

A circular pathway for developing resilience in healthcare during pandemics

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ARTICLE INFO

Keywords:

Resilience
Dynamic capabilities
Supply chain
Healthcare
COVID-19
Pandemics

ABSTRACT

In the last few years, the studies on supply chain resilience have increased dramatically also due to the need to face the COVID-19 pandemic. However, although resilience has been studied in many fields, there is still a lack of in-depth understanding of how supply chains can develop resilience in healthcare. To contribute to this research gap, empirical data were gathered from nine fine-grained case studies belonging to the first European country affected by COVID-19, i.e., Italy.

Adopting the dynamic capability theory, the research contributes to theory with the conceptualization of the circular pathway and two theoretical propositions that support the understanding of how resilience is developed in healthcare during pandemics. Finally, the paper contributes to practice with the definition of 12 dynamic capabilities and relevant insights about the activities, practices and elements required to develop resilience during disruptive events, like pandemics. These results support practitioners in planning the future development of resilience in healthcare.

1. Introduction

Since the COVID-19 outbreak in 2020, resilience has become even more of a growing interest for research and practice. The advent of pandemics generated disruptions in business and service ecosystems as well as in the public and private sectors. COVID-19 was an unknown Low-Probability, High-Impact event, which shed light on several vulnerabilities of networks, supply chains and organisations.

Due to the nature of the shock, i.e. a pandemic, one of the most impacted sectors was healthcare. Firstly, COVID-19 disrupted healthcare supply chains (such as those related to the pharmaceutical industry and personal protective equipment – PPE), and second, once the contagion increased dramatically, hospital operations and, overall healthcare systems were disrupted. For example, there was a huge shortage of PPE which jeopardized health workers (WHO, 2020), but also a scarcity of medicines and medical devices due to the high demand and the restriction policies (OECD Health Policy Studies, 2023). In turn, the shortages of healthcare supply chains generated consequences on the internal operations of hospitals. The number of health workers, already reduced by the lack of investments in recent decades, further decreased due to the health conditions in which they operated. During the first wave of the pandemic, indeed, clinicians had to care for large numbers

of severely ill patients with limited resources and a lack of healthcare workers (Pan et al., 2020). Healthcare workers had to operate in an extremely complex environment without knowing if the number of incoming patients would become much greater than what the systems could cope with Remuzzi and Remuzzi (2020).

From 2020 onwards, even though resilience was not a new concept and numerous research areas have explored it in the past decades (Bhamra et al., 2011), new research has been devoted to resilience. With specific regard to the healthcare management field, all the previous studies developed after the occurrence of natural disasters or epidemics such as Ebola in 2014 (Gilson et al., 2017; Ling et al., 2017) and the pandemic plans made up for managing such disruptions, required a comprehensive revision to cope with COVID-19.

Moreover, despite several studies available on SCRES, current research is still claiming more theoretical approaches for the understanding of supply chain resilience (Ali et al., 2017a; Chowdhury et al., 2021). The dynamic capability theory is one of the most adopted theories to explore supply chain resilience (Teece, 2007; Teece et al., 1997) as they “integrate, build, and reconfigure internal and external competencies” (Teece et al., 1997), enabling organisations to deliver value, which, in the healthcare context, refers to care delivery. While recognising the effectiveness of this approach, a recent study by Chowdhury

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<https://doi.org/10.1016/j.ijpe.2023.109036>

Received 15 March 2022; Received in revised form 25 July 2023; Accepted 6 September 2023

Available online 7 September 2023

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et al. (2021) highlights that, on one hand, there is a great interest in supply chain resilience research after the COVID-19 pandemic, on the other hand, SCRES research requires further investigation for a better understanding of its theoretical foundations.

Rooted in the resilience literature, and in particular in supply chain resilience (SCRES) research, this paper aims at shedding light on how SCRES is built during pandemics in healthcare with particular attention to the theoretical foundation of resilience. The research investigates the research question (RQ) below.

RQ. How is supply chain resilience developed during pandemics in healthcare?

In line with other supply chain scholars (de Vries and Huijsman, 2011; Lillrank et al., 2011), the research adopts a supply chain perspective to analyse how healthcare organisations develop resilience during the first wave of the COVID-19 pandemic.

As the focus was on patient flow, the research concerns care pathways of hospitalized patients between wards and care pathways of COVID patients across healthcare organisations. The empirical investigation was carried out in the first most impacted region among OECD countries and, as here the health systems sought new ways for managing patient flows (Remuzzi and Remuzzi, 2020). This environment, already characterized by high Volatility, Uncertainty, Complexity and Ambiguity, i.e., VUCA (Bennett and Lemoine, 2014), determined a chaotic domain, according to the Cynefin framework (Snowden and Boone, 2007). The decision-makers did their best to act, sense and response.

Therefore, previous research on resilience and crisis management was not sufficient to support healthcare systems in coping with pandemics.

The study contributes to the existing theoretical knowledge by defining the development of resilience through the dynamic capability lens. A circular pathway for developing resilience in healthcare during pandemics and two theoretical propositions are provided. Finally, as a contribution to practice, the authors systematize and rationalize resilience activities, resilience practices and resilience elements developed to face during the COVID-19 pandemic, to provide 12 dynamic capabilities to manage patient flows in pandemic contexts.

The paper is structured as follows. Section 2 reviews the existing literature about SCRES to identify the most relevant elements of resilience. Section 3 describes the research methodology and the research process. Section 4 summarises the findings which then have been discussed in Section 5. Finally, Section 6 synthesises the main research conclusions.

2. Literature background

During the first months of 2020, patient management was critical for healthcare organisations and health systems. The entire flow of COVID and non-COVID patients had to be rearranged and along with them spaces and skills of medical and nursing staff were updated, as shown in Fig. 1 (Carenzo et al., 2020).

Moreover, to cope with the shock of supply and demand caused by the pandemic, the flow of patients had to overcome the physical hospital

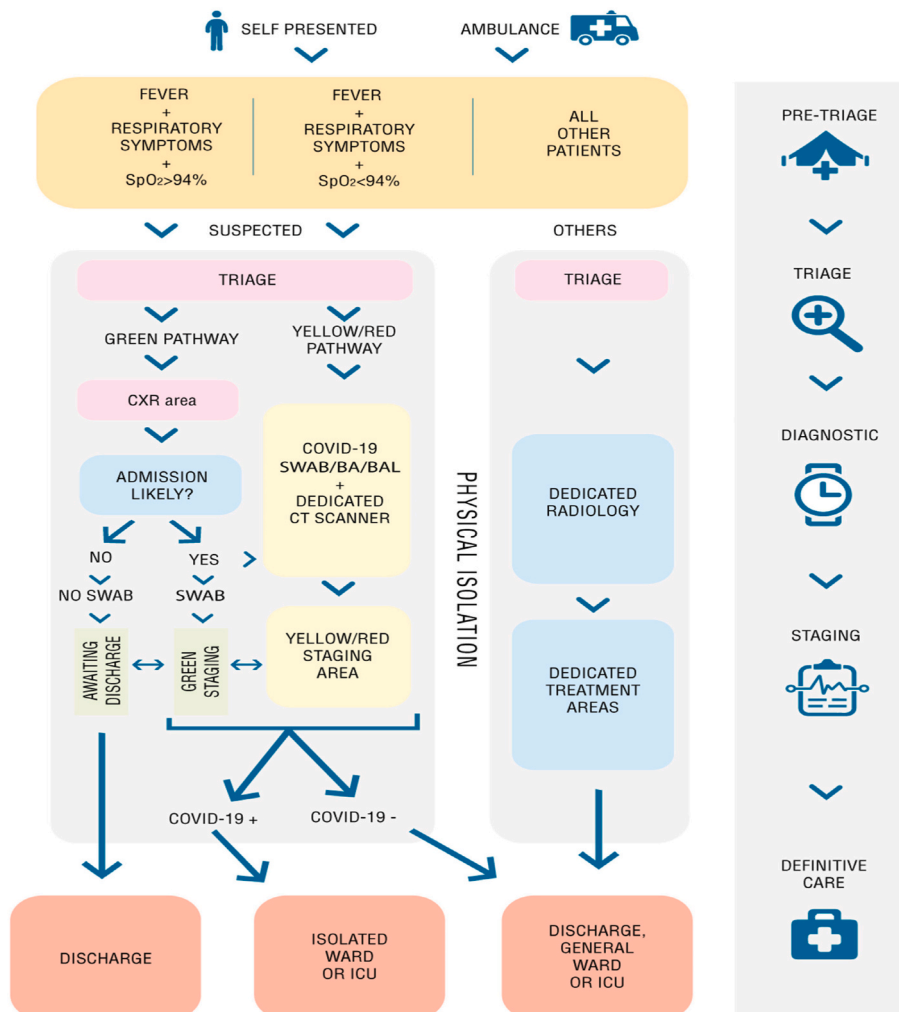


Fig. 1. Patient pathways within hospitals. Source: Carenzo et al. (2020).

boundaries by adopting inter-hospital patient practices (Essoussi et al., 2023). As shown in Fig. 2, at the beginning of 2020, to ensure the safety of patients and healthcare workers, doctors had to manage COVID patients within the organisations and, at the same time, they needed to plan activities at the system level such as the movement of critical patients across the intensive care units of hospitals within the system (Romani et al., 2021). Furthermore, the unexpected disruption of the whole healthcare network highlighted the need to pay particular attention to the network-related relationship and supply chain research. The halts in the production and distribution of medical devices and medicines further contributed to determining a shock in the entire healthcare system (WHO, 2020).

