environments. This could add interesting insights to our discussion.

The present study is one of the first attempts to investigate the relationship between sustainability and resilience, and as such it helps clarify the concepts, synergies and trade-offs. Therefore, it contributes to filling a research gap. Furthermore, it is of particular importance from a practical level, facilitating the implementation of sustainable and resilient supply chains by bringing a deeper awareness on the topic.

ORCID

Marta Negri https://orcid.org/0000-0002-8170-5349
Enrico Cagno https://orcid.org/0000-0001-8954-5928
Claudia Colicchia https://orcid.org/0000-0002-8210-3702
Joseph Sarkis https://orcid.org/0000-0003-0143-804X

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APPENDIX A

TABLE A1 Overview of the main definitions of sustainable supply chains

Authors	Year	Journal	Def	Pillars included
Handfield et al.	1997	*Journal of Operations Management*	"Application of environmental management principles to the entire set of activities across the whole customer order cycle, including design, procurement, manufacturing and assembly, packaging, logistics, and distribution."	Environmental
Zhu et al.	2005	*International Journal of Operations & Production Management*	"An important new archetype for enterprises to achieve profit and market share objectives by lowering their environmental risks and impacts while raising their ecological efficiency."	Environmental
Sheu et al.	2005	*Transportation Research Part E*	"Combination of both the product manufacturing supply chain and used-product reverse logistics chain."	Environmental
Hervani et al.	2005	*Benchmarking: An International Journal*	"Green Purchasing + Green Manufacturing/Materials Management + Green Distribution/Marketing + Reverse Logistics"	Environmental
Jorgensen and Knudsen	2006	*Corporate Governance*	"The means by which companies manage their social responsibilities across dislocated production processes spanning organizational and geographical boundaries."	TBL
Srivastava	2007	*International Journal of Management Reviews*	"GSCM is the integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life."	Environmental
H'Mida and Lakhal	2007	*International Journal of Global Environmental Issues*	"The practice of monitoring and improving environmental performance in the supply chain during a product's life cycle."	Environmental

TABLE A1 (Continued)

Authors	Year	Journal	Def	Pillars included
Lakhal et al.	2007	*International Journal of Environmental Technology and Management*	"Olympic green supply chain characterized by five-circled flag of the Olympics as zero emissions, zero waste in activities, zero waste of resources, zero use of toxic substances, zero waste in product life-cycle, in addition to green inputs and green outputs."	Environmental
Carter and Rogers	2008	*International Journal of Physical Distribution and Logistics Management*	"SSCM as the strategic, transparent intergration and achievement of an organization's social, environmental and economic goals in the systemic coordination of key interorganizational business processes for improving the long term economic performance of the individual companies and its sc."	TBL
Seuring and Muüller	2008	*Journal of Cleaner Production*	"SSCM is the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements."	TBL
Srivastava	2008	*Omega: The International Journal of Management Science*	"Integration of sound environmental management choices with the decision making process for the conversion of resources into usable products."	Environmental
Lee and Klassen	2008	*Production and Operations Management*	"A buying organization's plans and activities that integrate environmental issues into supply chain management in order to improve the environmental performance of suppliers and customers."	Environmental
Seuring	2008	*Supply Chain Management: An International Journal*	"The integration of sustainable development and supply chain management [in which] by merging these two concepts, environmental and social aspects along the supply chain have to be taken into account, thereby avoiding related problems, but also looking at more sustainable products and processes."	TBL
Ciliberti et al.	2008	*Journal of Cleaner Production*	"The management of supply chains where all the three dimensions of sustainability, namely the economic, environmental, and social ones, are taken into account."	TBL
Font et al.	2008	*Business Strategy and the Environment*	"Adding sustainability to existing supply chain management processes, to consider environmental, social and economic impacts of business activities."	TBL
Albino et al.	2009	*Business Strategy and the Environment*	"A strategic approach addressed to extend environmental measures to the whole supply chain."	Environmental
Pagell and Wu	2009	*Journal of Supply Chain Management*	"The specific managerial actions that are taken to make the supply chain more sustainable with an end goal of creating a truly sustainable chain."	TBL
Badurdeen et al.	2009	*International Journal of Product Lifecycle Management*	"Involvement of the planning and management of sourcing, procurement, conversion and logistics activities involved during pre-manufacturing, manufacturing, use and post-use stages in the life cycle in closed-loop through multiple life-cycles with seamless information sharing about all product life-cycle stages between companies by explicitly considering the social and environmental implications to achieve a shared vision."	TBL
Hake and Seuring	2009	*Sustainable Development*	"The set of supply chain management policies held, actions taken, and relationships formed in response to concerns related to the natural environment and social issues with regard to the design, acquisition, production, distribution, use, reuse, and disposal of the firm's goods and services."	TBL

