

# Being resilient for society: evidence from companies that leveraged their resources and capabilities to fight the COVID-19 crisis

Massimo Bergami<sup>1</sup>, Marco Corsino<sup>1</sup>,  
Antonio Daood<sup>2,\*</sup>  and Paola Giuri<sup>1</sup>

<sup>1</sup>Department of Management, Bologna University, Via Capo di Lucca 34, Bologna, 40126, Italy.  
max.bergami@unibo.it, marco.corsino@unibo.it, paola.giuri@unibo.it

<sup>2</sup>Department of Business and Management, Luiss University, Viale Romania, 32, Rome, 00197, Italy.  
adaood@luiss.it

**This study adopts a resilience perspective to explain how companies managed to contribute innovative solutions to fight the COVID-19 crisis. We studied how five companies operating in different industries (three in automotive, one in printing, and one in rubber and plastic products manufacturing) managed to reorganize activities and employ their R&D and innovation capabilities to enhance their resilience. Simultaneously, they increased the health system's capacity to cope with the outbreak. Through a qualitative inductive study, based on interviews with company managers, we found that the firms mobilized their resources and capabilities to expand their ability to adapt and cope with adversity at the organizational level. In addition, moved by the sensitivity to the extreme context and a perceived sense of urgency, the firms deployed the same endowments to strengthen the community's response to a crisis. Our study shows that an organization can directly and positively foster the broader social system's resilience. This study contributes to the innovation literature by identifying innovation capabilities as fundamental antecedents of resilience building for organizational response, paving the way for strengthening the link between resilience and innovation.**

## 1. Introduction

Italy is one of the countries that suffered the most severe impact of the coronavirus disease 2019 (COVID-19). The upsurge in the number of patients requiring hospitalization or intensive care unit admission has placed Italian health systems under

severe stress. In response, the Italian government has undertaken a series of gradually increasing interventions – from declaring a state of emergency to a complete lockdown.

When confronted with a disruptive crisis, such as the COVID-19 pandemic, organizations need to rethink their processes and adopt new ways of

Authors are listed in alphabetical order.

working to continue their operations, when possible, or prepare for the reopening phase. In such periods, companies test their adaptive capacity to cope with disturbance and retain their functioning, which is conceptualized as organizational resilience (Sutcliffe and Vogus, 2003; Vogus and Sutcliffe, 2007; Williams et al., 2017; Giustiniano et al., 2018). So far, extant research on resilience has mainly focused on a business organization's ability to overcome a crisis for its own sake (e.g., survival and return to profitability). It has not clearly explained how businesses can directly contribute to increasing resilience at a higher-order system level, that is, the social system in which the firm is embedded.

Despite its disjointed body of literature, innovation is recognized as a core component of the transformational change and renewal required for firms to be resilient (Hillmann and Guenther, 2021). Innovation is essentially a product of combinative capabilities (Kogut and Zander, 1992), which enable a firm to recombine existing knowledge elements to generate new technological applications (Yayavaram and Ahuja, 2008) or organizational configurations (Damanpour, 2014). Similar to the resilience literature, scholarly work on innovation has focused primarily on how firms deploy their innovation capabilities to navigate through competitive dynamics in ordinary times and safeguard their own survival in the face of adversity.

However, as the COVID-19 pandemic placed unprecedented pressure on the national health system and took numerous lives, many organizations deployed innovative and adaptive responses not only for their convenience, but also to create social value. For example, many companies are transforming their activities to produce the equipment needed to curb COVID-19, suggesting that the same capabilities may also be applied in a crisis context for the broader society's interest and serve to create resilience for the higher-order system. In this respect, some questions remain unanswered at the intersection of the two literature on resilience and innovation: How do companies deploy their R&D and innovation competencies to serve society during a crisis? How can they directly contribute to build resilience beyond their organizational boundaries?

This study addresses this gap by adopting a resilience perspective to explain how companies managed to contribute innovative solutions to fight the COVID-19 crisis. We studied how five companies operating in different industries (three in automotive, one in printing, and one in rubber and plastic products manufacturing) managed to reorganize

activities and employ their R&D and innovation capabilities to enhance their organizational resilience. Simultaneously, they increased the health system's capacity to cope with the outbreak. Through a qualitative inductive study based on interviews with company managers, we show that firms mobilize their resources and capabilities to adapt and cope with adversity at the organizational level. In addition, moved by the sensitivity to the extreme context and a perceived sense of urgency, firms deploy the same endowments to strengthen the community's response to a crisis.