To conclude, as the management of patient flows during the COVID-19 pandemic was one of the main challenges in healthcare, in reviewing the literature, we adopted a SCRES perspective.

2.1. Resilience and resilience elements

To contribute to supply chain disruption studies, research on SCRES has witnessed enormous growth over the last few years. However, a universally and commonly accepted definition is not available. Scholars describe it as a capability to face disruptions, as a measure of the system’s adaptability to shocks, or as a firm strategic initiative (Sheffi and Rice, 2005). As a capability, Sheffi and Rice (2005) define resilience as “the ability to bounce back from a disruption”; others as “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” (Ponomarov and Holcomb, 2009, p.131).

Several scholars investigated SCRES collecting extensive lists of definitions (see for instance Tukamuhabwa et al., 2015; Hohenstein et al., 2015; Kamalahmadi and Parast 2016; Kochan and Nowicki, 2018). Over the past decade resilience formative elements, i.e. the building blocks of resilience, have been investigated, but there is still a lack of understanding about how to develop resilience (Ambulkar et al., 2015; Chunsheng et al., 2019; Duchek, 2020) and its theoretical background (Ali et al., 2017a). Moreover, despite the consistency in definitions and phrases, a wide range of different terminologies (partially overlapping) has been applied to point out formative resilience elements (see Ponomarov and Holcomb, 2009 for an overview). In 2015, Hohenstein et al. (2015) identified eight key SCRES elements, i.e. collaboration, HRM, inventory management, predefined decision plan, visibility, redundancy, agility and flexibility. Two years later Ali et al. (2017a) listed twelve formative elements of SCR some of them

overlapping with the previous study (see for instance flexibility, visibility, collaboration, redundancy) and other new elements (such as situational awareness, robustness, contingency planning, resilience culture. etc.). In a recent study, Sawyerr and Harrison (2020) detailed seven elements to investigate high-reliability organisations i.e., HRM, avoidance, redundancy, collaboration, culture, agility and flexibility.

During the last few years, a notable growth of systematic literature reviews on SCRES has been published (see for instance Hohenstein et al., 2015; Ali et al., 2017a; Datta, 2017; Sawyerr and Harrison 2020). To identify a commonly accepted list of the formative resilience elements, we reviewed these literature reviews and we identified the most relevant elements i.e., those that appear in at least in 6 of the 12 identified literature reviews. We excluded elements such as security, avoidance, integration, innovation and decision-making, information sharing, trust and culture as identified by fewer than 6 authors or as they can be included in the definition of the other selected elements. In Table 1 we list the first seven elements and the literature reviews that include them.

Then, we review SCRES empirical articles to identify definitions and their contextualisation in the healthcare setting. In the below paragraphs for each element firstly we give an overall definition in the SCRES field and then we refer it to healthcare setting.

Collaboration is the ability to work effectively together at the intra- or inter-organisational level (Ali et al., 2017a; Ali and Gölgeci, 2019; Bak et al., 2020; Christopher and Peck, 2004; Hohenstein et al., 2015; Jüttner and Maklan, 2011; Kamalahmadi and Parast, 2016; Naghshineh and Carvalho, 2022; Pettit et al., 2013, 2010; Ponomarov and Holcomb, 2009; Scholten et al., 2014; Scholten and Schilder, 2015), able to reduce vulnerability against all types of disruptions (Datta, 2017) and positive impact on innovation (Sabahi and Parast, 2020).

Some authors place it in the pre-disruption phase (Hohenstein et al., 2015; Jüttner and Maklan, 2011; Kochan and Nowicki, 2018), while others place it in the responsiveness one (Ali et al., 2017a; Ali et al., 2017b). Collaborative behaviour favours information sharing and knowledge (Christopher and Peck, 2004; Hohenstein et al., 2015; Jüttner and Maklan, 2011; Pettit et al., 2013) among organisations or workers, and it facilitates decision-making (Cao et al., 2010; Ponis and Koronis, 2012; Scholten et al., 2014) and strengthens communication (Cao et al., 2010; Datta, 2017; Scholten and Schilder, 2015). Concerning healthcare, collaboration is described as a way to achieve complex goals by working together (McNamara, 2012). Because of the complex nature of healthcare settings, collaboration and cross-level collaboration, i.e. collaborations between different levels of physicians and nurses, as Senot et al. (2016) highlight, enhance the quality of delivered care.

Flexibility is the ability to adjust and change processes and structures

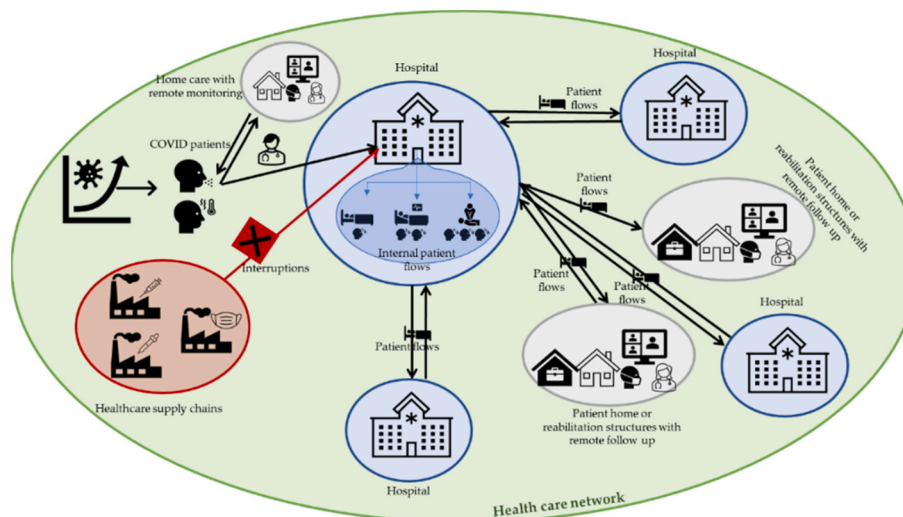


Fig. 2. Patient flows inside and outside the hospitals.

Table 1
The main SCRES elements described by SCRES literature reviews.

SCRES Elements	References											
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Collaboration	X	X	X	X	X	X	X	X	X	X	X	X
Flexibility	X	X	X	X		X	X	X	X	X	X	X
Visibility	X		X	X		X	X	X		X	X	X
Redundancy	X	X	X	X		X	X	X	X			
Agility	X	X	X	X	X	X	X	X	X	X	X	
Knowledge management	X		X	X				X	X		X	
Robustness	X	X		X	X	X	X	X	X			

[1] Hohenstein et al. (2015); [2] Tukamuhabwa et al. (2015); [3] Kamalahmadi and Parast (2016); [4] Ali et al. (2017a); [5] Datta (2017); [6] Kochan and Nowicki (2018); [7] Ali and Gölgeci (2019); [8] Sabahi and Parast (2020); [9] Sawyerr and Harrison (2020); [10] Polater (2021); [11] Bak et al. (2020); [12] Naghshineh and Carvalho (2022).

according to the contingent situation (Blackhurst et al., 2011; Christopher and Peck, 2004; Hohenstein et al., 2015; Jüttner and Maklan, 2011; Kamalahmadi and Parast, 2016; Lohmer et al., 2020; Pettit et al., 2010, 2013; Ponomarov and Holcomb, 2009). Most authors stress the relevance of flexibility during the responsiveness stage (Ali et al., 2017a; Ali et al., 2017b; Dolgui et al., 2018; Gunasekaran et al., 2015; Hohenstein et al., 2015; Jüttner and Maklan, 2011; Lima et al., 2018; Naghshineh and Carvalho, 2022; Ponomarov and Holcomb, 2009; Zsidisin and Wagner, 2010). Other researchers remark that flexibility facilitates the readiness to sense possible threats (Lima et al., 2018; Zsidisin and Wagner, 2010). Related to healthcare, Gnanlet and Gilland (2009) distinguished between staffing flexibility (e.g. cross-training nurses) and capacity flexibility whose internal or external resource use depends on several factors such as costs, and resource availability (Fagefors et al., 2020). Regarding the use of internal resources to achieve flexibility, also called internal flexibility, recently, Kumar, 2022 divided it into equipment, employee, material handling and auxiliary flexibility and identified these aspects as a set of capabilities of a firm. Although the above scholars emphasize different facets of flexibility, all of them define flexibility as a way to reconfigure, modify (i.e. internal flexibility) or extend (i.e. external flexibility) the physical, organisational and human resources of organisations.