(Continues)

TABLE A1 (Continued)

Authors	Year	Journal	Def	Pillars included
Wee et al.	2011	*International Journal of Production Economics*	"Integration of environment considerations into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end-of-life management of the greening products."	Environmental
Gavronski et al.	2011	*Transportation Research Part E*	"The complex of mechanisms implemented at the corporate and plant level to assess or improve the environmental performance of a supplier base."	Environmental
Lau	2011	*Benchmarking: An International Journal*	"Integrating environmental thinking into closed-loop supply chain management."	Environmental
El Saadany et al.	2011	*Management Research Review*	"Reducing energy and virgin raw material usage and waste generation, and increasing product recovery options. Greening usually refers to the forward supply chain functions such as production, purchasing, materials management, warehousing and inventory control, distribution, shipping, and transport logistics."	Environmental
Wu and Pagell	2011	*Journal of Operations Management*	"The environmental dimension of sustainability in a supply chain context."	Environmental
Gnoni et al.	2011	*International Journal of Sustainable Engineering*	"An approach that aims to integrate environmental issues into SC management procedure starting from product design, and continuing through material sourcing and selection, manufacturing processes, the final product delivery and end-of-life management."	Environmental
Yeh and Chuang	2011	*Expert Systems with Applications*	"Management between suppliers, their products and environment, that is to say, the environment protection principle is brought into suppliers' management system. Its purpose is to add environment protection consciousness into original products and to improve competitive capacity in markets."	Environmental
Sarkis et al.	2011	*International Journal of Production Economics*	"Integrating environmental concerns into the inter-organizational practices of SCM including reverse logistics."	Environmental
Kim et al.	2011	*International Journal of Services and Operations Management*	"A set of practices intended to effect, control and support environmental performance by allocating possible human material resources and redefining organizational responsibilities and procedures."	Environmental
Parmigiani et al.	2011	*Journal of Operations Management*	"The impact of supply chains on environmental performance."	Environmental
Wolf	2011	*Journal of Business Ethics*	"The degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organization processes for sustainability."	TBL
Closs et al.	2011	*Journal of the Academy of Marketing Science*	"Reflection of the firm's ability to plan for, mitigate, detect, respond to, and recover from potential global risks. Risks involving substantial marketing and supply chain considerations include product development, channel selection, market decisions, sourcing, manufacturing complexity, transportation, government and industry regulation, resource availability, talent management, alternative energy platforms, and security."	TBL
Wittstruck and Teuteberg	2011	*Corporate Social Responsibility and Environmental Management*	"An extension to the traditional concept of Supply Chain Management by adding environmental and social/ethical aspects."	TBL

TABLE A1 (Continued)

Authors	Year	Journal	Def	Pillars included
Hassini et al.	2012	*Int. J. Production Economics*	"Sustainable supply chain management as the management of supply chain operations, resources, information, and funds in order to maximize the supply chain profitability while at the same time minimizing the environmental impacts and maximizing the social well-being."	TBL
Min and Kim	2012	*Logistics Research*	"GSCM is an incorporation of environmentally friendly initiatives into every aspect of supply chain activities encompassing sourcing, product design and development, manufacturing, transportation, packaging, storage, retrieval, disposal, post sale services including end of product life management."	Environmental
Buyukozkan and Cidci	2012	*Expert Systems with Applications*	"A way for firms to achieve profit and market share objectives by lowering environmental impacts and increasing ecological efficiency."	Environmental
Andic et al.	2012	*Resources, Conservation and Recycling*	"Minimizing and preferably eliminating the negative effects of the supply chain on the environment."	Environmental
Ahi and Searcy	2013	*Journal of Cleaner Production*	"The creation of coordinated supply chains through the voluntary integration of economic, environmental, and social considerations with key inter-organizational business systems designed to efficiently and effectively manage the material, information, and capital flows associated with the procurement, production, and distribution of products or services in order to meet stakeholder requirements and improve the profitability, competitiveness, and resilience of the organization over the short- and long-term."	TBL
Stindt	2017	*Journal of Cleaner Production*	"We interpret SSCM in a broad sense as planning, execution and control of corporate value creation processes by integrated consideration of economic, ecological and social aspects for the purpose of improving the long-term performance of an individual company and the supply chain as a whole."	TBL
Barbosa-Póvoa et al.	2018	*European Journal of Operational Research*	"SSC are complex network systems that involve diverse entities that manage the products from suppliers to customers ad their associated returns, accounting for social, environmental, economic impacts."	TBL