Our work contributes to the literature in several ways. First, it underscores the connection between innovation and resilience, as innovation capabilities are essential constituents of the endowment of resources and capabilities used to build resilience. Second, we expand previous research on the capabilities enabling social innovation by identifying the precise set of capabilities – innovation, leadership, relational and emotional capabilities – that can be harnessed to help society in the face of an extreme emergency. Third, the study advances the resilience literature by showing that the same resources and capabilities that lead to organizational resilience could also be used to build resilience directly beyond the organizational boundaries, emphasizing the need for a cross-level understanding of resilience.

The remainder of this paper is organized as follows. First, we present a brief review of the literature on the theoretical framing of our work. Second, we explain the methodology and describe the cases included in the study. Finally, we detail our findings before discussing the results and presenting directions for further research.

## 2. Theoretical background

### 2.1. Organizational resilience

Resilience defines an organization's ability to absorb shocks and adapt accordingly to retain its functioning (Sutcliffe and Vogus, 2003). Management scholars use the concept of resilience to analyze how organizations can adapt, and thus respond to or anticipate, adversity (Giustiniano et al., 2018). Resilience is conceptualized as a continuous process of anticipating and adjusting to environmental changes (Hamel and Välikangas, 2003) and the ability to overcome disruptive events; the latter is more related to crisis management (Williams et al., 2017) and better fits our context. Although there are several definitions of organizational resilience, we refer to it as the

process by which an organization ‘builds and uses its capability endowments to interact with the environment in a way that positively adjusts and maintains functioning before, during, and following adversity’ (Williams et al., 2017, p. 742).

Scholarly research has outlined several traits of resilient organizations (e.g., Sutcliffe and Vogus, 2003; Vogus and Sutcliffe, 2007; McManus et al., 2008; Weick and Sutcliffe, 2011; Zolli and Healy, 2012; Giustiniano et al., 2018; Tengblad & Oudhuis, 2018). However, there is no consensus on the traits that make an organization resilient due to different conceptualizations of resilience within the management literature (Linnenluecke, 2017; Conz and Magnani, 2019; Hillmann, 2020). Besides underscoring the importance of an organization’s endowment of resources and competencies in absorbing shock, such as slack of cognitive, relational, and emotional capabilities (see Sutcliffe and Vogus, 2003), scholars emphasize the organizational flexibility required to differently integrate existing resources, as well as source or develop new ones to boost organizational responses (e.g., Sutcliffe and Vogus, 2003; McManus et al., 2008). After all, innovation depends on the ability to develop or acquire new competencies, adapt the existing ones to new contexts, or recombine them differently (Schumpeter, 1939). As such, innovation is the means through which organizations can anticipate, adapt to, and recover from extreme damage (Giustiniano et al., 2018).

## 2.2. Organizational resilience and innovation

Innovation and organizational resilience are closely related, but the link between the two has been scarcely researched. The innovation literature has posited organizational adaptive capacity (Staber and Sydow, 2002), which is closely related to resilience, as a means of managing the challenges that emerge within collaborative innovation settings (Mahdad et al., 2020). Additionally, resilience capacities are functional to organizational creativity (Richtner and Löfsten, 2014) and business model innovation can emerge from a resilient response (Buliga et al., 2016). Indeed, the recent literature has examined innovation as an opportunity for firms to engage in strategic renewal in response to a crisis (Wenzel et al., 2020).

Innovation is, indeed, at the core of the transformational change and renewal required for firms to be resilient – not only in terms of ‘bouncing back’ from a disaster, but also ‘bouncing forward’ (Giustiniano et al., 2018). Such a transformation

might result from both technological and organizational innovation. For example, cattle ranches in Zimbabwe were transformed into game-hunting and safari parks when ranching was no longer viable in the 1980s (Walker and Salt, 2012). In this sense, innovation is a product of combinative capabilities (Kogut and Zander, 1992), whereby firms recombine existing knowledge elements to generate new technological applications (Yayavaram and Ahuja, 2008) or organizational configurations (Damanpour, 2014). Firms usually rely on their innovation capabilities to navigate the competitive environment, but these can also be used to create societal value (Chesbrough and DiMinin, 2014; Ahn et al., 2019).