Redundancy is identified as a driver of resilience (Christopher and Peck, 2004; Dolgui et al., 2018; Hearnshaw and Wilson, 2013; Hohenstein et al., 2015; Ivanov et al., 2019; Kamalahmadi and Parast, 2016; Pettit et al., 2010, 2013; Ponis and Koronis, 2012), by describing it as the surplus of capacity and/or resources needed during a disturbance such as having multiple suppliers, safety stock, overcapacity, and backup suppliers (Sabahi and Parast, 2020).

Redundancy occurs either in the readiness (Alikhani et al., 2021; Chowdhury and Quaddus, 2017; Hearnshaw and Wilson, 2013) or in the responsiveness stage (Ali et al., 2017a; Ali and Gölgeci, 2019; Kochan and Nowicki, 2018).

Besides velocity and flexibility, visibility is mentioned as a building block of agility. Concerning SCRES, it is the ability to gain knowledge about the SC environment (Ali et al., 2017a; Blackhurst et al., 2011; Brandon-Jones et al., 2014; Jüttner and Maklan, 2011; Pettit et al., 2010; Ponomarov and Holcomb, 2009; Scholten and Schilder, 2015) as well as the status of the operating assets (Naghshineh and Carvalho, 2022). Christopher and Peck (2004) describe visibility as an antecedent of agility and collaboration. Its notion is strictly related to communication, information sharing and knowledge (Barratt and Oke, 2007; Brandon-Jones et al., 2014; Jain et al., 2017) as collaboration, and to the anticipation of possible threats as the antecedent of agility (Ali et al., 2017a; Ali and Gölgeci, 2019).

During the responsiveness phase, the ability to rapidly respond to changes is known as agility (Ali et al., 2017a; Christopher and Peck, 2004; Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009; Wieland and Wallenburg, 2013). It is constituted by velocity and visibility (Christopher and Peck, 2004) and also by flexibility (Jüttner and Maklan, 2011). It also necessitates to have the capability of problem

recognition (sensing), determination of required resources (seizing) and revising the strategies for effective disaster SC operations (reconfiguring/transforming) (Polater 2021).

Although quite close to the flexibility concept, some authors clearly distinguished between the notions of flexibility and agility (Christopher and Peck, 2004; Hohenstein et al., 2015; Wieland and Wallenburg, 2013). An agile system or supply chain can perform effective communication and information sharing, and at the same time, can proceed faster and respond to changes. As highlighted by Datta (2017), a combined intervention of supply chain understanding and agility is effective in situations of unexpected disaster worsened by internal vulnerabilities. Although defined in the same way, concerning the healthcare setting, Vaishnavi et al. (2019) identified twelve factors for agility readiness, including, related resilience factors, i.e. collaboration, decision-making, leadership, training and resource availability.

Knowledge management enables the organisation to understand its own organisational and information structures (Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009; Scholten et al., 2014).

Ali et al. (2017a) identified knowledge management as a resilience element that allows an organisation to anticipate a crisis through the development of practices such as training, the development of a risk management culture, and simulations and exercises to address risks. At the same time, knowledge management enables organisations to recover from the crisis through learning (Ali et al., 2017a). Concerning healthcare, knowledge management is an essential resilience element because healthcare organisations are brain-intensive organisations (Lega, 2011) and, thus, they create continuously new knowledge (Ayatollahi and Zeraatkar, 2020). Moreover, a large body of literature on knowledge management (KM) in healthcare focuses on KM tools and initiatives (Nicolini et al., 2008), such as IT tools, social learning and training initiatives. For example, KM strategies support hospitals in controlling infectious diseases (Chen et al., 2011) and information systems help organisations in clinical decision-making during pandemics (Devadoss et al., 2005).

Robustness is the ability to hold out change generated after a disruptive event (Datta, 2017; Scholten et al., 2014; Wieland and Wallenburg, 2013).

Although conflicting with the definition of resilience by Ponomarov and Holcomb (2009), robustness is noteworthy in the healthcare environment. This element favours the strategic decision-making process to redesign and reorganise the supply chain (Ali et al., 2017a) or the patient flows if narrowed in healthcare. Some scholars highlight that robustness is promoted by redundancy (Dolgui et al., 2018), communication, cooperation, and integration (Wieland and Wallenburg, 2013). Concerning healthcare, ensuring the robustness of the healthcare systems implies care delivery and provision of healthcare activities. Moreover, during the COVID-19 pandemic, the postponement of routine activities had an indirect impact on the health systems (Pifarré i Arolas et al., 2021; Sutherland et al., 2020); thus, holding out change by redesigning patient flows become essential.

2.2. Dynamic capabilities – the theoretical foundation of resilience

As highlighted by Chowdhury et al. (2021), notwithstanding the great interest in supply chain resilience research after the COVID-19 pandemic, the majority of SCRES studies still pay insufficient attention to the understanding of theoretical foundations. Reviewing the SCRES studies, we identified the prevailing theories such as the resource-based theory (Blackhurst et al., 2011; Brandon-Jones et al., 2014; El Baz and Ruel, 2021; Ponomarov and Holcomb, 2009), the complexity theory (Day, 2014; Tukamuhabwa et al., 2015), the contingency theory (Brandon-Jones et al., 2014), and recently the resource orchestration theory (Queiroz et al., 2022) and organisational information processing theory (Dubey et al., 2021). Compare to these, particular attention has been given to the dynamic capability theory as a theoretical lens of research on SCRES (Ali et al., 2022; Brusset and Teller, 2017; Chowdhury and Quaddus, 2017; Dubey et al., 2023; El Baz and Ruel, 2021; Golgeci and Ponomarov, 2013; Ponomarov and Holcomb, 2009; Scholten et al., 2019; Yu et al., 2019). Scholten et al. (2019) and Yu et al. (2019) define supply chain resilience as a dynamic capability and Brusset and Teller (2017) as a supply chain’s operational capability. Other authors (Golgeci and Ponomarov, 2013; Ponomarov and Holcomb, 2009) describe SCRES as an adaptive capability integrated with a set of dynamic capabilities, such as logistics capabilities (Ponomarov and Holcomb, 2009), to achieve a sustained competitive advantage. Recently, Ali et al. (2022) grounding their research on dynamic capabilities, explored resilience readiness, response and recovery as dynamic capabilities to face disruptions.

Reviewing the literature, we found out that dynamic capabilities have been defined as “the firm’s ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments” (Teece et al., 1997). They are configured as a set of high-order routines (Winter, 2003) that are purposefully (Helfat et al., 2007; Helfat and Winter 2011) carried out by firms to maintain a competitive advantage (Teece et al., 1997). As a consequence, in studying dynamic capabilities, three main characteristics have to be investigated: the hierarchical order of dynamic capabilities, the intentionality of the firm to develop them, and the competitive advantage they generate.

Over the years, the hierarchical order of dynamic capabilities has been investigated by several authors (Collis, 1994; Winter, 2003; Zollo and Winter 2002). Collis (1994) distinguished three levels of dynamic capabilities i.e., first-order capabilities, which are ordinary capabilities that companies develop daily, second-order dynamic capabilities, which generate dynamic improvement and third-order dynamic capabilities, which guide organisations to develop new strategies. In the same vein, a few years later, Winter (2003) provided a hierarchical order to the capabilities defining dynamic capabilities as “those that operate to extend, modify or create ordinary capabilities”. Hence, in line with Collis (1994), Winter (2003) identified dynamic capabilities as the highest-order capabilities that operate on the zero-level capabilities, i.e. those that run under normal conditions to carry out ordinary activities. Thus, zero-level capabilities (Winter, 2003), first-order capabilities (Collis, 1994), operating routines (Zollo and Winter 2002) or operational capabilities (Helfat and Winter 2011) refer to routines developed for the normal functioning of organisations.

To conclude, the strategic management literature reveals that in studying capabilities particular attention has to be paid also to their hierarchical order of capabilities and that the highest order capabilities operate on those of the lowest orders.

Regarding the purposefulness of organisations to develop dynamic capabilities, in line with Helfat et al. (2007), dynamic capabilities are intentionally developed by organisations. They have a specific aim, different from ordinary capabilities that they lack intent.

