

Supply Chain Resilience in the Pharmaceutical Industry: A Qualitative Analysis from Scholarly and Managerial Perspectives

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Abstract

This paper aims to collect evidence from Global Supply Chains (SCs) actors in the pharmaceutical sector to understand how they define a resilient supply chain and what are the main resilience elements useful to measure the degree of resilience of a supply chain considering the lessons learned from the COVID-19 pandemic period. In doing so, our purpose is to make a comparison between the two categories and uncover on which supply chain resilience-related topics there is agreement or not. Through a qualitative research design, a two-round focus group was conducted with supply chain players that represent different nodes along the chain (e.g., as for supplier, manufacturers, service providers, CMO). Key findings, related to the conducted discussions among the focus group, show how managers appreciate and agree comprehensive supply chain resilience definitions provided by extant literature. Nonetheless, although there is a general agreement on some recent definitions, managers asserted that some key resilience elements are currently missing in those definitions, regarding human resources and technology roles in enhancing the resilience of supply chains. In addition, supply chain resilience elements considered most important by managers of the pharmaceutical supply chain are adaptability, flexibility, agility, and collaboration.

Keywords: supply chain resilience, COVID-19 pandemic, supply chain disruption, focus group, supply chain, qualitative, super disruption

1. Introduction

In the last two years, COVID-19 has dramatically changed the individuals' life, and the everyday routines of worldwide organizations (Ivanov & Das, 2020). Given its long-lasting widespread effects, the pandemic may be qualified as a "super disruption" to promptly react to long-lasting exogenous crisis (e.g., as for wars, pandemics, and so on; Ivanov, 2020; 2021) for companies and for global supply chains (SCs) because representing an important "breaking point" with the past by considering processes, activities, ways to work, managerial styles, organization strategies and so on for the whole organizations around the world (Ivanov, 2020; Sestino, Simonetti & Gastaldi, 2020). Coherently, the pandemic due to the COVID-19 has been considered as one of the worst disruptions in decades (Chowdhury et al., 2021; Ivanov, 2021). Even if all economic sectors have been deeply disrupted by COVID-19 effects, it is undoubted that some sectors, more than others, have been called to do their part not only to mitigate the effects of the disruptions, but also to find solutions to establish an escape route from economic and social perspectives (European Central Bank, ECB, 2022). For instance, the pharmaceutical sector has been one of the most important among them, by considering companies' efforts in trying to find vaccines to protect people from COVID-19 infections (Yu et al., 2020). Since the production and the delivery of vaccines, and goods more in general, strictly depends on the continuity of SC forward and backward flows of operations, understanding how SCs can be more resilient to super disruption is of crucial importance (Ponomarov & Holcomb, 2009; Toba et al., 2008). Given the scope of pharmaceutical SC (PSC), not only limited to providing products to be consumed for mere pleasure, but also aimed to produce and deliver medicines, vaccines, and personal protective equipment (PPE) to protect people from diseases, understanding how PSC actors interpret and define their resilience ability may be a crucial issue.

Indeed, such aforementioned Supply chain resilience (SCR) is not a new term in the managerial vocabulary, but it has been previously defined by seminal literature on the field (e.g., as in Christopher & Peck, 2004; Sheffi & Rice, 2005): Such a concept related to resilient supply chain is defined by its capacity for resistance and recovery, also

implying capability to mitigate most supply chain disruptions and greatly limit the impact of those that occur. Coherently, previous studies (Kamalahmadi & Parast, 2016) focused on SCR by emphasizing the ability of a SC to prepare, resist, and recover from disruptive negative events (disruptions) in a timely and cost-effective manner. However, despite the general meaning of SCR seems to be clear, it is less clear “how” a SC could practically be resilient to disruptions: Indeed, according to the literature, SCR may be interpreted as a multifaceted concept that is strictly related to the competitive environment in which a firm or a SC operate (Ruel et al., 2021). Moreover, the extent to which a SC can be considered as resilient is also deeply influenced by the type of disruptions that may affect it (e.g., a long-lasting pandemic vs. an instantaneous earthquake), as different types of disruptions require different responses to overcome their effects (Ivanov, 2021).

Despite the crucial importance of understanding how a SC that operates in a certain sector can be resilient, to date only few studies have explored how PSCs are working to gain higher level of resilience and how the recent pandemic have affected their own conceptions of SCR (Vann Yaroson et al., 2021). In addition, the COVID-19 pandemic is not over yet, and new virus variants (Delta, and Omicron) are again threatening SC networks on a global scale (Levin-Scherz & Toro, 2021).

Based on above, by considering the current COVID-19 pandemic scenario and the threats that could affect SCs in the near future, to the best of authors’ knowledge and according to the relevant literature on this domain (Scala & Lindsay, 2021), a lack of studies on PSC-related SCR strategies clearly emerges: Thus, the goal of this paper is aimed to add knowledge on this important research stream, by adopting the lenses of practitioners who in the last two years have worked in the field to understand and measure the concept of resilience for their SC. Through a qualitative research design a two-round focus group was conducted with supply chain players that represent different nodes along the chain (e.g., as for supplier, manufacturers, service providers, CMO). Findings have shown that although there is a general agreement on some recent definitions, some fundamental issues and resilience dimensions are currently missing. Moreover, by considering the peculiarities of the pharmaceutical industry, four important elements should be considered in SCRs strategies in terms of: 1) adaptability; 2) flexibility; 3) agility; and 4) and collaboration.

Findings also shed light on managers' perception of SCR definitions and its related elements, also through a comparison with theoretical foundations on the matter, in the attempt to catch whether research is going in the right direction towards the understanding of the SCR phenomenon and offer some advice for future theoretical and empirical research. Indeed, by considering the lack of previous literature on this theme, the paper reaches this goal by adopting a qualitative research methodology, as the most appropriate to capture new useful insights on this kind of phenomenon characterized by high levels of uncertainty, such as the SCR within the pharmaceutical sector.

2. Theoretical Background

2.1 Current Issues and Challenges of Global PSCs

Despite the importance of global PSCs, especially due to the COVID-19 pandemic together with the increasing demand for vaccines, research on this topic is currently scarce, and the few ones resulted in a set of disorganized knowledge on the matter (Kumar & Kumar Pundir, 2020). Moreover, research is currently lacking within the domain of healthcare and pharmaceutical supply chain resilience (Scala & Lindsay, 2021), thus resulting in a call for new research in these fields (Burinskiene, 2018).

To date, according to Ding (2018), providing a broad access to medicines and drugs is one of the primary goals for PSCs: Even if medicines and generally drugs may be categorized as commodities, they have special attributes given their value for society, that is helping patients to recover from a disease, sometimes also on the basis of solid perceptions of drugs’ brands (Sestino & Amatulli, 2021). Historically, pharmaceutical industries and SCs have been more inclined to mass production, rather than continuous production (Stagemann, 2016) resulting in a rigid structure in which redundancies have been crucial to satisfy demand for products in a sort of “push” logic (Herwig, 2017). Today, similar to the other industries, the advent of Industry 4.0 consisting in the current disruptive revolution that focuses heavily on interconnectivity, automation, machine learning, smart objects, and real-time data analysis (Ghobakhloo, 2020). Nonetheless, even if these technological innovations enhanced PSCs’ ability to respond to unexpected risks ensuring more dynamicity, some characteristics of the pharmaceutical sector still deeply affect PSCs’ performances and resilience capabilities. That said, even if in recent years PSCs could count on new advanced digital technologies that allow them to achieve a stronger control over the network and flexibility along the chain, evidence from the last great pandemic showed weaknesses in the PSCs that cannot be ignored (Patil et al., 2021). Moreover, to illustrate, as for new technologies integrations, Omar and Basir (2020) reported that disruptions and malpractices still affect PSCs. In addition, Ding (2018) noted that in the pharmaceutical sector there are high levels of waste and that it is an energy-intensive, and contamination-sensitive sector. Accordingly,

some authors believe that another, underexplored, topic of interest might be the reuse of expired or unusable pharmaceuticals to address the challenge of waste in the PSCs (Singh et al., 2016). Moreover, drug shortages appear to be very frequent, as reported in the study by Nematollahi et al. (2018). Finally, these kinds of disruptions are even more crucial in this sector, rather than in others, because of their importance not only for PSCs' performance, but also for public health and well-being (Kumar et al., 2019).

In this regard, scholars argued that PSCs are responsible for the social impact of their activities in terms of preventing product shortages and potential stock-outs, because pharmaceutical manufacturers usually have direct control over the outbound transportations to distributors and wholesalers (Ding, 2018). The latter, in turn, are responsible to ensure appropriate levels of inventory (i.e., high levels) to ensure the availability of pharmaceutical products (Borumand & Beheshtinia, 2018). The push to keep high levels of inventory and creating redundancies in order to achieve the above-mentioned objective is a practical issue when dealing with unexpected negative events that must be overcome. In fact, achieving resilience for PSCs require a more controlled and just-in-time and lean logistics, whereas the dominant approach discussed above usually results in an increasing of costs and/or in a negative impact on revenues (Zahiri et al., 2017). Moreover, another fundamental challenge for PSCs discussed in the literature is the quality of drugs. In fact, especially for the transportation and storage of specific pharmaceutical products (e.g., as for vaccines) that require cold temperatures, most distributors struggle in facing this important challenge (Kabir, 2013).