TABLE A2 Overview of the main definitions of green supply chains

Authors	Year	Journal	Def
Handfield et al.	1997	*Journal of Operations Management*	"Application of environmental management principles to the entire set of activities across the whole customer order cycle, including design, procurement, manufacturing and assembly, packaging, logistics, and distribution."
Zhu et al.	2005	*International Journal of Operations & Production Management*	"An important new archetype for enterprises to achieve profit and market share objectives by lowering their environmental risks andimpacts while raising their ecological efficiency."
Sheu et al.	2005	*Transportation Research Part E*	"Combination of both the product manufacturing supply chain and used-product reverse logistics chain."
Hervani et al.	2005	*Benchmarking: An International Journal*	"Green Purchasing + Green Manufacturing/Materials Management + Green Distribution/Marketing + Reverse Logistics"
Srivastava	2007	*International Journal of Management Reviews*	"GSCM is the integrating environmental thinking into supply-chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life."

(Continues)

TABLE A2 (Continued)

Authors	Year	Journal	Def
H'Mida and Lakhal	2007	*International Journal of Global Environmental Issues*	"The practice of monitoring and improving environmental performance in the supply chain during a product's life cycle."
Lakhal et al.	2007	*International Journal of Environmental Technology and Management*	"Olympic green supply chain characterized by five-circled flag of the Olympics as zero emissions, zero waste in activities, zero waste of resources, zero use of toxic substances, zero waste in product life-cycle, in addition to green inputs and green outputs."
Srivastava	2008	*Omega: The International Journal of Management Science*	"Integration of sound environmental management choices with the decision making process for the conversion of resources into usable products."
Lee and Klassen	2008	*Production and Operations Management*	"A buying organization's plans and activities that integrate environmental issues into supply chain management in order to improve the environmental performance of suppliers and customers."
Albino et al.	2009	*Business Strategy and the Environment*	"A strategic approach addressed to extend environmental measures to the whole supply chain."
Wee et al.	2011	*International Journal of Production Economics*	"Integration of environment considerations into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers, and end-of-life management of the greening products."
Gavronski et al.	2011	*Transportation Research Part E*	"The complex of mechanisms implemented at the corporate and plant level to assess or improve the environmental performance of a supplier base."
Lau	2011	*Benchmarking: An International Journal*	"Integrating environmental thinking into closed-loop supply chain management."
El Saadany et al.	2011	*Management Research Review*	"Reducing energy and virgin raw material usage and waste generation, and increasing product recovery options. Greening usually refers to the forward supply chain functions such as production, purchasing, materials management, warehousing and inventory control, distribution, shipping, and transport logistics."
Wu and Pagell	2011	*Journal of Operations Management*	"The environmental dimension of sustainability in a supply chain context."
Gnoni et al.	2011	*International Journal of Sustainable Engineering*	"An approach that aims to integrate environmental issues into SC management procedure starting from product design, and continuing through material sourcing and selection, manufacturing processes, the final product delivery and end-of-life management."
Yeh and Chuang	2011	*Expert Systems with Applications*	"Management between suppliers, their products and environment, that is to say, the environment protection principle is brought into suppliers' management system. Its purpose is to add environment protection consciousness into original products and to improve competitive capacity in markets."
Sarkis et al.	2011	*International Journal of Production Economics*	"Integrating environmental concerns into the inter-organizational practices of SCM including reverse logistics."
Kim et al.	2011	*International Journal of Services and Operations Management*	"A set of practices intended to effect, control and support environmental performance by allocating possible human material resources and redefining organizational responsibilities and procedures."
Parmigiani et al.	2011	*Journal of Operations Management*	"The impact of supply chains on environmental performance."
Min and Kim	2012	*Logistics Research*	"GSCM is an incorporation of environmentally friendly initiatives into every aspect of supply chain activities encompassing sourcing, product design and development, manufacturing, transportation, packaging, storage, retrieval, disposal, post sale services including end of product life management."
Buyukozkan and Cidci	2012	*Expert Systems with Applications*	"A way for firms to achieve profit and market share objectives by lowering environmental impacts and increasing ecological efficiency."
Andic et al.	2012	*Resources, Conservation and Recycling*	"Minimizing and preferably eliminating the negative effects of the supply chain on the environment."