Concerning competitive advantage, even if it is meaningless concerning the public sector in the traditional definition of Porter (1980), public organisations should maintain and sustain their public value. In some healthcare systems, such as the Italian ones, organisations must

fulfil several governance constraints, such as budget limits or the quality of care targets, to deliver efficient and effective public value to the citizens. Dynamic capabilities, as previously defined by the above scholars (Helfat et al., 2007; Teece et al., 1997; Zollo and Winter 2002), are thus essential in a rapidly changing environment (Piening, 2013).

Furthermore, the consistency between the phases of resilience identified by the SCRES literature and Teece’s (2007) classification of dynamic capabilities further supports the choice of the dynamic capability theory for studying how healthcare organisations developed resilience during the first wave of the COVID-19 pandemic. As shown in Table 2, Teece (2007) distinguishes dynamic capabilities as those which “(1) sense and shape opportunities and threats, (2) seize opportunities, and (3) maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise’s intangible and tangible assets”. In addition, grounded on Teece (2007)’s categorization of dynamic capabilities (see Table 2) and in line with Kähkönen et al. (2021), SCRES sensing, seizing and reconfiguring capabilities matches the capabilities of resilience in the three resilience phases (i.e., anticipation, responsiveness, and recovery). Moreover, to support this comparison, Kähkönen et al. (2021) argue that during a global supply chain disruption, like the pandemic, SCRES depends on the capabilities developed by organisations to seize (i.e., respond) and re-configure (i.e., recover) themselves rather than sense (i.e., anticipate) because of the disruption is already present.

The comparison between sensing, seizing and reconfiguring capabilities and the resilience phases in Table 2 further supports that:

- (1) dynamic capability is a suitable theoretical approach for studying supply chain resilience;
- (2) the capabilities merging from the need to maintain and sustain public value are dynamic;
- (3) the dynamic capabilities to develop resilience can be classified as sensing, seizing and transforming capabilities in line with Teece’s classification.

Moreover, in line with several SCRES scholars (such as Ponomarov and Holcomb, 2009), we identify resilience as a dynamic capability. Additionally, hierarchical order of the dynamic capabilities, we clarify that resilience is a high-order dynamic capability. It means that it guides organisations to develop new strategies (Collis, 1994; Winter, 2003) and, thus, it is the result of a strategic initiative (see Sheffi and Rice, 2005’s definition of resilience in Section 2.1) developed by organisations with a certain degree of intentionality. This means, according to Helfat et al. (2007), with a specific aim.

Table 2
Comparison between the classifications of resilience phases and dynamic capabilities.

Dynamic capabilities categorization (Teece, 2007)	Resilience phases
Sensing and shaping opportunities. It refers to the activities of scanning and creation learning. To carry out these activities, knowledge acquisition is essential to explore the external environment.	Anticipation. It refers to sensing potential disruptions (Sheffi and Rice, 2005) and interpreting threats with early warning strategies (Ali et al., 2017a).
Seizing opportunities. It refers to addressing opportunities through new products, processes and services that involve maintaining and improving technological competencies and complementary assets.	Responsiveness. It refers to addressing and coping with threats caused by the crisis through collaboration, agility, flexibility, etc.
Managing threats and reconfiguration. It refers to the activities of recombining and reconfiguring assets and organisational structures to sustain profitable growth.	Recovery. It refers to the learning matured after a crisis and the consequent activities of reconfiguring and recombining organisations for better preparedness for the future (Ponomarov and Holcomb, 2009).

To conclude, by merging the review of the SCRES studies, mainly proposed by operations management scholars, and the dynamic capability theory, well investigated by strategic management researchers, we could define supply chain resilience as a *high-order dynamic capability* that organisations *decide* to develop with a *specific aim* to maintain the continuity of operations.

Finally, as SCRES literature refers to the different hierarchical order of the dynamic capabilities using partially different labels, we fix the meaning of the labels used in this research as below:

1. Supply chain resilience is a high-order dynamic capability because, as a strategic initiative, guides organisations to develop new strategies. Thus, from here below, in line with Collis (1994), we labelled it as the third-order dynamic capability;
2. The sensing, seizing and transforming dynamic capabilities in line with Teece's classification generate dynamic improvement. Thus, from here below, in line with Collis (1994), we labelled them as second-order dynamic capabilities;
3. Operational capabilities (Helfat and Winter 2011) refer to routines developed for the normal functioning of organisations. Thus, from here below, in line with Collis (1994), we labelled them as first-order dynamic capabilities.

3. Research methodology

To provide useful insights into the contemporary events in healthcare during the COVID-19 pandemic, an inductive case study research was carried out (Benbasat et al., 1987; Meredith, 1998). Due to the scant literature concerning how to develop resilience in pandemic contexts in a specific setting (i.e. the patient flows), the nature of our research is exploratory. Two main reasons support the adoption of the exploratory case study approach. First, there is a lack of knowledge on how resilience could be developed in a chaotic domain (Barratt et al., 2011; Benbasat et al., 1987; Eisenhardt and Graebner, 2007; Meredith, 1998). Second, a case study approach allows the collection of data using several methods and tools, and it generates richness and a depth of understanding (Eisenhardt and Graebner, 2007; Yin, 2018), which can be used as a basis to form an in-depth understanding of resilience in the context of healthcare organisations.

To increase the understanding of such a new and rapidly evolving phenomenon and to strengthen the grounding of theory (Eisenhardt, 1989), this study investigates nine public healthcare organisations. The development of multiple case studies is structured in research design, data collection and analysis.

3.1. Research design and data collection

The unit of analysis is the COVID inpatient flow, i.e. the flow of hospitalized COVID patients. We involved healthcare organisations and mainly the organisational units that deliver care to COVID patients. In addition, some non-COVID units were also included in the analysis to understand if the hospitals were able to provide patients with urgent and non-deferrable care not related to the pandemic.

The selected cases follow the criteria below:

4. They should be public healthcare organisations placed in the most COVID-19-affected Italian regions;
5. They should provide urgent emergency care during the first wave of the COVID-19 pandemic;
6. They should reach at least the acceptable levels of care (i.e. score ≥ 160) as defined by the Italian Ministry of Health [see the "Griglia LEA 2017" (Ministero della Salute, 2021)].

The nine investigated public healthcare organisations (named A, B, C, D, E, F, G, H, and I for anonymity) are placed in six Italian regions severely impacted by COVID-19, i.e. Emilia Romagna, Liguria,

Lombardy, Piedmont, Tuscany, and Veneto. The spread of COVID-19 began on the February 21, 2020 in Lombardy. After a few days, on the February 28, 2020, Lombardy had 59.8% of the confirmed cases in Italy, Veneto 17%, Emilia Romagna 16.3%, Liguria 2.1%, Piedmont 1.2% and Tuscany 0.9%, while in the rest of Italy (consisting of other 13 regions and 2 provinces), confirmed cases were only 2.6% of the total cases (Dipartimento della Protezione Civile and Presidenza del Consiglio dei Ministri, 2020).

Despite the huge number of COVID-19-affected incoming patients, the selected healthcare organisations were always able to provide emergency care during the first wave of the COVID-19 pandemic. Although planned activity was suspended by national law and referral centres were moved by regional regulations to larger and/or less affected hospitals, these nine organisations were resilient in providing emergency care services at all times, even though they were heavily affected by the pandemic.

Finally, the selected healthcare organisations belong to the leading Italian regional healthcare services in terms of effectiveness and efficiency. They obtained among the highest scores for delivered levels of care in 2017: Piedmont reached the first (221) highest value, Veneto and Emilia Romagna reached the second-highest value (218), Tuscany the third one (216), while Lombardy and Liguria the fourth (212) and eighth (195) ones, respectively (Ministero della Salute, 2021).

Once cases were identified, a protocol was designed to drive interviews, empirical observations and document analysis (Eisenhardt, 1989; Yin, 2018).

As shown in Fig. 3, the literature review described in the previous section supported the definition of 18 main guiding questions (see Appendix A). The 18 guiding questions have been formulated to understand what actions and strategies the organisations carried out during the pre-, during, and post-emergency phases (see Appendix A for more details). These questions were used to collect empirical data that allowed the within and cross-case analysis through open coding (Miles and Huberman, 1994). Then, activities, resilience practices and dynamic capabilities have been identified to answer the research question (see sections 4 and 5).

The empirical data were collected after the first wave in order to collect evidences on the changes introduced during the pandemic and immediately after it.

In the following sections, each of the aforementioned processes (Fig. 3) has been described.