## 2.3. Building resilience beyond the organization through innovation?

In management studies, organizational resilience research has mainly focused on a business organization’s ability to overcome a crisis for its own sake (e.g., survival and return to profitability). Organizations also contribute to community resilience through positive externalities from employment, services, and cash flow granted by the organization’s ability to continue operating during a crisis (McManus et al., 2008). However, this is not the only way business organizations can contribute to the system’s resilience. Building on the idea of *compassion organizing*, through which individuals can collectively respond to a situation causing human suffering (Dutton et al., 2006), scholars have investigated how emergent groups and new ventures could help communities recover (Majchrzak et al., 2007; Shepherd and Williams, 2014; Williams and Shepherd, 2016). For instance, Williams and Shepherd (2016) highlighted the role that emergent organizations played in alleviating the suffering caused by an earthquake disaster, which extended the existing systems’ capacity to cope with the adversity and, thus, enhanced resilience at the community level. However, it is still not clear what direct contribution resilient incumbent firms make to increasing resilience at a higher-order-system level (e.g., national health system). In other words, how can organizations deploy their resilience traits to serve society?

Firms play an essential role in social value creation: indirectly through corporate philanthropy or social responsibility, and directly when they manage to tackle social issues aligned with their core value chain (Porter and Kramer, 2011; Menghwar and Daood, 2021). However, during the COVID-19 pandemic, firms are making considerable efforts to

convert their production processes to cope with the shortage of supplies needed to curb the pandemic. This suggests that the same innovation capabilities that companies use in the competitive arena may also be applied in a crisis context for the broader society's interests, thereby serving to create resilience for the higher-order system. When confronted with disasters causing profound human suffering and a perceived *sense of urgency* (Majchrzak et al., 2007), firms might take actions that deviate, *in toto* or in part, from the conventional value appropriation imperative, shifting the balance toward social value creation and delivery to the community. From this perspective, it is worthwhile to investigate how resilience traits can enable firms to serve society in perilous moments.

### 3. Methodology

Given our research objectives, we opted for a qualitative inductive study focused on the contextual and organizational factors that allow firms to contribute to a higher-order system's resilience. We followed the method by Gioia et al. (1994, 2013) for data collection and analysis.

In line with our qualitative approach, we adopted a theoretical sampling method to identify suitable cases that shed light on the dynamics underlying the investigated phenomenon (Eisenhardt and Graebner, 2007, p. 27). More specifically, we sought cases of firms that undertook remarkable transformations to help the Italian national health system in response to the COVID-19 crisis. Several companies deployed resources to support the health system, such as respirator valves, protective masks, and other useful equipment. While some companies were operating in the production sectors of the required devices, others reconverted or combined their capabilities to produce products that were distant from their core businesses. We focused on the second group of firms and identified five Italian firms that we considered as potentially illuminating and revelatory cases (Yin, 1994).

#### 3.1. Cases

##### 3.1.1. Ferrari

During the emergency, Ferrari's production department, which ordinarily develops new car prototypes, promptly started to manufacture respirator valves and fittings for protective masks that were to be donated to help with the coronavirus pandemic. Furthermore, in response to a requested collaboration from the Italian Institute of Technology of Genoa, Ferrari

deployed its fluid dynamics expertise and innovation competencies to ideate, design, and prototype a new pulmonary ventilator, in just five weeks, to help combat the COVID-19 crisis. This project, named FI5, was entirely carried out via remote working, except for the phases requiring physical activities, such as the prototype realization and testing. Moreover, it was made available as an open-source product so that institutions worldwide were able to utilize it for free to produce efficient, lightweight and cheaper ventilators.