TABLE A3 Overview of the main definitions of resilient supply chains

Authors	Year	Journal	Def	Level
Horne	1997	*Business Forum*	"Organizational resilience is the ability of a system to withstand the stresses of environmental "loading" based on the combination/composition of the system pieces, their structural interlinkages, and the way environmental change is transmitted and spread throughout the entire system."	System
Rice and Caniato	2003	*Supply Chain Management Review*	"Resilience is widely used to characterize an organization's ability to react to an unexpected disruption, such as one caused by a terrorist attack or a natural disaster, and restore normal operations"	Firm
Sheffi and Rice	2003	*EurOMA POMS Joint International Conference*	"The ability to bounce back from a disruption"	Firm
Christopher and Peck	2004	*International Journal of Logistics Management*	"The ability of a system to return to its original state or move to a new, more desirable state after being disturbed"	System
Datta et al.	2007	*International Journal of Logistics: Research and Applications*	"Not only the ability to maintain control over performance variability in the face of disturbance, but also a property of being adaptive and capable of sustained response to sudden and significant shifts in the environment in the form of uncertain demands"	Network
Ponomarov and Holocomb	2009	*The International Journal of Logistics Management*	"The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function"	Network
Klibi et al.	2010	*European Journal of Operational Research*	"Resilience is the capability of a SCN to avoid disruptions or quickly recover from failures"	Network
Pettit et al.	2010	*Journal of Business Logistics*	"The capacity for an enterprise to survive, adapt and grow in the face of turbulent change"	Firm
Ponis and Kronis	2012	*The Journal of Applied Business Research*	"The ability to proactively plan and design the Supply Chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operations, if possible, more favourable than the one prior to the event, thus gaining competitive advantage"	Network
Wieland and Wallenburg	2013	*International Journal of Physical Distribution & Logistics Management*	"In this research, resilience is understood as the ability of a supply chain to cope with change"	Network
Melnyk et al.	2014	*Supply Chain Management Review*	"The ability of a supply chain to both resist disruptions and recover operational capability after disruptions occur"	Network
Day	2014	*International Journal of Production Research*	Resilience is "the capability to anticipate risk, limit impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change"	Network
Durach et al.	2015	*International Journal of Physical Distribution & Logistics*	"Resilience is the ability of a supply chain to withstand change. Since not all changes can be resisted, some need to be avoided in order to stay robust."	Network
Hohenstein et al.	2015	*International Journal of Physical Distribution & Logistics Management*	"Supply chain's ability to be prepared for unexpected risk events, responding and recovering quickly to potential disruptions to return to its original situation or grow by moving to a new, more desirable state in order to increase customer service, market share and financial performance"	Network
Almbulkar et al.	2015	*Journal of Operations Management*	"Firm's resilience to supply chain disruptions is defined as the capability of the firm to be alert to, adapt to and quickly respond to changes brought by a supply chain disruption"	Firm

(Continues)

TABLE A3 (Continued)

Authors	Year	Journal	Def	Level
Chowdhury and Quaddus	2016	*Supply Chain Management*	"The capability of a SC to prevent disruptions and to reduce the impact of disruptions through developing required level of readiness, quick response and recovery ability."	Network
Chen et al.	2017	*IEEE Transactions on Reliability*	"It is the ability of a sc to fulsill end customer demand to the desired level within an acceptable period of time after any pre or postdisruption mitigation efforts."	Network
Rajeesh	2019	*Sustainable Production and Consumption*	"In the SC context, resilience is the technological capability to manage and mitigate from disruptions"	Network