To collect the relevant information, interviews involved managers with three different organisational roles (Table 3), i.e. (1) the heads of the COVID units (such as Intensive Care Unit, Pneumology, Internal Medicine, Infectious Disease), (2) the medical and support unit directors, and (3) in some cases, the heads of the non-COVID units that provided urgent care activities (such as Emergency Departments and Surgery). The first ones hold information regarding the flows of COVID patients and the care delivered at the unit level. The second took all the strategic decisions, and they organised all the services and the displacement of resources, either physical or human, inside and outside the organisations. Finally, the third had information regarding the continuity of delivered care activities. Table 3 details the profile and interview information of each case study.

3.2. Data analysis

The study adopted an iterative approach to data coding and analysis (Miles and Huberman, 1994). A group of three researchers worked separately to code the recorded data to enhance the validity and reliability of the data analysis (Voss et al., 2002; Yin, 2018). Then, 20 meetings were held to discuss the coding.

To effectively manage large data sets and easily handle the coding process, we used R-package for qualitative data analysis (RQDA), an open-source computer-assisted qualitative data analysis software. As Chandra and Shang (2017) highlight, the use of CAQDAS software

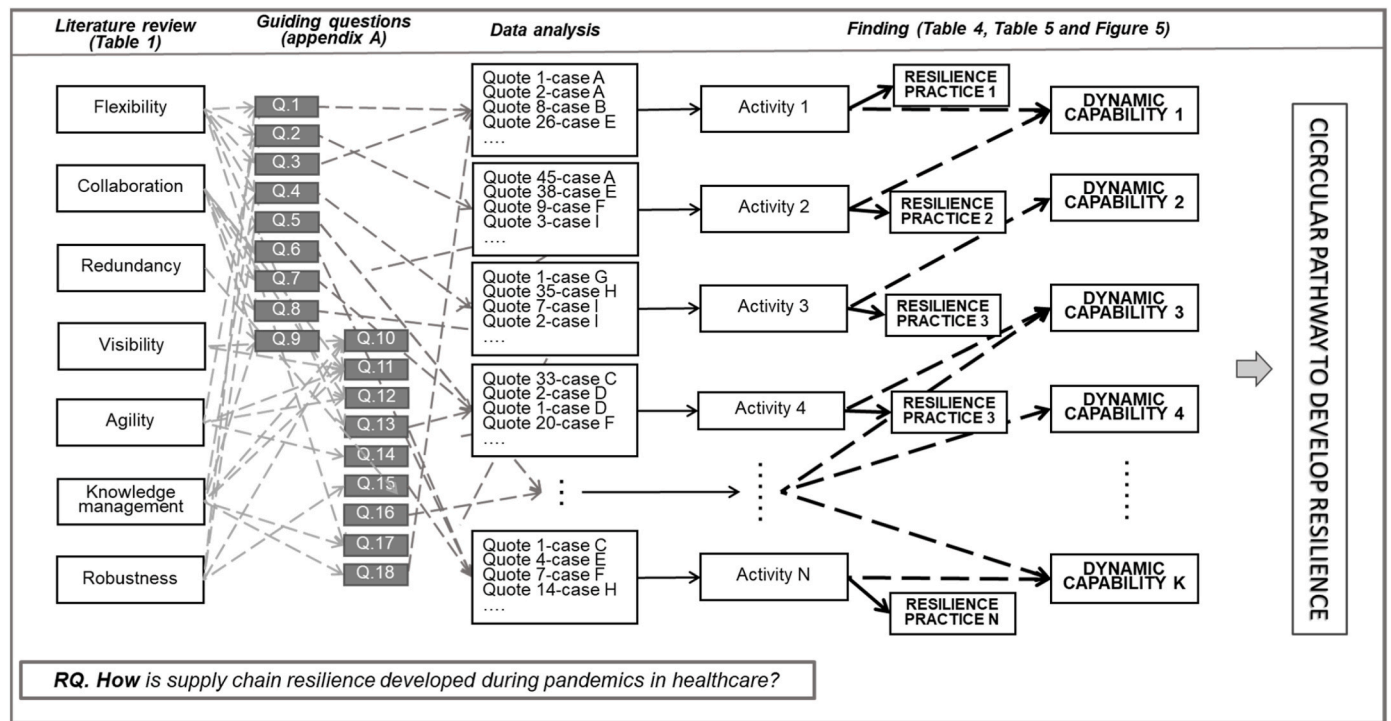


Fig. 3. The research process of this study.

Table 3
Details of the case profile and interview information for each case study.

		Cases								
		A	B	C	D	E	F	G	H	I
Place		Lombardy		Piedmont	Liguria	Emilia Romagna		Veneto	Tuscany	
Type ¹		LHA	LHA	LHA	LHA	UH	LHA	UH	LHA	LHA
No. of hospitals		<5	>5	<5	<5	1	>5	1	>5	>10
No. hospital beds		>500	>1000	>1000	>500	>1500	>1000	>1500	>2000	>2500
Crisis beginning		21/02	29/02	04/03	01/03	01/03	27/02	21/02	24/02	25/02
		/20	/20	/20	/20	/20	/20	/20	/20	/20
Investigated units	Health Director	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Infectious Diseases	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Emergency Unit	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Internal Medicine	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Pneumology	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Intensive Care	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Urology	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Hospital Director	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Medical Direction	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Health Profession	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Operations	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Management									
	Emergency services							✓		
	Microbiology			✓		✓		✓	✓	
	COVID Swabs Service		✓							
	PPEs Procurement				✓					
	Service									
Maternal and Child					✓		✓			
Health Area										
Cardiology		✓								
Surgery					✓					
Duration of each interview [minutes]		45	45	45	45	45	45	45	45	45
Qualitative data collection period		Jun–Jul	Jul	Aug–Sept	Jul–Aug	Aug–Sept	Aug–Sept	Aug–Sept	Jul–Aug	Sept–Oct
		2020	2020	2020	2020	2020	2020	2020	2020	2020

1 LHA = Local health authority; UH = University hospital.

increases the transparency, validity, rigour and trustworthiness of qualitative research.

We analysed data through the open coding methodology i.e., a methodological process to interpret the investigated phenomena from

the data collected (Strauss and Corbin, 1990), to identify activities and then, conceptualize them into 12 dynamic capabilities and resilience practices.

Firstly, the identification of dynamic capabilities was developed

through the clustering of activities according to their focus (e.g., temporary transfers, healthcare worker training, and multidisciplinary teamwork creation refer to human resources, thus, we cluster them into a main dynamic capability, named “Human resource management capability”).

Then, as shown in Fig. 4, the identification of resilience practices was developed through cross-case analysis. The definition of practices refers to Bititci et al. (2011a, 2011b) where the authors describe a practice as the way an activity is executed. A practice can be evaluated as a good or a bad practice according to its maturity level (Bititci et al., 2011b). Consistent with Bititci et al. (2011a, 2011b)’s definition of practices, we defined resilience practices as the ways to carry out activities to be resilient. Notwithstanding the lack of appropriate indicators or maturity assessments to develop the resilience of healthcare organisations in the first phase of the COVID-19 pandemic, we evaluate resilience practices according to the number of resilience elements they develop. Thus, the greater the number of resilience elements developed by the practices, the better the resilience level the practices developed.

Each practice requires the development of at least three resilience elements to be considered a resilience practice. For instance, in Fig. 4 practice A is a resilience practice as it includes five resilience elements; on the contrary, practice B cannot be considered a resilience practice as it includes only two resilience elements.

4. Findings

The data analysis reveals the resilience activities were performed during the COVID-19 first wave by the investigated healthcare organisations for managing patient flows and ensuring care continuity.

After the within-case analysis where the specific activities of each case were analysed, through the cross-case analysis, these activities have been grouped considering the subject area to define the dynamic capabilities. For example, as shown in Table 4, the activities of “time overuse”, “healthcare worker training”, “temporary transfers”, “multidisciplinary teamwork creation” and “supporting actions” were grouped into the subject area related to human resources. Then, these activities have been identified as the constituent activities of human resource management capability. Finally, each activity has been identified as a resilience practice according to the number of resilience elements they developed (Table 4).

The analysis identified 12 dynamic capabilities. A detailed description of each dynamic capability has been provided below:

8. *Human resource management capability* is the capability to manage healthcare workers (such as doctors, nurses, and administrative staff) during pandemics. This capability developed three main SCRES elements i.e., collaboration, knowledge management and

flexibility, and it is one of the main capabilities developed and strengthened by the investigated organisations. It implies the development of flexible human resource management through collaboration between workers at different levels (e.g. health directors and doctors, and nurses and doctors) and the understanding of organisational and information structures, i.e. knowledge management. The creation of multidisciplinary teams and the temporary transfers based on the number of inpatients and admissions in the emergency department are some of the activities that ensure continuity of care to patient flows and characterise a flexible hospital, which is one of the pillars of the hospital for the intensity of care discussed for years in Italy. At the same time, healthcare organisations carried out activities to generate short-term flexibility leading to a change limited in time (Kumar et al., 2018). In line with Fagefors et al. (2020), in hospitals, short-term flexibility is developed by time overuse activities, healthcare worker transfers between different wards and recruiting activities. These activities do not generate change in the medium to long term as they are contingent on the immediate term but develop the dissemination of knowledge through training and the involvement of operators in organisational decisions for managing patient flows.