##### 3.1.2. Automobili Lamborghini

The company joined the fight against the pandemic by reconverting some of its production plant departments to produce surgical masks and protective medical shields for donation to the Sant'Orsola-Malpighi Hospital in Bologna. The company's upholstery department for manufacturing car interiors has been reconverted into a production line of surgical masks, whereas its R&D department and composites production plant were dedicated to the 3D printing of protective medical shields. They also deployed their competencies and 3D printing technology to supply lung-simulators in order to support an Italian top manufacturer of ventilators: the breathing simulator enables the tester to carry out an initial evaluation of the ventilator's performance before reaching the final checking stage. Lamborghini produced and donated more than 28,000 certified surgical masks and more than 7,300 shields mainly to Sant'Orsola-Malpighi Hospital.

##### 3.1.3. Dallara Automobili

While collaborating with the Parma Hospital, Dallara exploited its expertise to perfect the intuition of adapting a Decathlon snorkeling mask to provide non-invasive ventilation to patients affected by COVID-19. An initial valve developed in Brescia was functional only for patients who were able to breathe autonomously. Dallara's aerodynamics expertise enhanced the perfection of the valve to support continuous positive airway pressure (CPAP), which ensures that airways are always kept open. They redesigned the valve to convert the snorkeling mask into a low-cost CPAP mask and made the CAD data and instructions available as open-source for anyone to 3D print.

##### 3.1.4. Grafica Veneta

To mitigate the outbreak, Grafica Veneta dedicated one line to the production of facemasks by adapting their rotary press machine and using a particular non-woven fabric. Although they were not certified PPEs, laboratory tests found these facemasks to be non-cytotoxic, non-irritating, and to have filtration

capacity. Grafica Veneta produced and donated more than 10 million facemasks that were then distributed to the population through civil protection. Hence, they enabled citizens to protect themselves against the virus and allocated certified PPEs to medical venues in times of scarcity.

### 3.1.5. SIOM Termoplast

To help contain the COVID-19 emergency, SIOM Termoplast designed, prototyped, and realized a semi-rigid, reusable, and removable mask made of a plastic shell, a rubber gasket, and a filter-housing plastic head. When the mask was tested, it had an optimal filtration capacity (99%) and above-standard breathability (11 Pa/cm<sup>2</sup>). After usage, the mask's hard parts can be disassembled and, once the filter is removed, cleaned in a dishwasher. The mask's reusability proved to be useful for dealing with a shortage of equipment while limiting waste. SIOM Termoplast donated 20,000 masks to numerous Italian municipalities.

## 3.2. Data collection

Our study relies on multiple data sources: namely, interviews and other documentary materials, such as press articles, press releases, and media documentation.

We gathered primary data through semi-structured interviews based on an ad-hoc interview protocol (Appendix 1), which we developed based on concepts from the literature of innovation and resilience with respect to the context and the phenomenon under investigation. We conducted the interviews during the emergency, at the end of Italy's lockdown phase; hence, we had to rely on distant interviews through videoconferencing or phone calls, while considering technological and organizational constraints. We conducted six interviews – ranging from 37 to 78 min in length (Table 1) – with representatives of the five firms selected for the study. We recorded

and transcribed ex-post interviews to capture every bit of information and obtained 58 transcript pages. During the interviews, we took notes while trying to maintain the interviewees' terminology to improve our understanding of their experience (Gioia et al., 2013); these notes proved extremely useful in the subsequent analysis phase.

To enhance our understanding of the cases and triangulate the data from the interviews, we also relied on secondary data (Appendix 2). These consisted of 49 documentary materials, which were mainly press articles, magazines, blogs, company press releases, and media documentation (e.g., video news broadcast online or on television, and video talks regarding the emergency). We developed the 'content summary' of each record to facilitate the process of complementing and cross-checking the data coming from interviews (no discrepancies were found). All secondary data extended and enriched the limited interview data, allowing us to have a more precise understanding of the innovative solutions both conceptually and visually, for instance. In this process, we used third-party material for data triangulation to avoid corporate rhetoric. For instance, we triangulated interview data regarding donations from informants with corporate public communications (company websites) and third-party sources (e.g., public announcements of municipalities receiving the donation, news agencies, and media coverage).