Particularly in the first phase of the pandemic, PSCs experienced an unprecedented combination of demand surge and supply crunch. Firstly, demand for generic medicines increased, since hospitals struggled to treat severely ill patients; secondly, a strong stockpiling of many other medicines also occurred, due to the "emergency state" caused by the spreading of the pandemic (European Pharmaceutical Review, 2021). Moreover, the national lockdowns and the border closures, negatively affected the sustainability and the resilience of pharmaceutical companies, also because of the export restrictions imposed by the Chinese and Indian government, as two of the largest countries active pharmaceutical ingredient (API) manufacturers worldwide (Chowdhury et al., 2021). The significant impact of such a super disruption led to the conclusion that PSC resilience is a topic that needs to be further investigated, adopting an inductive, qualitative, approach in order to bring out new insights about the establishment of a more resilient SC network in this sector when dealing with super disruptions like the COVID-19 pandemic.

2.2 Supply Chain Resilience: Definitions

Defining the SCR is a complex mission for several reasons. Firstly, the concept of SCR is a not univocal, but strictly associated to the socio-economic context in which a SC operates (Azadegan et al., 2019). For instance, by considering the pharmaceutical industry, this is strongly influenced by the geopolitical regulatory frameworks (Mehralian et al., 2015). Secondly, the SCR is a multifaceted concept that is greatly dependent on SC actors' type of relationships (e.g., a higher/lower dependence from a certain type of supplier; Håkansson & Persson 2004). To illustrate, a typical difficulty in forecasting pharmaceutical products' demand implies the need of choosing suppliers that are highly flexible (Salama & McGarvey, 2021): As a result, to systematically define a concept that is so much different adopting different points of view, is not easy. Nonetheless, several attempts to define SCR have been developed over the years and today there is a general agreement among authors about what macro-characteristics a SC must have to be resilient (Hohenstein et al., 2015). These macro-characteristics (also known as SCR phases) are the following ones: 1) Readiness, 2) Response, 3) Recovery, and 4) Growth. Readiness refers to the SC's capability to be prepared to deal with unexpected risks of disruptions (before disruptions occur); response is related to the efficacy of a SC to overcome the damages caused by disruptions (during disruptions); recovery indicates the time a SC takes to overcome the impact of disruptions (after disruptions have occurred); growth means that being resilient means not only to return to the original state before disruptions occurred (pre-shock conditions), but to gain a new and more desirable state after being disrupted (Chowdhury & Quaddus, 2017; Chowdhury et al., 2021).

Among the others, a valuable SCR definition that includes the four SCR phases has been developed by Tukamuhabwa et al. (2015, p. 5599), who defined the SCR as "the adaptive capability of a supply chain to prepare for and/or respond to disruptions, to make a timely and cost-effective recovery, and therefore progress to a post-disruption state of operations – ideally, a better state than prior to the disruption". Furthermore, another comprehensive definition is the one provided by Hohenstein et al. (2015, p. 108), describing the SCR as "the 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 to increase customer service, market share and financial performance". Such two definitions clearly illustrate the importance of the four phases of SCR and extend our knowledge about this thematic by including competitive factors such as costs' minimization and the increase of market share and financial performance.

However, despite these valuable efforts in trying to define and explain SCR, the current pandemic has revealed several weaknesses and vulnerabilities of global PSC in terms of dealing with super disruptions like COVID-19 (BCI, 2021). Indeed, recent studies (e.g., as for Tucker et al., 2020), reported that managerial decisions have been one of the main causes of the vulnerability of SCs. That said, to advance our understanding “why” the global SCs have suffered (and are still struggling) in finding solutions to deal with COVID-19 related disruptions (e.g., closing of plants and borders) we believe that giving voice to global SC managers of a specific sector (in our case, the pharmaceutical sector) is needed to increase knowledge on this issue. Moreover, today it is still unclear whether SCR is an “emergency-related ad hoc strategy” or whether PSC managers consider it a core capability that must be therefore institutionalized in global SC routines to become a systematic response to future disruptions (Azadegan & Dooley, 2020).

Based on above, the most relevant SCR definitions are shown in the synoptical table below (Table 1).

Table 1. SCR most relevant definitions emerging from the literature review

References. Author(s) and year	SCR definition
Ponomarov et al. 2009	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.
Juttner et al. 2011	The apparent ability of some supply chain to recover from inevitable risk events more effectively than others, based on the underlying assumption that not all risk events can be prevented.
Pereira et al. 2014	The capability of supply chain to respond quickly to unexpected events so as to restore operations to the previous performance level or even to a new and better one.
Hohenstein et al. 2015	Supply chain resilience is the 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.
Junwei Wang et al. 2016	A resilient system is a system with an objective to survive and maintain function even during the course of disruptions, provided with a capability to predict and assess the damage of possible disruptions, and enhanced by the strong awareness of its ever-changing environment and knowledge of the past events, thereby utilizing resilient strategies for defence against the disruptions.
Elleuch et al. 2016	Resilience is defined as the ability of a system to return to its original state or a more favourable condition, after being disturbed.
Kamalahmadi et al. 2016	The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations.
Geng et al. 2013	Cluster supply chain network suffers from cascading failure when dealing with undesirable disruption, but it can conduct self-repair through adaptability and make it fast recover to a new stable state.
Wieland et al. 2013	The ability of a supply chain to cope with change, if its original stable situation is sustained or if a new stable situation is achieved.
Berle et al. 2013	The ability of the supply chain to handle a disruption without significant impact on the ability to serve the supply chain mission.
Brandon-Jones et al. 2014	The ability of a supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed.
Birkie et al. 2016	The ability of a business to anticipate, and adapt to sustain and recover operations against disruptions.
Rice et al. 2003	The ability to react to unexpected disruptions and restore normal supply network operations.
Christopher et al. 2004	The ability of a system to return to its original state or move to a new, more desirable state after being disturbed.
Christopher et al. 2004	The ability of a system to return to its original (or desired) state after being disturbed.
Closs et al. 2004	The ability to withstand and recover from an incident. A resilient supply chain is proactive—anticipating and establishing planned steps to prevent and respond to incidents. Such supply chain quickly rebuild or re-establish alternative means of operations when the subject of an incident.
Gaonkar et al. 2007	The ability to maintain, resume, and restore operations after a disruption.
Priya Datta et al. 2007	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.
Falasca et al. 2008	The ability of a supply chain system to reduce the probabilities of disruptions, to reduce the consequences of those disruptions, and to reduce the time to recover normal performance
Barroso et al. 2010	The ability to react to the negative effects caused by disturbances that occur at a given moment in order to maintain the supply chain's objectives
Erol et al. 2010	Is a response to unexpected or unforeseen changes and disturbances, and an ability to adapt and respond to such changes
Carvalho et al. 2011	Concerned with the system ability to return to its original state or to a new one, more desirable, after experiencing a disturbance, and avoiding the occurrence of failure modes
Ponis et al. 2012	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
Carvalho et al. 2012	The ability of supply chain to cope with unexpected disturbances
Ponomarov 2012	The adaptive capability of a firm's supply chain to prepare for unexpected events, respond to disruptions, and recover from them in a timely manner by maintaining continuity of operations at the desired level of connectedness and control over structure and function
Xiao et al. 2012	The supply chain's ability of returning to the original or ideal status when this supply chain system has been disturbed by external interruption, and resilient supply chain show abilities on adaptability to environment and recovery
Kim et al. 2014	We define supply network resilience as a network-level attribute to withstand disruptions that may be triggered at the node or arc level speed.
Novak et al. 2021 (New)	A supply chain is resilient to the extent that the system can maintain core functionality by continually adapting, evolving, and transforming in response to the dynamic multiscale feedbacks that occur between the multitude of interconnected organizations, institutions, and social and ecological systems that are all parts of the larger supply chain.
Weiland and Durach 2021 (New)	Supply chain resilience is the capacity of a supply chain to persist, adapt, or transform in the face of change.
Pires-Ribeiro and Barbosa-Povoa 2018 (New)	A resilient supply chain should be able to prepare, respond and recover from disturbances and afterwards maintain a positive steady state operation in an acceptable cost and time.

Finally, by considering these premises, the first two research questions we would answer are:

RQ1. Do global PSC managers think that SCR definitions provided by scholars are valuable, considering their experience in the field?

RQ2. Is SCR an “emergency-related ad hoc strategy” or a capability that must be institutionalized in global PSC routines, in the opinion of global PSC managers?