- 9. *Forecasting capability* generates abilities for detection, preparedness for adverse events (Teece, 2007) and discerning future events (Petit et al., 2013). It developed mainly three SCRES elements i.e., collaboration at inter and intra-organisational levels, flexibility and agility to timely reorganise the structures in line with the pandemic plans. Moreover, it reveals that supply chains (i.e. in our case the patient flows) should discern the potential disruption of the external environment, but they must also know their vulnerabilities within the supply chain (Lima et al., 2018), and in this case, the departments of the hospitals.
- 10. *Patient pathway management capability* is the ability to manage patient pathways at inter- and intra-hospital levels to ensure accessibility to the hospitals during the emergency. The creation of specific pathways for managing COVID patients at different intensities of care, their admission and discharge, the unit conversions into COVID-19 areas and the consequent structural and system changes have enabled the organisations to manage COVID-19 patient flows during the first wave of the pandemic. The key role played by patient pathway management capability in facing resilience connects mainly with flexibility because it develops new spaces and pathways to deliver care, but also with agility because it responds timely to new admissions of patients and collaboration between multi-professional teams.
- 11. *Procurement capability* is essential to ensure the patients’ care and the safety of health workers. The first wave of the COVID

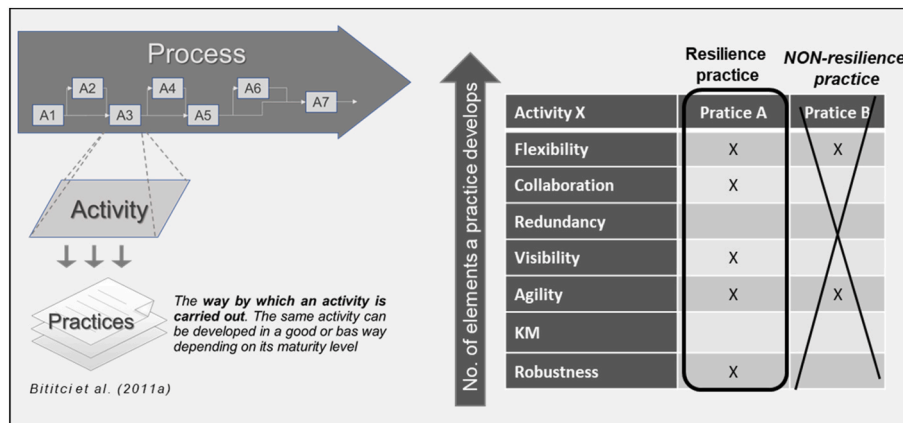


Fig. 4. The method used to identify the resilience practices.

Table 4
Dynamic capabilities with the corresponding resilience practices to develop them.

Activities	Resilience practices	Resilience elements ^a							DC ^b	
		C	F	R	V	A	K	R		
Anticipation: Sensing capabilities										
Detection activities	Detection activities based on official communication channels between the hospital networks	✓			✓	✓	✓			Forecasting capability
Pandemic plan/ procedure planning	Development of pandemic plans and procedures based on emergency room admissions, monitoring of other hospitals and management of patient flows in the hospital network		✓			✓		✓		
Recruitments	Pre-emergency recruitment activities with the integration of newcomers in the wards	✓	✓	✓	33%	67%	33%	33%		
PPEs procurement	PPE procurement from civil protection and donations and concurrently from autonomous procurement initiatives promoted by the organisation	✓	✓	✓	✓			✓		Procurement capability
Equipment procurement	Equipment procurement from other organisations, donations and autonomous initiatives	✓	✓	✓	✓	0%	0%	50%		
Responsiveness: Seizing capabilities										
Time overuse	Shift changes planned by management in agreement with healthcare workers	✓	✓						✓	Human resource management capability
Temporary transfers	Healthcare worker transfers to COVID-19 areas based on skill mix, competencies and needs of the workers	✓	✓	✓				✓		
Healthcare worker training	Healthcare worker on-the-job training (coordinated by a supervisor or a team leader) via video or consultation	✓		✓				✓		
Multidisciplinary teamwork creation	Multidisciplinary teamwork coordinated by a team leader and organised through standardised procedures (defined within the ward)	✓						✓		
Supporting actions	Supporting activities for healthcare workers promoted by the direction	✓	✓	40%	✓	0%	80%	25%		
COVID pathway creation	Identification of standardised patient paths through internal and external networks of hospitals to manage patient flows across intensity levels of care	✓	✓		✓	✓				Patient pathway management capability
Structural changes	Adjustments to buildings and the air and oxygen systems planned for the medium term	✓	✓			✓			✓	
Unit conversions	Conversion of departments based on the evolution trend of the pandemic	✓	✓	✓	33%	✓	✓	33%		
Functional integration	Integration between management and care services with the involvement of liaison figures between clinicians and directions	✓	✓			✓	✓			Integration capability
Professional integration	1. Internal integration through scheduled daily consultations 2. Creation of shared protocols for COVID patient management among doctors of different specialities 3. External integration through formal networks of professionals and data collection through shared information systems	✓				✓	✓	✓		
Service integration	Health system integration of the patient flows across hospitals of the regional health systems. See, for instance, the COVID-19 patient clustering in COVID-19 hospitals to guarantee the delivery of care to non-COVID-19 patients in COVID-19-free hospitals.	✓	✓	✓	✓	✓		✓		
Governance integration	Coordination through board meetings with technical and scientific committees and revision of the organisational strategies based on needs	✓	✓	25%	25%	✓	✓	✓		
Clean-dirty path creation	Subdivision of the paths in the ward with separation of the entrance and exit and separation of the guardhouses and double filter room at the entrance and exit of the COVID-19 areas		✓	✓					✓	Organisational safety capability
Wearing PPE training	Training of operators through face-to-face courses organised in all departments			✓				✓	✓	
Health surveillance	Screening of all healthcare workers regularly depending on the exposure to the virus	0%	✓	67%	0%	0%	✓	✓		
Organisational innovation development	Radical innovation practices. Healthcare organisations create innovations that affect not only hospital management but also the outcomes of care. For instance, the creation of new procedures for taking care of patients from home with the intermediation of the general practitioner.		✓					✓	✓	Innovation capability
Technological innovation development	Creation and use of technological innovations based on needs with the support of private companies and universities and their consequent diffusion at the organisational level	✓	✓					✓	✓	
Dashboard/data systems use	Creation of inter-organisational information systems to share COVID-19 patient information, available beds, etc.	33%	✓	0%	0%	✓	✓	✓		
Material distribution	Preparation of COVID-19 areas with the stock of materials to ensure effective and safe patient management without the need to move patients or wait for materials within the COVID-19-affected areas and the possibility of remote control of patients		✓	✓	✓		✓			Material management capability

(continued on next page)

Table 4 (continued)

Activities	Resilience practices	Resilience elements ^a						DC ^b	
		C	F	R	V	A	K		R
PPE furniture and distribution	Centralized distribution of PPE based on estimated consumption needs and number of patients hospitalized through a digitalised procedure				✓	✓	✓	✓	
COVID swab management	Swab management based on the priority of urgency, increased capacity of swab analysis and digitalisation of swab report sending	0%	33%	33%	✓ 100%	✓ 67%	✓ 100%	✓ 67%	
Crisis unit model	Crisis unit with the involvement of clinical organisational figures linking the COVID-19 wards and the leadership	✓				✓	✓		Decision-making capability
Leadership based on COVID unit	Single leadership of the COVID-19 area with the collaboration of competent professionals on the COVID-19 disease	✓ 100%	✓ 50%	0%	0%	✓ 100%	50%	✓ 50%	
Internal communication	Formal and informal communication organised and managed by leadership	✓		✓		✓	✓		Communication capability
External communication with the patients' relatives	Communication with patients' families organised and managed by a reference team	✓ 100%	0%	50%	0%	50%	✓ 100%	✓ 50%	
Recovery: Transforming capabilities									
Delivering non-COVID hospital care	Division of patient pathways in the emergency departments, isolation of grey patients and internal reorganisation of the facility		✓		✓			✓	Reduction of impact capability
Remote delivery of care	Remote care delivery through calls/video calls and telemonitoring	0%	50%	✓ 50%	50%	0%	✓ 50%	✓ 100%	
Learning	Defining step-by-step pandemic plans and reorganising the hospital structure	0%	✓ 100%	0%	0%	✓ 100%	0%	✓ 100%	Learning capability

^a Resilience elements: C = Collaboration; F = Flexibility; R = Redundancy; V = Visibility; A = Agility; K = Knowledge Management; R = Robustness.