## 3.3. Data analysis

We began the analysis with coding to classify raw data into first-order codes, mainly reflecting and adhering to informants' terms. The interview transcripts (except the interviewer-related text) were uploaded into Nvivo software for the coding phase, which helped us attach fragments of raw data to labeled nodes. The analysis continued with the

Table 1. Interview data

Company	Location	Since	Size (employees)	Industry	Interviewee	Duration
Ferrari	Maranello (IT)	1939	Large (>250)	Automotive	Head of Ferrari Chassis Area	65 min
Automobili Lamborghini	Sant'Agata Bolognese (IT)	1963	Large (>250)	Automotive	Head of Production	42 min
					Head of CFK Center	38 min
Dallara Automobili	Varano de' Melegari (IT)	1972	Large (>250)	Automotive	Chief Executive Officer	78 min
Grafica Veneta	Trebaseleghe (IT)	1982	Large (>250)	Printing	Press manager	37 min
SIOM Termoplast	Fiume Veneto (IT)	1976	Small (<50)	Molding	Owner	45 min

process of distilling second-order themes (i.e., grouping nodes into parent ones), which then led to the identification of the aggregate dimensions representing our theoretical constructs. While first-order codes reflect informant-centric terms, second-order themes and aggregate dimensions involve a more researcher-centric understanding of concepts (Gioia et al., 2013). In practical terms, we grouped first-order codes into second-order themes that emerged from our sense-making, which was clearly informed by the existing literature. At this stage, the process transitioned from being purely inductive to going back and forth from the data to the literature in a more abductive fashion, as suggested by Gioia et al. (2013). Hence, the development of second-order themes was informed by resilience factors (Sutcliffe and Vogus, 2003; Williams et al., 2017), innovation

capabilities (Kogut and Zander, 1992; Prajogo and Ahmed, 2006), and contextual factors (i.e., sense of urgency; Majchrzak et al., 2007) that have been recognized by existing studies.

During the analysis, we repeatedly read the transcripts, coding and re-coding the data multiple times based on our evolving understanding (Corbin and Strauss, 2014) until we obtained the final data structure depicted in Figure 1. The four aggregate dimensions reflect the identification of organizational factors (i.e., endowment of resources and capabilities) that – in line with the literature – are mobilized to reach a strictly organizational outcome (i.e., organizational resilience), but that in the presence of contextual factors (i.e., sensitivity to the extreme context) can be mobilized to directly achieve a broader outcome (i.e., the higher-order system’s resilience).