2.3 Supply Chain Resilience: Elements and Structure

The SCR elements enclose all the elements that literature consider the most important in making a SC more resilient. Sometimes, scholars also refer to them as “attributes”, “dimensions”, “enablers”, “enhancers”, or “drivers”, characterized by strong dynamicity due to their nature, according to extant literature, because useful to rapidly react to adverse situations (Chowdhury et al., 2021; Hohenstein et al., 2015; Pires-Ribeiro & Barbosa-Povoa, 2018). The first element consists in SCR *flexibility*, defined as the “company’s ability to adjust following a disruption” (Liu & Lee, 2018, p. 7), and “to adapt to the changing environment” (Al-Omouh et al., 2020, p. 282); Such a concept has been often studied in combination with *agility* and *responsiveness*, as some authors consider flexibility to be an antecedent of these two capabilities (Shekarian et al., 2020). In addition, according to some authors agility and flexibility are subsumed in responsiveness (e.g., Chen et al., 2019), while others consider agility as a stand-alone concept, describing it as the capability to respond to changes in market in a timely manner (Mohammed et al., 2019). According to Shekarian et al. (2020), responsiveness consists in “the ability of a supply chain to respond purposefully and within an appropriate timeframe to customer requests or changes in the marketplace” (p. 3). Flexibility, agility, and responsiveness are at the core of redundancy strategies of SCs, as to be able to respond rapidly and effectively to changes in the business environment is essential to reduce the impact of disruptions (Albertzeth et al., 2020; Duong & Chong, 2020; Gaur et al., 2020).

Another important SCR element is its *adaptability*, that is “the ability to modify supply chain design in order to accommodate structural changes in the market and adjust the supply network according to strategies, technologies

and products” (Aslam et al., 2020, p. 1188). According to many researchers, an adaptable SC leads to resilience and to a superior competitive advantage (Ali & Gölgeci, 2019; Vanpoucke & Ellis, 2020). Strictly related to the previous capabilities is the SC *reconfigurability*. Reconfigurability is considered an essential capability to mitigate the ripple effect after a disruption occurs and it can be defined as “a network designed in a cost-efficient, responsive, sustainable and resilient manner (...) to survive in a changing environment by redesigning the supply chain structures” (Dolgui & Ivanov, 2020, p. 2). SC *robustness* “relates to a firm’s ability to maintain its planned performance following a disruption’s (or a series of disruptions) impacts” (El Baz & Ruel, 2021, p. 11). From this perspective, it is considered to be different from resilience, which concerns the “ability to recover the performance after having absorbed the disruption effects” (El Baz & Ruel, p. 12). On the other hand, SC *vulnerability* is often considered as the inverse of robustness, and therefore it is characterized by the degree to which a SC can be damaged from a disruption (Gu et al., 2021). Finally, SC *visibility* refers to the exchange and the sharing of information between the actors of the SC network, thus comprising an internal and external dimension, to enable stronger relationships between actors, and to push them to be more transparent and visible (Doetzer, 2020).

Achieving a real-time and end-to-end visibility is considered a valuable and strategic goal by actors, even though it is often unclear “how” to do that, since research has shown that firms and SCs often have several difficulties in obtaining that result (Colicchia et al., 2019). Since end-to-end and real-time visibility are difficult goals to achieve, especially for globally dispersed supply network as PSCs are, research has also showed that to enhance SC visibility, *trust* and *collaboration* between SC actors must be at the core of their resilience strategies (Giannoccaro & Iftikhar, 2019; Hou et al., 2018; Mwesiumo et al., 2021).

By considering the SCR definitions and seminal literature on the matter, despite the aforementioned elements are valuable to gain resilience for SC, less is known in terms of “how much” managers consider them as important in the design of their PSC resilience strategy and *why*.

Based on above, the most relevant definitions of SCR elements are reported in the synoptical table below (Table 2).

Table 2. SCR elements most relevant definitions emerging from the literature review

References. Author(s) and year	SCR definition
Albertzeth et al. 2020	Agility. Supply chain agility can be characterized as the capacity to quickly react to an erratic change in supply and demand. An agile supply chain has increased velocity to rapidly adapt to unpredicted changes in demand or supply, and acceleration to increase the response time.
Duong & Chong 2020	Flexibility. To be resilience, a supply chain should be flexible and it is characterized as the capacity of a supply chain to adjust according to the required necessities of its partners and environmental condition in the smallest amount of time.
Gaur et al. 2020	Robustness. Robustness is the capacity of the supply chain to oppose change and involves a proactive expectation of progress before it happens. It withstands and adapts to stuns by holding its dependability when changes happen.
Shekarian et al. 2020	Redundancy: Redundancy includes the vital and serious utilization of extra stock that can be conjured amid an emergency to adapt, e.g., request surges or with supply deficiencies. Redundancy is like a buffer stoke; sometimes it can be expensive methods for building resilience because it accounted the holding cost.
Dolgui & Ivanov 2020	Visibility. Supply chain visibility is defined as the ability of supply chain manager to see from one end to another and can find the place of disruptive event. Visibility is an intercession apparatus that permits managers the opportunity to react rapidly to interruptions or unsettling influences in view of exact, continuous evaluation.
Doetzer, 2020	IT Capability/Info Sharing. In supply chain, sharing the right information is very desirable and it reduces the risk in the supply chain. In the present dynamic and indeterminate supply chain environment, to minimize the risk in the supply chain, it is essential to form a group of active partners and right information should flow among all partners of that particular group.
Giannoccaro & Iftikhar, 2019	Collaboration. In the supply chain, collaboration is simply means that supply chain operations are planned and executed jointly by two or more autonomous firms for mutual benefits. Collaborative partnership helps to anticipate the disruption and manage risks efficiently. In a situation of disaster, collaboration can keep supply chain organizations together.
Colicchia et al., 2019	Sustainability. Sustainability procedures make numerous security benefits for both providers and

	makers. It helps for better quality choice and reduction in the wastes and dangers of the whole organizations.
Singh et al. 2019	Awareness/Sensitiveness. Sensitiveness can be defined as anticipating the actual demand. Awareness includes comprehension of supply chain vulnerabilities and making arrangements for such occasions, and it requires capacity to perceive a conceivable disturbance by detecting and translating occasions through early cautioning systems, and congruity arranging.
El Baz & Ruel 2021	Supply Chain Risk Management Culture. Dynamic supply chain with more complexity is more vulnerable to disruptions. To make supply chain resilient, one should be initiative and each and every organization should have a member in members of the board that have a proper understanding of the risk, an element of supply chain resilience and the structure of the supply chain.
Singh et al. 2019	Velocity. Supply chain velocity is speed of reaction of the supply chain to advertise changes. The capacity to react to showcase changes to a great extent relies upon the effectiveness of data sharing between supply chain individuals.
Ivanov 2021	Market Position. A strong market position is related to having increased market share and as a result allows investment in supply chain resilience, which surely help to maintain the relationship with the customers aftermath the unwanted event. Having a solid market position builds an association's capacity to recuperate from supply chain disturbances because of money-related quality.
Munir et al. 2020	Risk Control/Revenue Sharing. Revenue sharing encourages sharing the risk among supply chain accomplices. Sharing profit with the top of the stream and down of stream accomplices to make competitive advantage. If some organization wants to collaborate for mutual benefit, then risk and revenue sharing plays a vital role.
Yang & Lien 2019	Public-Private Partnership. Making social capital among supply chain partner and other organizations, e.g., community shareholder, increases the strength of the organization and gives the opportunity to learn from each other. Public-private partnership may help post-disruption in the supply chain because of interpersonal relation and social capability.
Ivanov 2021	Adaptability. Adaptive capabilities are characterized as tolerating the certainty of progress and to make a framework that is fit for adjusting to new conditions and objectives. If a supply chain has the capability to adapt things easily, then it can get back to its original or enhanced state after disruption.
Ivanov & Dolgui 2020	Supply Chain Network Design. It seems many times that a supply chain becomes more vulnerable to disruption when it is complex and dynamic. To make supply chain resilient, it is necessary that there should be a proper understanding of supply chain network design. Consequently, supply chain resilience is enhanced by developing learning.
Asante et al. 2021	Security. Security is a basic piece of supply chain resilience that ought to be composed ahead of time instead of looked for after an episode. Building security secures the supply chain against counterfeiting, for example cyber-security and freight security.
Yang et al. 2019	Employees and management: Tech savviness/Tech orientation. Since technology plays a vital role in building supply chain resilience, the tech savviness/orientation degree of people working in company is crucial to enhance the overall structure resilience. In other words, without a proper degree of tech proneness among employees and managers, building resilience will probably be difficult, if not impossible.

Thus, based on above, these argumentations led to the last and third research question:

RQ3. Given the most important SCR elements reported by extant literature, how much do managers of global PSC consider them as important in the formulation of their SCR strategy and why?