^b DC = Dynamic Capabilities.

pandemic was characterised by the breaking of supply chains for materials and personal protective equipment (PPE) required to carry out care activities and manage inpatient flows. Supply chains have been broken due to the lack of materials and PPEs around the world (Finkenstadt and Handfield, 2021). Although procurement was handled nationally, the healthcare organisations also launched parallel procurement campaigns to manage the emergency. In this study, in line with many authors on resilience and the COVID-19 outbreak (Finkenstadt and Handfield, 2021), the development of this capability requires the growth of visibility. However, our empirical investigation highlights also the key role of collaboration, flexibility and redundancy.

- 12 *Integration capability* is the capability of integrating internal and external departments, health practitioners and the health system. During the first wave of the pandemic, it developed mainly agility and collaboration for managing operations on time and with the support of the other actors of the health systems. In line with Lyngso et al. (2016), there are six dimensions of integration and in our data analysis four of them (i.e. functional, organisational, professional and service or clinical) have been identified as essential to deliver care to COVID and non-COVID patient flows and to develop effective organisational strategies during the first wave of COVID-19. The degree of integration between the actors (healthcare workers, back offices and wards, and organisations) results in a differently designed management of activities. As recently highlighted by El Baz and Ruel (2021) related to SCRES, the COVID outbreak shed light on the need for cooperation between the members of the supply chain (in our case, the organisations, systems and workers involved in managing patient flows).
- 13 *Organisational safety capability* promotes activities and practices to improve safety within the organisations, it enables organisations to continue to deliver care activities and as a consequence, it develops robustness. Screening campaigns on health workers, clean-dirty path creation activities in COVID-19-affected areas

and wearing PPE training activities allowed hospitals to manage safety related to infection spread. In line with Rathore and Gupta (2021), organizational safety is classified based on risk factors and its development is strictly related to interventions that limit risk factors such as inadequate training of operators, and lack of infrastructure and emergency services. The capability to manage organisational safety is, therefore, the ability to limit the aforementioned risk factors. Despite being a capability developed ad hoc by the organisations during the first wave of COVID-19, the ability to ensure safety generates even more awareness of the importance of infection protection and prevention measures in delivering care to patients, favouring the dissemination of culture and practices also in areas less affected by the pandemic.

- 14 *Innovation capability* is the capability to find new technological and organisational ways to perform specific clinical activities and procedures. It develops three main SCRES elements, i.e., flexibility, knowledge management and robustness. During a pandemic event, indeed, due to the lack of human and material resources, healthcare organisations develop new ways of managing contingent situations thanks to their knowledge of organisational structures which enables the robustness of the organisations. As investigated by several scholars (Golgeci and Ponomarov, 2013; Kamalahmadi and Parast, 2016; Parast, 2020), innovation enhance resilience to disruptions. Radical and incremental innovations bring about a change in the hospital which, despite being conceived in a contingent situation, is the driving force of new solutions in the short- and medium-long term.
- 15. *Material management capability* is the capability of healthcare organisations developed to effectively monitor and distribute materials during a pandemic event. During the first wave of COVID-19, this capability enhanced visibility and knowledge management elements. On the one hand, indeed, visibility allows seeing what is happening inside the supply chain (Ali et al., 2017a), on the other hand, knowledge management allows organisations to develop proper information systems to manage materials (Devadoss et al., 2005). When, as in the case of the first wave of the

pandemic, companies ran out of material resources such as PPEs and swab reagents, effective and efficient management became essential both for workers' and patients' safety and for managing and delivering care to huge patient flows. The capability to manage materials develops new material management and monitoring practices based on the digitalisation and centralization of requests for materials and the diversification of suppliers to ensure the continuity of supply chains.

16. *Decision-making capability* is the capability to make quick and timely decisions because of a short decision-making chain and a clear command line. It developed agility, the SCRES element to respond effectively after a change (Ali et al., 2017a; Christopher and Peck, 2004), and collaboration between the administrative officers and clinicians. Healthcare organisations develop and enhance this capability during a crisis event by developing functional hierarchies, i.e. based on skills and not on ordinary hierarchies and the crisis unit model. The crisis unit model is adopted close to a crisis event when organisations establish a crisis unit constituted by the management and stakeholders involved in the crisis (e.g. in the COVID-19 pandemic context the COVID unit directors). The adoption of the crisis unit model shortens the decision-making chain. This increases the effectiveness of clinical and organisational governance within the organisation and ensures effective management of inpatient flows.
- 17 *Communication capability* is the capability to disseminate information at all levels of the health system and the healthcare organisation. It developed the knowledge management element of supply chain resilience (Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009; Scholten et al., 2014), as organisations needed to restore communication and information after a low-chance, high-impact event (Lloyd-Smith, 2020), and collaboration. The involvement of health workers develops awareness of the internal and external situation and strict collaboration among health care workers in promoting initiatives of the direction. During the first wave of the pandemic, because of the requirement for timely and direct ways of communication, less formal and more digital forms of communication were generated and spread.
- 18 Reduction of impact capability is the capability the healthcare organisations develop to limit the consequences of the pandemic on care services and non-pandemic related activities. Reduction of the impact capability enhanced the robustness of healthcare (Scholten et al., 2014; Wieland and Wallenburg, 2013), i.e. how long health organisations and systems withstand the pandemic by maintaining pre-COVID-19 care services. As recently highlighted in Ma et al. (2022)'s study, by dynamically improving patient bed allocation during several phases of the outbreak both COVID and non-COVID patients benefit from it. Moreover, this capability captures how healthcare organisations change and how they adapt non-COVID-19 related care services to continue to deliver care after a pandemic event.
- 19 Learning capability of the organisation takes place after a crisis event following a self-analysis process regarding the activities carried out during the emergency phase. It developed flexibility and agility to timely reorganise internal processes thanks to daily learning mechanisms, and robustness because learning ensures the robustness of the supply chains, i.e. The ability to hold out change generated after a disruptive event (Scholten et al., 2014; Wieland and Wallenburg, 2013). In line with Vassalou (2001), there are three types of organisational learning: single-loop learning generated by the decisions made on observations of the errors, double-loop and triple-loop learning based on the analysis and rethinking of the existing knowledge and the deepening of the existing norms and assumptions. During the post-emergency phase, healthcare organisations analyse what

happened during the emergency phase of the first wave of COVID-19 and set pandemic plans for the future based on their experience.

5. Discussions

As previously described, the review of literature portrayed in Section 2.2 allow us (1) to identify dynamic capability theory as a suitable theoretical approach for investigating SCRES, (2) to define resilience using a dynamic a view and (3) to identify the hierarchical order of the dynamic capabilities. In particular, regarding the hierarchical order of dynamic capabilities, as described in Section 2.2:

1. Supply chain resilience is a third-order dynamic capability;
2. The capabilities for anticipating, responding to, and recovering from uncertain events, which correspond to sensing, seizing and transforming dynamic capabilities of Teece (2007) are second-order dynamic capabilities;
3. The operational capabilities, which are the routines developed for the normal functioning of organisations (Helfat and Winter 2011) are the first-order dynamic capabilities.

Then, narrowing the analysis on the SCRES in healthcare, we define supply chain resilience as a *high-order dynamic capability* that healthcare organisations *decide* to develop with the *specific aim of managing patient flows* to ensure continued delivery of care.

In this section, through the analysis of empirical data gathered during the COVID-19 first wave, we reveal how resilience is developed in healthcare. In particular, we identified the circular pathway to develop resilience in uncertain events, like pandemics. This circular pathway is characterized by a bottom-up and a top-down approach and it has been conceptualized in the subsequent paragraphs (see Fig. 5 below).

First, resilience grounds on a bottom-up approach (see Fig. 5 left side). During an unexpected event, like the COVID-19 first wave, healthcare organisations are not sufficiently prepared for and aware of the huge effects of the virus spread and they are not able to make strategic decisions affecting operational capabilities for the daily supply chain management. For instance, in the COVID-19 first wave, healthcare organisations began to manage wards according to their operational capabilities, i.e. moving patients according to their diseases. Then, through experience acquired, they started to move them according to a number of admissions of COVID patients and transferring non-COVID patients to other units. Therefore, they developed second-order capabilities (that in this case we labelled "patient pathway capability") that fuelled the development of resilience. This means that resilience was developed starting from first-order capabilities, i.e. those that enable a firm to make a living in the present (Helfat and Winter 2011; Winter, 2003). In the cases investigated initially there was no strategic decision aimed at changing the communication process. Learning day-by-day how to effectively communicate with each other and with patients' relatives, all the hospital staff changed the activities of internal communication and external communication with patients. New communication practices have been created by scheduling online meetings with patient families and using redundant ways of sharing information (face-to-face, signals in the wards, intranet, etc.) to ensure the spread of important news, regulations, etc. and this contribute to the improvement of the communication capability (i.e., second-order dynamic capability). Thus, living on short-term decisions brought to learning day-by-day how to reconfigure their organisational, human and material resources (see Fig. 5 - left side).