3. Materials and Method

In the attempt to increase knowledge on the topic related to SCR strategies for PSC in time of pandemic, through a qualitative research design, a focus group has been conducted in the attempt to capture managers' and practitioners' perception related to the phenomenon under investigation (Dilshad & Latif, 2013). The focus group as qualitative research method may be particularly useful when investigating a topic that involves different types of actors (e.g., in this case as for SC partners, supplier, manufacturer, retailer, service providers) who assume different roles in a specific setting (Kitzinger, 2005): Indeed, the latter stimulates an intense participation and confrontation between the participants involved, overcoming the lack of stimulation that is present in one-to-one interviews (Rabiee, 2004).

By considering the two main macro-research issues to investigate (i.e., SCR definitions and SCR elements), the

following subsections are organized consequently to show the projective activities (tasks) in which the focus group participants have been involved.

3.1 Focus Group Design

3.1.1 Materials

RQ1 and RQ2: SCR definitions

To investigate the reasons, motives, and behaviors that lead managerial decisions toward SCR for global PSCs, a preliminary phase of collecting materials for participants was undertaken by the authors. By considering the proposed *RQ1* and *RQ2*, aimed to shed light on how practitioners evaluate the efforts made by scholars in establishing SCR definitions, we used the valuable set of recent SCR definitions, systematized in Pires-Ribeiro and Barbosa-Povoa (2018) as the basis for our focus group.

Moreover, to better capture the nuance behind SCR, and because their research did not consider more recent SCR definitions (i.e., as for those one advances on the topic conducted 2018 and 2021), a preliminary literature recognition has been conducted by mining Google Scholar and other scholarly databases (e.g., Emerald, ScienceDirect, Taylor & Francis), and social networks (e.g., ResearchGate) to collect potential new definitions published in the last years. The main definition used in the focus group and provided to the involved participants, coincides with the SCR definition emerged from our initial literature review, reported in the table above (Tab. 1).

Thus, based on the above, a structured file containing such SCR definitions has been proposed to the involved participants by asking them to order every single definition from the best to the worst, on the basis of their perception of appropriateness for their specific sector before their participation in the focus group session.

RQ3. SCR elements

A similar process has been followed for SCR elements: Since, the main goal was to understand “how much” global PSCs managers considered the main SCR elements reported in extant literature to be important, and to subsequently ask them “why” these were more or less important during the focus group session.

All SCR elements has been described with a unique definition based on the recognition of extant literature made by the authors in order to align practitioners’ knowledge about specific SCR elements, resulting in a glossary drawn by the collected SCR elements definitions emerging from our literature review and reported in the Table 2 above. Then, we asked participants to assign a score between 1= “absolutely not relevant” and 5= “absolutely relevant” to every single element, differentiating each score for the overall SC and for the specific node of the chain in which their companies operate.

3.1.2 Participants

Participants, operating in different supply chain nodes (e.g., as for manufacturer, logistics operator, and so on) have been personally and directly contacted via e-mail to join the focus group. To provide rich and diverse viewpoints on the issues the focus group wanted to address (i.e., SCR definition and SCR elements), participants from companies who occupied different nodes on the pharmaceutical global SC were summoned. The final sample finally included participants representing each level in the PSC: Manufacturer; logistics operator; contract manufacturer (CMO); and service provider.

Moreover, coherently to our research scope, we assured that each participant was currently involved in decision-making activities regarding SCR and SC disruption management, even if at different levels, in structured business realities.

In total, four invited participants took part in the focus group with the authors (Table 3): Such a small group is considered optimal for participant interactions and generating relevant and deeper data about the topics of interest, also assuring a decent content validity (Krueger & Casey, 2015).

Table 3. Profile of participants involved in the Focus Group

Code	Function	Role of company in the PSC	Company size
P1	Senior Global Supply Chain Director	Manufacturer	Large
P2	Head of Airfreight	Logistics operator	Large
P3	Advanced Analytics Advisor	Service provider	Medium
P4	Director of Business Operations	Contract manufacturer	Medium

3.1.3 Focus Group Activities

The focus group took place on the 22nd June, 2022, from 3 p.m. to 5 p.m. CET. The session was opened with 15 minutes' oral presentation by the authors to remind the participants of the focus group's main scope(s) and structure (two rounds for each subphase).

Then, the involved researchers asked the participants to introduce themselves to each other to align them about each role in the PSC. A first round of discussion took place to understand how participants would generally describe SCR and whether resilience is currently seen in their companies as an "emergency-related topic" or whether, instead, SCR might be a macro-capability that should be institutionalized in companies' routines. Once having obtained their opinions towards these topics (*RQ1*), a second round of discussion took place. Authors showed participants the results of their preferences regarding the SCR definitions provided by the extant literature, asking them to comment on the results obtained. At the end of this second round (*RQ2*), a short break was taken before starting the second phase.

Subsequently, the researcher opened the second phase (about SCR elements) by showing participants a graph in which the aggregate results were reported for each SCR element. Then, a first round of discussion took place, asking participants to discuss the findings.

3.1.4 Data Collection and Analysis

The entire focus group session has been recorded with the consent of participants. Moreover, in order to assure a full capturing of the emerging insights, the researchers also take notes about participants opinions and behaviors by considering for instance their tone-of-voice used to express a specific concept (Belk, 2007). To obtain the most consistent insights as possible, the records has been entirely transcribed and compared with the caught notes, to increase reliability and internal consistency in a debriefing session. Then, after multiple times of reading the answers provided by participants, by following Tong et al. (2007) researchers independently coded the findings to identify key concepts and issues emerged during the focus group, before a cross comparison on emerging insights.

4. Findings

4.1 Results of "SCR Definitions" Round of Discussion

The first emerging concept that has been really "stressed" by all participants consists in that despite SCR is widely recognized as a capability that must be institutionalized in a company's culture, this goal is very far from being achieved in reality. Indeed, also by considering the COVID-19 pandemic, a participant stated that:

"When the COVID-19 pandemic exploded, our response was based on our existing risk management protocols that were not adapted to overcome such a disruption. So, in that case, we treated that disruption trying to adapt an inappropriate model of response, and in fact we failed in it." (P2, Head of Airfreight, Logistics operator).

While multiple participants agreed with this description of the early consequences of the COVID-19 pandemic, they also reported that, starting from this "emergency" response, they initiated new internal projects that aimed to both 1) finding solutions to super disruptions events such as in the case of the COVID-19 pandemic, and 2) disseminating a new "culture" aimed to embrace a strong SCR oriented behavior. The latter is considered as crucial to avoid future inefficiencies while dealing with large-scale disruptions. To illustrate, one of the participants told us:

"We started a division-level project which was then embraced by the corporate also for the other non-pharma divisions and we are currently working to implement a control tower, therefore a sort of control room that connects the entire network, mainly the production and the supply side. We are therefore connecting with systems and providers to make it an organizational and corporate process model that is no longer "event-based" but is a measurement of resilience performance on a recurring basis" (P1, Senior Global Supply Chain Director, Manufacturer).

Regarding extant SCR definitions, participants agreed with academic literature, confirming how researchers provided several appropriate definitions for PSC realities in the last years. To illustrate, one of the participants stated:

"I must admit that years ago I thought academic definitions were a bit too theoretical, but since I have been working in our headquarters, I have realized that the theme of language is extremely important. So, establishing definitions that are communicable, around which a consensus can be formed, is crucial, otherwise we talk about elements such as agility, flexibility, and the others, without ever extracting real value from these terms." (P1, Senior Global Supply Chain Director, Manufacturer).

Confirming this statement, over a total amount of thirty definitions, only ten of them have been considered as the

most valuable by the involved participants, and here reported in the Table 4 below.

Table 4. The final ten most relevant SCR definitions selected by the Focus Group participants

Author(s) and year	Chosen SCR definitions
Ponomarov et al. 2009	The adaptive capability of a firm’s supply chain to prepare for unexpected events, respond to disruptions, and recover from them in a timely manner by maintaining continuity of operations at the desired level of connectedness and control over structure and function.
Juttner et al. 2011	The apparent ability of some supply chain to recover from inevitable risk events more effectively than others, based on the underlying assumption that not all risk events can be prevented.
Hohenstein et al. 2015	Supply chain resilience is the 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.
Kim et al. 2014	We define supply network resilience as a network-level attribute to withstand disruptions that may be triggered at the node or arc level speed.
Ponis et al. 2012	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.
Falasca et al. 2008	The ability of a supply chain system to reduce the probabilities of disruptions, to reduce the consequences of those disruptions, and to reduce the time to recover normal performance.
Pereira et al. 2014	The capability of supply chain to respond quickly to unexpected events so as to restore operations to the previous performance level or even to a new and better one.
Birkie et al. 2016	The ability of a business to anticipate and adapt to sustain and recover operations against disruptions.
Berle et al. 2013	The ability of the supply chain to handle a disruption without significant impact on the ability to serve the supply chain mission.
Xiao et al. 2012	The supply chain’s ability of returning to the original or ideal status when this supply chain system has been disturbed by external interruption, and resilient supply chain show abilities on adaptability to environment and recovery.

After the discussion, participants concluded that considering at the relevant terms that those definitions had in common, it would be possible to come to an interpretative operational framework that is appropriate for global PSC. That framework consisted of four macro-pillars that are logically related to the main questions while formulating a strategy (Koontz & Wehrich, 2010), in terms of “to do” (i.e., “what do we have to do to be resilient?”), “how” (i.e., “how can we be resilient?”), “what” (i.e., “what brings more resilience to our SC?”), and “why” (i.e., “why/for what purpose do we want to be resilient?”), as summarized in the Figure 1.

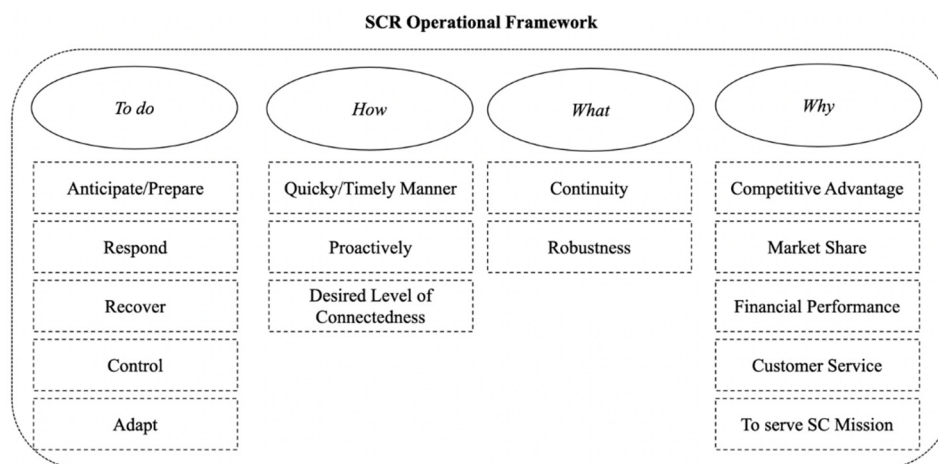


Figure 1. The interpretative operational framework

The most relevant *to do* elements concern the capability of a SC to be prepared to anticipate disruptions in such a manner that the response and recovery when the disruption occurs may be smooth and effective. Moreover, keeping control over functions and networks is crucial while facing disruptions, and so SC adaptability also plays a crucial role in this regard. To achieve resilience, it is necessary to decide *ex ante* *how* to do it and, in this respect, practitioners considered it important to do it in a cost-effective and timely manner by proactively anticipating disruptions’ effects in order to maintain the desired level of connectedness among all SC nodes. This is necessary to increase robustness and to guarantee continuity in SC operations and activities (“what”) with the end of reaching a new and better state after disruptions if compared to the pre-disruption competitive position. Thus, the purpose for which a SC must be resilient (“why”) relies on the increasing of competitive advantage, market share, financial performance, and customer service level. Finally, participants agreed that achieving SCR is a prerequisite to guaranteeing that the SC mission achieves effective application in inter- and intra-organizational relationships and regarding customers’ expectations.

Accordingly, participants recognized that to be resilient not only helps SCs to overcome a disruption in terms of internal operations’ continuity, but it also has a direct effect on their relationships with external stakeholders, since the brand might be directly affected by the way they deal with disruptions in terms of how external customers might see it as a reliability indicator.

4.2 Results of “SCR Elements” Round of Discussion

In this round of discussion, we reported those findings related to participants’ comments about the aggregate results of their preferences towards SCR’s most important elements. A first issue that has been addressed by participants was to make clear whether they considered SCR as an overall concept that is referred to the SC in its entirety or whether it must be interpreted at node-level. Participants agreed about the fact that for large and dispersed SCs as PSCs usually are, SCR must be seen as a whole or, at least, as the sum of the resilience of a selected set of main critical nodes. In this regard, one of the participants stated:

“If the network is well designed and optimized, the problem [distinguishing between node and SC resilience] arises less, because flexibility is certainly higher and there is complete or almost complete visibility up to even the Tier-1 and Tier-2 supplier”. (P4, Director of Business Operations, Contract Manufacturer).

Regarding the specific SCR elements, participants reported that *agility, flexibility, collaboration, and adaptability* are the most important for PSCR, primarily because of the specificities of this industry, which include stringent regulations, manufacturing complexity and patents-related issues.

In that sense, to be able to quickly and proactively intervene when a disruption occurs is crucial as well to be able to count on solid partnerships with companies that can guarantee valuable collaboration when the context calls for it. The latter has been a fiercely discussed point, because SCR is largely considered by practitioners as a context/industry-depending concept. An interesting comment on adaptability was also made by one of the participants, who asserted that:

“There cannot be adaptability and decent level of agility and flexibility, and so resilience, without appropriate technologies that support the continuity of network activities. This is a main point that has necessarily to be included in future SCR strategies and definitions.” (P3, Advanced Analytics Advisor, Service Provider).

Therefore, the scores given to each SCR attribute for end-to-end SC and for nodes are very similar, are reported in the Figure 2.

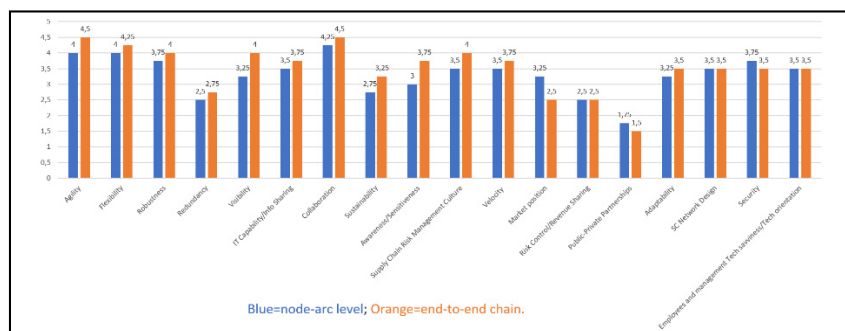


Figure 2. Aggregated results

Participants also discussed that those SCR elements become even more important in such a context as the actual pandemic, since the latter caused panic among customers who have demanded much higher volumes of medicines, personal protective equipment (PPE) and other pharmaceutical products and so the risk of shortages has dramatically increased for all those SCs that could not count on collaborative partners, redundancies and on an agile, flexible, and adaptable network. Moreover, due to government policies due to the COVID-19 pandemic, such as national lockdowns, the role of alternative routes to transport inputs or products has become a major concern for managers since it represents a cost opportunity for SCs, adding significant costs to organizations that have to count on safe journeys for their inputs or product. In fact, some medicines or vaccines need to be transported in cold cells and at a certain speed to prevent them from being ruined. Therefore, the optimal design of a SC network is a critical activity in developing resilience strategies in the long run.

Other SCR elements that are at the core of resilience strategies of PSCs included the inclusion of SCR and SC risk management principles inside the organizational culture and the propensity/capacity to promptly share information with other chain actors. In fact, the absence of the latter elements often leads to an asymmetry between SC partners, which reflects negatively on partners' satisfaction and trust. That kind of transparency seems to be particularly important when looking at supply chain financial issues. Participants asserted that if information sharing is widely demanded by all partners, this is not so in terms of the share of revenues. Coherently, a participant confirmed that such an event may occur because is common that some suppliers do not want to share revenues and financial information to disguise the fact they are in need of cash for fear that this may be perceived as a weakness: In this case, this issue might be addressed by the usage of specific contracts, but often the propensity to sign those types of contracts depends on the organizational culture that leads to a degree of openness towards making such a deal. Thus, in this light, it would be interesting for some partners to exercise a negotiating power on others, sometimes this is not possible due to several reasons, as expressed by the example provided by one of the participants:

"In China, regulation does not allow second sourcing, that is, I cannot approve two factories to export to China, so it is single source by definition." (P1, Senior Global Supply Chain Director, Manufacturer).

Interestingly, another important theme that has been remarked on during the discussion was the role of human resources as a core resilience element.

Participants stated that people, both at managerial and non-managerial level, assume a crucial role in understanding the degree of readiness of a SC in terms of resilience and that the COVID-19 pandemic has drastically enhanced their role as key factors to overcome disruptions. Their role has been described from a double perspective: Firstly, their commitment to companies has been determinant in guaranteeing the continuity of business operations and activities; Secondly, their level of technological savviness has been extremely important, since it has ensured a tight control with the aid of digital technologies on the SC network visibility. Moreover, participants admitted that before a global disruption like COVID-19, people were usually considered in terms of efficiency in carrying out their tasks and that SC governance had never seen them as a resilient element before: In this regard, the role of employees in contributing to SCR has been significantly reconsidered at the corporate level.