Even if in the traditional view of the hierarchical order of capabilities (Collis, 1994; Winter, 2003; Zollo and Winter 2002), the second and third-order dynamic capabilities operate on first-order ones (i.e. the operational capabilities); we observed the reversed process during this pandemic outbreak. The immediate and unpredictable consequences of

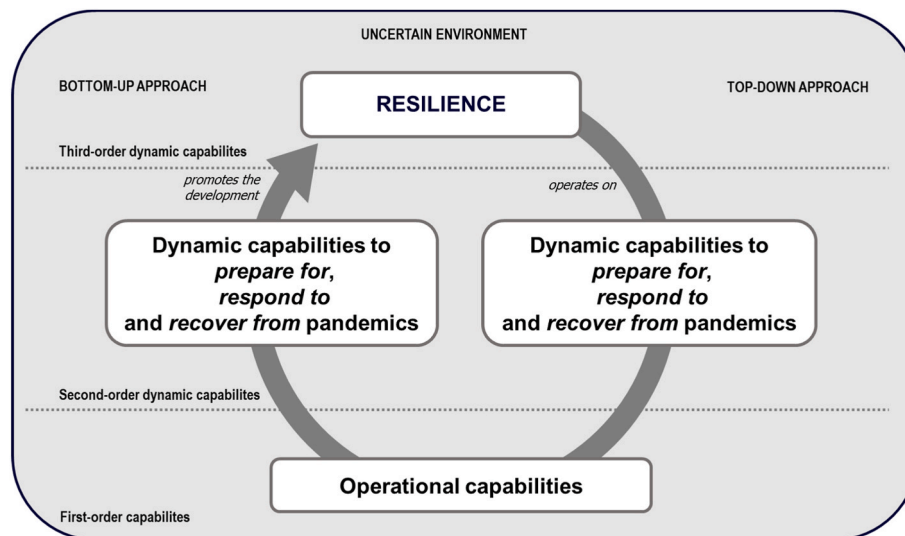


Fig. 5. The circular pathway for the development of resilience.

the COVID-19 first wave inverted the traditional view by Zollo and Winter (2002), who suggested that dynamic capabilities (in our case, those of second and third orders) emerge from learning mechanisms and operate on lower-order capabilities (in our case first order capabilities). Thus, the following propositions have been formulated:

P1: During unexpected pandemic events, supply chain resilience develops with a bottom-up approach from the first-order capabilities which build second-order dynamic capabilities through day-by-day learning mechanisms. These capabilities, in turn, develop the third-order dynamic capability, i.e. supply chain resilience.

Second, as shown in Fig. 5, the right side of the circular pathway is consistent with the one adopted by strategic scholars (Collis, 1994; Zollo and Winter 2002). Once the second-order dynamic capabilities which feed supply chain resilience has been developed, resilience (i.e., the third-order dynamic capability) acts as a *strategic initiative purposefully* developed by organisations and it operates on second second-order dynamic capabilities, which, in turn, work on the first-order capabilities.

As revealed by the analysis of empirical data, a few weeks after the end of COVID-19's first wave (i.e., during the recovery phases of resilience) healthcare systems developed two dynamic capabilities, named "learning" and "reduction of impact" (see Table 4). These second-order dynamic capabilities are related to a number of resilience practices, such as those concerning the definition of step-by-step pandemic plans for scheduling the management of COVID-patients according to the number of admissions, and new ways of delivering care remotely. The investigated organisations were able to plan new procedures for managing patient flows and changes within the facilities of health systems rooted in the experience and knowledge acquired day-by-day during the responsiveness phase, i.e. the first wave of COVID-19 (Feb–May 2020). Moreover, they improve their abilities to deliver care remotely by adopting new technologies to avoid the admission of non-COVID patients into the hospitals.

Thus, the second phase of the development of resilience follows a top-down approach. Resilience, as a third-order dynamic capability, operates on second second-order dynamic capabilities, which, in turn, work on the first-order capabilities, in line with Collis (1994) and Zollo and Winter (2002). Based on these premises, the second theoretical proposition states:

P2: After coping with the most critical phase of unexpected pandemic events, supply chain resilience is developed with a top-down approach. As a third-order dynamic capability, it acts as a strategic initiative and operates on the second-order dynamic capabilities, which, in turn, work on the first-order capabilities.

Finally, based on the empirical analysis, the circularity of the pathway for developing resilience (see Fig. 5) determines that, through day-by-day experience, first-order capabilities modify (left side – Fig. 5) and, in turn, they are modified (right side – Fig. 5) by the second-order dynamic capabilities by continuously feeding the pathway of resilience.

6. Conclusions

Adopting the dynamic capability theory for developing resilience in healthcare during pandemics allowed us to provide a twofold contribution to the theory. First, while in Teece et al. (1997) conceptualization, dynamic capabilities are built to maintain competitive advantage, in healthcare dynamic capabilities emerge to sustain the delivery of care. Thus, they are classified as anticipating, responding and recovering capabilities for sensing, seizing and reconfiguring the organisation's resources to sustain the continuity of care. Secondly, we define resilience as a third-order capability and we identified a circular pathway for developing supply chain resilience to face uncertain events. The pathway emerges from the empirical study of how healthcare organisations developed SCRES during an unprecedented pandemic in terms of effects and globality. The resilience conceptualization and the identified circular pathway result from empirical evidence and the merger of operational studies, related to supply chain resilience in operations management, and strategic management research, related to dynamic capabilities.

The study provides also a contribution to the practice. To support the understanding of how SCRES is developed, the authors systematized and rationalized activities, resilience practices, resilience elements and dynamic capabilities developed to face the COVID-19 pandemic. Even if the study is framed during a crisis period in the most affected European region by COVID-19, and in one of the most COVID-19-affected sectors (i.e., healthcare), the identified activities and resilience practices are context-specific, thus, they could not have general validity. However, they represent a useful starting point for planning new future effective strategies for facing pandemic contexts.

As with all research, this study has some limitation. Given the exploratory nature of our study, we adopted a qualitative approach to provide an in-depth perspective of the investigated phenomena. Thus, the results are limited to pandemic events and public healthcare organisations. Future studies could further investigate the identified dynamic capabilities and the resilience practices in different healthcare systems or private healthcare organisations after and during future crisis events.

Moreover, the research was carried out after the first wave of the COVID-19 pandemic, future research should focus on longitudinal studies to analyse how resilience practices, resilience activities and dynamic capabilities have been developed between the first, second, and third waves of the COVID-19 pandemic. This could be useful also to validate empirically the identified circular pathway.

Declaration of competing interest

none.

Data availability

No data was used for the research described in the article.

Appendix A

The 18 guiding questions for semi-structured interviews and observations.

Q.1	Which are the main changes developed to cope with the crisis? Please, provide us with a few examples.
Q.2	Which were the departments most affected by the crisis? How have they been reorganised?
Q.3	How long was the reorganisation of the departments/units? Which were the main obstacles you should cope with? (for example, shortage of medical equipment, PPEs, beds, human resources, skills, and internal/external communication)
Q.4	What are the main innovations developed?
Q.5	What are the essential resources needed to cope with the crisis? Which were available? Which not?
Q.6	How was the internal collaboration between healthcare workers?
Q.7	How was the collaboration with other (health/hospital) companies and bodies (Region) managed?
Q.8	How was the collaboration between the medical staff managed?
Q.9	What were the main forms of formal (structured meetings) and informal (direct contacts between staff) communication?
Q.10	Which tools were used to collect/process information in the external context (positive, symptomatic patients treated at home, non-COVID patients) and in the internal context (facilities/residences of the same social health/hospital organisation)?
Q.11	How was knowledge shared between internal and external structures?
Q.12	How will this pandemic affect future collaboration/communication?
Q.13	What are the main measures taken to ensure the safety of operators and patients?
Q.14	Were decisions on organisational choices individual or shared? Who was involved? How often were choices discussed?
Q.15	Have you created plans to ensure continuity of care and the operation of departments not directly affected? Or what hindered the creation of a plan?
Q.16	How will this affect the future way of operating this company? How has the way of handling emergencies changed?
Q.17	What are the main three strengths of the company that facilitated the management of the emergency?
Q.18	What were the main three difficulties encountered in managing the emergency?

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