Furthermore, this discussion led participants to also reflect on the type of disruption that a SC may face, distinguishing between internal/operational disruptions and external disruptions. By referring to COVID-19, they reported that the recent pandemic had been a super disruption that had had a deep impact on both the internal and external sides of the chain, as on the one hand it affected forward and reverse flows between SC partners, both upstream and downstream (e.g., due to the borders closing policies), and on the other one, it caused troubles internally to employees (e.g., as for ill employees). On this issue, a participant stated:

"We were not ready for COVID-19. It integrated all the problems that we were able to foresee and also, in part, to manage individually, but not all together. When a disruption of that magnitude occurs, the overall damage it produces is greater than the sum of the individual problems that are generated and therefore disjointed solutions are not sufficient." (P2, Head of Airfreight, Logistics operator).

Finally, participants spontaneously added some reflections that went beyond the mere topic of SCR elements, claiming the necessity for appropriate SCR metrics to measure the impact on the value at risk (VaR) of all those elements, in the attempt to statistically measure of the riskiness of financial entities or portfolios of assets in such unforeseen scenarios.

According to them, one of most important obstacles to understanding SCR and to its inclusion in organizational culture is related to the difficulty in measuring how much it could affect business from the competitive and financial perspectives. This often brings a sort of "myopia" in SC governance, that does not always recognize the importance of being resilient or, at least, recognizes it only when a disruptive event occurs, making impossible a proactive respond and a quick recovery. In this regard, participants clearly reported that that they would be very

glad to collaborate with academics to find new models and metrics able to give a numerical value to their SCR and to understand how each of the SCR elements contribute to SCR “in real terms.”

By considering the proposed *RQs*, the emerging findings deriving from the analysis of SCR definitions in PSCs, and SCR elements in PSCs are summarized in the Table 5 below.

Table 5. Emerging findings from our Focus group: SCR definitions and elements

Emerging findings from the conducted Focus Group	
Topic 1. SCR definitions in PSCs	Topic 2. SCR elements in PSCs
1) Extant literature SCR concept definitions are heading in the right direction to understanding the concrete meaning of SCR, because they include all the topics considered most important by practitioners to being resilient.	1) PSC managers consider SCR as a concept related to SCs as a whole, as in the pharmaceutical sector SCs are globally dispersed and it will be very difficult to map the entire network and measure every single node's resilience.
2) After being disrupted by major disturbances like the COVID-19 pandemic, PSC managers are reflecting on their actual plans for resilience, identifying weaknesses in their structure and strategies and trying to institutionalize SCR in their organizational culture.	2) SCR elements reported by extant literature as extremely important, although they are not all important at the same levels. In particular, adaptability, flexibility, agility, and collaboration are considered as the most important for PSCs given their globally extended networks, which require strong partnerships among the actors and an adaptive and quickly collective response in order to recover.
3) SC managers are increasingly committed to incorporating the thematic of SCR in their organizational culture as an essential condition to anticipate and overcome future super disruptions like the COVID-19 pandemic.	3) While considering potential disruptive events, usually risk protocols are insufficient because they do not consider an event that can disrupt a firm or an entire SC both at internal and external levels simultaneously and on a large scale. As such, to be able to institutionalize and to incorporate SCR in organizational culture it is crucial to avoid the repetition of errors made in the past.

5. General Discussions and Conclusion

5.1 Toward a Consensual Definition of SCRs and Its Elements

The purpose of this paper was aimed to shed light on a consensual agreement toward SCR definitions and its element, by aligning academics' and scholars' studies with managers' and practitioners' perceptions, by considering a severe historical period in which SCR should be required, that is the one related to the COVID-19 pandemic. Findings provided evidence of emerging practitioners' perceptions regarding SCR strategies, by revealing congruence and incongruence points on the manner related to theoretical perspectives.

Adopting the practitioners' perspective to understand if and how they consider scholars' assumptions on SCR as valuable, our study contributes to extant literature by identifying the perimeter in which managerial and academic viewpoints converge and in what areas there is the need to do more research. In responding to calls for research both from the theoretical and empirical sides, our paper found a significant consonance about how academic and managerial actors define SCR. In building SCR, an adaptable, flexible, and agile SC network able to proactively prepare, respond and recover from disruptions is a first set of patterns that managers must guarantee to their SCs. Moreover, practitioners agreed with the most recent vision on this concept that considered a resilient SC can gain a new and better state after disruption, instead of focusing only on the return to the pre-shock competitive position (e.g., Pires Ribeiro & Barbosa-Povoa, 2018).

Our study may contribute to the theoretical advance in several ways. First of all, findings reveal that two elements seem to be missed in the current SCR academic definitions according to practitioners, focusing on: 1) the indispensable role of new technological advances to achieve a full end-to-end visibility and continuity of operations; 2) the need to find new synthetic metrics able to quantify the degree of network resilience, and then, how much each of the SCR elements contribute to the resulted metric(s).

Therefore, in developing new and more holistic SCR definitions, scholars should also mention these two core elements to provide an even more valuable theoretical tool to literature and to practitioners. Moreover, findings reveal that often, SCR is little more than a “buzzword” for most of PSC managers: This usually leads them to treat SCR as a reactive strategy after an event's manifestation instead of proactively anticipating potential shocks.

Findings shed light on the lack of knowledge about the importance of institutionalizing SCR into the SC routine, thus imposing to reconsider SCR as a business core dynamic capability, especially by considering the effects of exogenous crisis such as in the case of the last pandemic.

Furthermore, by focusing on the COVID-19 pandemic as a super disruption, findings reveal how such an unforeseen event may affect PSC at all levels and both internally and externally simultaneously, and how several SC actors are currently working on “control towers” based on advanced digital technologies to monitor, prevent, and anticipate future similar disruptions. Such supply chain control tower may be built as a cloud-based solution that leverages advanced technologies (e.g., as for artificial intelligence, machine learning, and the Internet of), to proactively manage supply chains: These findings also confirm the fundamental role that new technologies should have in implementing newer SCRs strategies. This will require a large number of financial resources, and so probably not all firms will be able to afford such an investment, like, example, SMEs. Because some of them might be a critical node of the chain for large manufacturers, representing a key source for them, ensuring the supply chain end-to-end and real-time visibility are issues of primary importance. Along with the investment in appropriate technologies, the increase in the level of openness and collaboration also becomes crucial, as not all partners are inclined to be collaborative with other SC actors. Thus, we finally add knowledge on this domain by highlighting how, consistently with recent literature, the deep collaboration between partners becomes an essential and crucial element for SC to be effectively agile and flexible, and thus resilient (Salama & McGarvey, 2021).

5.2 Managerial Implications

Managerially, our findings may suggest interesting implications for managers and practitioners for several reasons. Firstly, our paper suggests that academic contributions to SCR are not merely made by theoretical institutions as they discretely match managers' beliefs about this matter, thus indicating that collaboration between the academic and the managerial world is valuable to better understand a topic such as the resilience of SC, thus by promoting an approach research-based in manage such complexity. A second implication for managers relies on the role of technology to ensure a full end-to-end visibility of SCs: Even if technological support to overcome major and minor disruptions is not a new topic in extant literature (e.g., Lai et al., 2021), SC actors have not begun to invest a proper number of resources into this direction, or at least they are still struggling into understand how technologies may serve in order to forecast and minimize the impact of disruptions on their SC. This misalignment between evidence from literature and SC investment in technologies also reinforces our first implication presented in this section. Thirdly, our findings shed light and recall attention to the fundamental role of human resources as a key SCR element, that, when related to business continuity and SCR strategies has been recently underrated according to extant literature (Scala & Lindsay, 2021). Thus, findings confirm how the role of human resources in sustaining winning SCR strategies should be not neglected, consistently, on the basis of the other contributions, to the diffusion of an SCR-inspired organizational culture. Moreover, findings suggests that since human resources are often not included as a strategic SCR in business continuity and SCR plans, future SCR-inspired strategies should consider such factor as their response to disruptions is often suboptimal given this lack of preparedness. Furthermore, a final consideration regards human resources involved their capacity to be technologically savvy and so the readiness of employees in operating with technologies is necessary to guarantee SC visibility and resilience: According to the findings, the degree of tech savviness is usually underestimated by SC decision-makers and this causes several issues when it comes to investing resources in advanced technologies to increase resilience in their SC, thus supporting recent research has already observed (e.g., as in Sawyerr & Harrison, 2019).

5.3 Limitations, Future Research and Conclusion

Based on above, despite the promising both theoretical and managerial implications deriving by the emerging findings, our study is not exempt from limitations. A first limitation is about the data collected: Indeed, the since the focus group has been conducted during the COVID-19 pandemic period, participants' response could have been arguably deeply influenced by the effects carried by this unprecedented disruption. As SCR is a context-related concept, it is impossible to disregard how the pandemic scenario might have influenced their considerations about the resilience of PSCs. A second limitation concern the industry under investigation: Indeed, the study considered only a specific sector that is the pharmaceutical industry, and so this has not allowed us to make a comparison with the perspectives of managers of other deeply impacted sectors, which could have provided more and richer insights for our study.

As future research avenues, we believe that replicating this study with multiple global SC actors from multiple sectors is therefore a first future research direction for scholars who want to delve into the complexity of SCR. Moreover, since managers involved in this study were SC actors mainly located in developed countries, there is great scope for further investigations in developing countries, who often also have different and less homogeneous

regulatory frameworks that regulate pharmaceutical companies' activities: This might lead to different conceptualizations of SCR, depending on the specific geographical area: In this sense, understanding how the SCR concept may differ if seen from this other perspective may certainly represent an interesting suggestion for future research. Furthermore, by considering our research goal, this paper focused on exogenous crisis such as the health ones, as in the case of the pandemic: Future studies may extend our findings by considering similar deriving scenario related to exogenous crisis such as the current conflict due to the friction between Ukraine and Russia that is currently impacting worldwide business.

References

- Albertzeth, G., Pujawan, I. N., Hilletoft, P., & Tjahjono, B. (2020). Mitigating transportation disruptions in a supply chain: A cost-effective strategy. *International Journal of Logistics Research and Applications*, 23(2), 139-158. <https://doi.org/10.1080/13675567.2019.1648640>
- Ali, I., & Gölgeci, I. (2019). Where is supply chain resilience research heading? A systematic and co-occurrence analysis. *International Journal of Physical Distribution & Logistics Management*, 1-39. <https://doi.org/10.1108/IJPDLM-02-2019-0038>
- Al-Omoush, K. S., Simón-Moya, V., & Sendra-García, J. (2020). The impact of social capital and collaborative knowledge creation on e-business proactiveness and organizational agility in responding to the COVID-19 crisis. *Journal of Innovation & Knowledge*, 5(4), 279-288. <https://doi.org/10.1016/j.jik.2020.10.002>
- Asante, M., Epiphaniou, G., Maple, C., Al-Khateeb, H., Bottarelli, M., & Ghafoor, K. Z. (2021). Distributed ledger technologies in supply chain security management: a comprehensive survey. *IEEE Transactions on Engineering Management*, 1-27. <https://doi.org/10.1109/TEM.2021.3053655>
- Aslam, H., Khan, A. Q., Rashid, K., & Rehman, S. U. (2020). Achieving supply chain resilience: the role of supply chain ambidexterity and supply chain agility. *Journal of Manufacturing Technology Management*, 31(6), 1185-1204. <https://doi.org/10.1108/JMTM-07-2019-0263>
- Azadegan, A., & Dooley, K. (2021). A typology of supply network resilience strategies: Complex collaborations in a complex world. *Journal of Supply Chain Management*, 57(1), 17-26. <https://doi.org/10.1111/jscm.12256>
- Azadegan, A., Srinivasan, R., Blome, C., & Tajeddini, K. (2019). Learning from near-miss events: An organizational learning perspective on supply chain disruption response. *International Journal of Production Economics*, 216, 215-226. <https://doi.org/10.1016/j.ijpe.2019.04.021>
- Belk, R. W. (Ed.). (2007). *Handbook of qualitative research methods in marketing*. Edward Elgar Publishing.
- Borumand, A., & Beheshtinia, M. A. (2018). A developed genetic algorithm for solving the multi-objective supply chain scheduling problem. *Kybernetes*, 47(7), 1401-1419. <https://doi.org/10.22059/IJMS.2019.254633.673069>
- Burinskiene, A. (2018). Pharma supply chain: Efficiency modelling approach. *Journal of System and Management Sciences*, 8(2), 65-73.
- Business Continuity Institute (2021). Supply Chain Resilience Report 2021. Retrieved from <https://www.thebci.org/uploads/assets/e02a3e5f-82e5-4ff1-b8bc61de9657e9c8/BCI-0007h-Supply-Chain-Resilience-ReportLow-Singles.pdf>
- Chen, L., Lu, Y., & Zhao, R. (2019). Analysis and application of modern supply chain system in China. *Modern Supply Chain Research and Applications*, 1(2), 106-119. <https://doi.org/10.1108/MSCRA-01-2019-0004>
- Chowdhury, M. M. H., & Quaddus, M. (2017). Supply chain resilience: Conceptualization and scale development using dynamic capability theory. *International Journal of Production Economics*, 188, 185-204. <https://doi.org/10.1016/j.ijpe.2017.03.020>
- Chowdhury, P., Paul, S. K., Kaisar, S., & Moktadir, M. A. (2021). COVID-19 pandemic related supply chain studies: A systematic review. *Transportation Research Part E: Logistics and Transportation Review*, 148, 102271. <https://doi.org/10.1016/j.tre.2021.102271>
- Colicchia, C., Creazza, A., & Menachof, D. A. (2019). Managing cyber and information risks in supply chains: insights from an exploratory analysis. *Supply Chain Management: An International Journal*, 24(2), 215-240. <https://doi.org/10.1108/SCM-09-2017-0289>
- Dilshad, R. M., & Latif, M. I. (2013). Focus group interview as a tool for qualitative research: An analysis. *Pakistan Journal of Social Sciences*, 33(1), 191-198.

- Ding, B. (2018). Pharma Industry 4.0: Literature review and research opportunities in sustainable pharmaceutical supply chains. *Process Safety and Environmental Protection*, 119, 115-130. <https://doi.org/10.1016/j.psep.2018.06.031>
- Doetzer, M. (2020). The role of national culture on supply chain visibility: Lessons from Germany, Japan, and the USA. *International Journal of Production Economics*, 230, 107829. <https://doi.org/10.1016/j.ijpe.2020.107829>
- Dolgui, A., & Ivanov, D. (2020). Exploring supply chain structural dynamics: New disruptive technologies and disruption risks. *International Journal of Production Economics*, 229, 107886. <https://doi.org/10.1016/j.ijpe.2020.107886>
- Duong, L. N. K., & Chong, J. (2020). Supply chain collaboration in the presence of disruptions: a literature review. *International Journal of Production Research*, 58(11), 3488-3507. <https://doi.org/10.1080/00207543.2020.1712491>
- El Baz, J., & Ruel, S. (2021). Can supply chain risk management practices mitigate the disruption impacts on supply chains' resilience and robustness? Evidence from an empirical survey in a COVID-19 outbreak era. *International Journal of Production Economics*, 233, 107972. <https://doi.org/10.1016/j.ijpe.2020.107972>
- European Central Bank (2022), Bottlenecks and monetary policy. Retrieved from <https://www.ecb.europa.eu/press/blog/date/2022/html/ecb.blog220210~1590dd90d6.en.html>
- European Pharmaceutical Review. (2021), Nearly two years on, how are European pharma supply chains coping with COVID-19? Retrieved from <https://www.europeanpharmaceuticalreview.com/article/166689/nearly-two-years-on-how-are-european-pharma-supply-chains-coping-with-covid-19/>
- Gaur, J., Amini, M., & Rao, A. K. (2020). The impact of supply chain disruption on the closed-loop supply chain configuration profit: a study of sourcing policies. *International Journal of Production Research*, 58(17), 5380-5400. <https://doi.org/10.1080/00207543.2019.1657244>
- Ghobakhloo, M. (2020). Industry 4.0, digitization, and opportunities for sustainability. *Journal of Cleaner Production*, 252, 119869-119992. <https://doi.org/10.1016/j.jclepro.2019.119869>
- Giannoccaro, I., & Iftikhar, A. (2019). Is network trust beneficial for supply network resilience? A simulation analysis. *IFAC-PapersOnLine*, 52(13), 2437-2442. <https://doi.org/10.1016/j.ifacol.2019.11.572>
- Gu, C., Wei, J., & Wei, Y. (2021). Sourcing under competition: The implications of supplier capital constraint and supply chain co-opetition. *Transportation Research Part E: Logistics and Transportation Review*, 149, 102262. <https://doi.org/10.1016/j.tre.2021.102262>
- Håkansson, H., & Persson, G. (2004). Supply chain management: the logic of supply chains and networks. *The International Journal of Logistics Management*, 15(1), 11-26. <https://doi.org/10.1108/09574090410700202>
- Herwig, C., Wölbeling, C., & Zimmer, T. (2017). A holistic approach to production control. *Pharm. Eng*, 37, 44-46.
- Hohenstein, N. O., Feisel, E., Hartmann, E., & Giunipero, L. (2015). Research on the phenomenon of supply chain resilience: a systematic review and paths for further investigation. *International Journal of Physical Distribution & Logistics Management*, 45(1/2), 90-117. <https://doi.org/10.1108/IJPDLM-05-2013-0128>
- Hou, Y., Wang, X., Wu, Y. J., & He, P. (2018). How does the trust affect the topology of supply chain network and its resilience? An agent-based approach. *Transportation Research Part E: Logistics and Transportation Review*, 116, 229-241. <https://doi.org/10.1016/j.tre.2018.07.001>
- Ivanov, D. (2020). Viable supply chain model: integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research*, 1-21. <https://doi.org/10.1007/s10479-020-03640-6>
- Ivanov, D. (2021). Supply chain viability and the COVID-19 pandemic: A conceptual and formal generalization of four major adaptation strategies. *International Journal of Production Research*, 59(12), 3535-3552. <https://doi.org/10.1080/00207543.2021.1890852>
- Kabir, M. I. (2013). Reverse logistics in pharmaceutical industry. *International Journal of Supply Chain Management*, 2(1).
- Kamalahmadi, M., & Parast, M. M. (2016). A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. *International Journal of Production*

- Economics*, 171, 116-133. <https://doi.org/10.1016/j.ijpe.2015.10.023>
- Kitzinger, J. (2005). Focus group research: using group dynamics. *Qualitative Research in Health Care*, 56, 70-83.
- Koontz, H., & Wehrich, H. (2010). *Essentials of management: An international perspective*. McGraw Hill.
- Kumar, A., Zavadskas, E. K., Mangla, S. K., Agrawal, V., Sharma, K., & Gupta, D. (2019). When risks need attention: adoption of green supply chain initiatives in the pharmaceutical industry. *International Journal of Production Research*, 57(11), 3554-3576. <https://doi.org/10.1080/00207543.2018.1543969>
- Lai, J. Y., Wang, J., & Chiu, Y. H. (2021). Evaluating blockchain technology for reducing supply chain risks. *Information Systems and e-Business Management*, 1-23. <https://doi.org/10.1007/s10257-021-00533-4>
- Levin-Scherz J., Toro, P. (2021), The Omicron Variant: How Companies Should Respond. Retrieved from <https://hbr.org/2021/12/the-omicron-variant-how-companies-should-respond>
- Liu, C. L., & Lee, M. Y. (2018). Integration, supply chain resilience, and service performance in third-party logistics providers. *The International Journal of Logistics Management*, 29(1), 5-21. <https://doi.org/10.1108/IJLM-11-2016-0283>
- Mehralian, G., Zarenezhad, F., & Ghatari, A. R. (2015). Developing a model for an agile supply chain in pharmaceutical industry. *International Journal of Pharmaceutical and Healthcare Marketing*, 9(1), 74-91. <https://doi.org/10.1108/IJPHM-09-2013-0050>
- Mwesiumo, D., Nujen, B. B., & Buvik, A. (2021, June). Driving collaborative supply risk mitigation in buyer-supplier relationships. In *Supply Chain Forum: An International Journal* (pp. 1-13). Taylor & Francis. <https://doi.org/10.1080/16258312.2021.1932567>
- Nematollahi, M., Hosseini-Motlagh, S. M., Ignatius, J., Goh, M., & Nia, M. S. (2018). Coordinating a socially responsible pharmaceutical supply chain under periodic review replenishment policies. *Journal of Cleaner Production*, 172, 2876-2891. <https://doi.org/10.1016/j.jclepro.2017.11.126>
- Novak, D. C., Wu, Z., & Dooley, K. J. (2021). Whose resilience matters? Addressing issues of scale in supply chain resilience. *Journal of Business Logistics*, 42(3), 323-335. <https://doi.org/10.1111/jbl.12270>
- Omar, A. S., & Basir, O. (2020). Secure anti-counterfeiting pharmaceuticals supply chain system using composable non-fungible tokens. *Blockchain for Cybersecurity and Privacy: Architectures, Challenges, and Applications*, 243-259.
- Patil, A., Madaan, J., Shardeo, V., Charan, P., & Dwivedi, A. (2021). Material convergence issue in the pharmaceutical supply chain during a disease outbreak. *The International Journal of Logistics Management*, 33(3), 955-996. <https://doi.org/10.1108/IJLM-11-2020-0425>
- Pires-Ribeiro, J., & Barbosa-Povoa, A. (2018). Supply Chain Resilience: Definitions and quantitative modelling approaches—A literature review. *Computers & Industrial Engineering*, 115, 109-122. <https://doi.org/10.1016/j.cie.2017.11.006>
- Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The International Journal of Logistics Management*, 20(1), 124-143. <https://doi.org/10.1108/09574090910954873>
- Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the Nutrition Society*, 63(4), 655-660. <https://doi.org/10.1079/PNS2004399>.
- Ruel, S., El Baz, J., Ivanov, D., & Das, A. (2021). Supply chain viability: conceptualization, measurement, and nomological validation. *Annals of Operations Research*, 1-30. <https://doi.org/10.1007/s10479-021-03974-9>
- Salama, M. R., & McGarvey, R. G. (2021). Resilient supply chain to a global pandemic. *International Journal of Production Research*, 1-31. <https://doi.org/10.1080/00207543.2021.1946726>
- Sawyer, E., & Harrison, C. (2019). Developing resilient supply chains: lessons from high-reliability organisations. *Supply Chain Management: An International Journal*, 25(1), 77-100. <https://doi.org/10.1108/SCM-09-2018-0329>
- Scala, B., & Lindsay, C. F. (2021). Supply chain resilience during pandemic disruption: evidence from healthcare. *Supply Chain Management: An International Journal*, 26(6), 672-688. <https://doi.org/10.1108/SCM-09-2020-0434>
- Sestino, A., & Amatulli, C. (2021). Branded vs. Generic drugs: the role of self-perceived seriousness of disease.

- International Journal of Pharmaceutical and Healthcare Marketing*, 16(1), 21-39. <https://doi.org/10.1108/IJPHM-10-2020-0090>
- Sestino, A., Gastaldi, L., & Simonetti, A. (2021). COVID-19 and digital acceleration: An investigation about citizens' perception of digitalized public services in Italy. In *4th INICART International Conference "Digital Transition and Green Sustainable Economy"* (pp. 137-146). Valletta (Malta).
- Sheffi, Y., & Rice Jr, J. B. (2005). A supply chain view of the resilient enterprise. *MIT Sloan Management Review*, 47(1), 41.
- Shekarian, M., Nooraie, S. V. R., & Parast, M. M. (2020). An examination of the impact of flexibility and agility on mitigating supply chain disruptions. *International Journal of Production Economics*, 220, 107438. <https://doi.org/10.1016/j.ijpe.2019.07.011>
- Singh, C. S., Soni, G., & Badhotiya, G. K. (2019). Performance indicators for supply chain resilience: review and conceptual framework. *Journal of Industrial Engineering International*, 15(1), 105-117. <https://doi.org/10.1007/s40092-019-00322-2>
- Singh, R. K., Kumar, R., & Kumar, P. (2016). Strategic issues in pharmaceutical supply chains: A review. *International Journal of Pharmaceutical and Healthcare Marketing*, 10(3), 234-257. <https://doi.org/10.1108/IJPHM-10-2015-0050>
- Stegemann, S. (2016). The future of pharmaceutical manufacturing in the context of the scientific, social, technological and economic evolution. *European Journal of Pharmaceutical Sciences*, 90, 8-13. <https://doi.org/10.1016/j.ejps.2015.11.003>
- Toba, S., Tomasini, M., & Yang, Y. H. (2008). Supply chain management in hospital: a case study. *California Journal of Operations Management*, 6(1), 49-55.
- Tucker, E. L., Daskin, M. S., Sweet, B. V., & Hopp, W. J. (2020). Incentivizing resilient supply chain design to prevent drug shortages: policy analysis using two-and multi-stage stochastic programs. *IIE Transactions*, 52(4), 394-412. <https://doi.org/10.1080/24725854.2019.1646441>
- Tukamuhabwa, B. R., Stevenson, M., Busby, J., & Zorzini, M. (2015). Supply chain resilience: definition, review and theoretical foundations for further study. *International Journal of Production Research*, 53(18), 5592-5623. <https://doi.org/10.1080/00207543.2015.1037934>
- Vanpoucke, E., & Ellis, S. C. (2019). Building supply-side resilience—a behavioural view. *International Journal of Operations & Production Management*, 40(1), 11-33. <https://doi.org/10.1108/IJOPM-09-2017-0562>
- Wieland, A., & Durach, C. F. (2021). Two perspectives on supply chain resilience. *Journal of Business Logistics*, 42(3), 315-322. <https://doi.org/10.1111/jbl.12271>
- Yang, C. L., & Lien, S. (2018). Governance mechanisms for green supply chain partnership. *Sustainability*, 10(8), 2681. <https://doi.org/10.3390/su10082681>
- Yarosan, E. V., Breen, L., Hou, J., & Sowter, J. (2021). Advancing the understanding of pharmaceutical supply chain resilience using complex adaptive system (CAS) theory. *Supply Chain Management: An International Journal*, 26(3), 323-340. <https://doi.org/10.1108/SCM-05-2019-0184>
- Yu, D. E. C., Razon, L. F., & Tan, R. R. (2020). Can global pharmaceutical supply chains scale up sustainably for the COVID-19 crisis? *Resources, Conservation, and Recycling*, 159, 104868-104877. <https://doi.org/10.1016/j.resconrec.2020.104868>
- Zahiri, B., Zhuang, J., & Mohammadi, M. (2017). Toward an integrated sustainable-resilient supply chain: A pharmaceutical case study. *Transportation Research Part E: Logistics and Transportation Review*, 103, 109-142. <https://doi.org/10.1016/j.tre.2017.04.009>

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