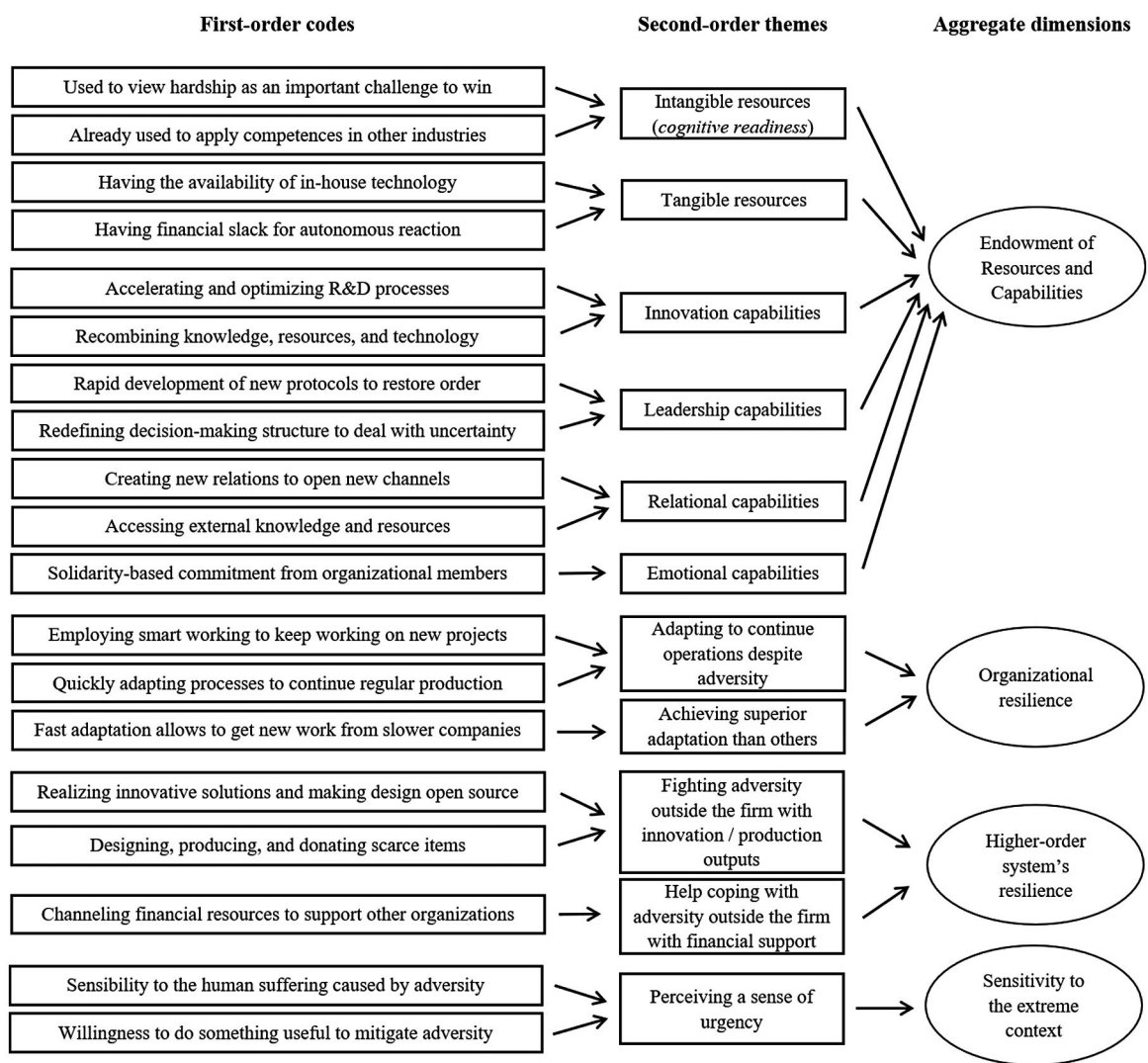


Figure 1. Final data structure.

## 4. Findings

In this section, we systematize our findings per aggregate dimension and explain the underlying logic through propositions.

### 4.1. Endowment of resources and capabilities

Our analysis indicates several organizational elements that underpin their resilience to the COVID-19 crisis and aggregate into their endowments of resources and capabilities. This comprises an organization's endowment of resources that allow it to 'be ready' to adjust and cope with disturbance, as well as the actual capabilities deployed by the organization in response to the adversity.

First, endowments concern intangible and tangible resources that prepare organizations to cope with adversity (see Table 2). Regarding intangible resources, organizations displayed *cognitive readiness*, which involves a positive mental attitude that is fertile to adaptation and change. All firms were found to have a flexible mindset that helped them identifying opportunities to apply their competencies to other industries, even those distant from their businesses. A recurrent theme was the predisposition to consider the crisis, and hardship in general, like a competition to be won or an opportunity to transform and improve the organization. As far as *tangible resources* are concerned, the availability of technological and financial resources was vital for the crisis response. For instance, Dallara's advanced system, based on a private cloud, allowed its employees to gain remote access to the computational capacity required for complex designs and simulations immediately after the lockdown announcement. Further, financial buffers allowed companies to bear the reconversion and reorganization costs without the time-consuming search for external funds via bureaucratic procedures (e.g., state resources).

As far as capabilities are concerned, we found that the overall ability to respond to adversity by adaptation or renewal is based on four different, yet interrelated, capabilities deployed in response to the crisis (see Table 2).

Initially, we identified *innovation capabilities*, which first pertain to a firm's R&D and technology competencies (Prajogo and Ahmed, 2006) and allow for a quick transformation of ideas into innovations. For instance, Ferrari's Formula 1 team deployed its competencies in the R&D process, alongside its well-trained personnel, in order to provide innovation outputs in designing a new, lightweight respirator whose designs were made available in open source.

Innovation is also the result of combinative capabilities (Kogut and Zander, 1992) deployed to adapt existing resources and competencies to transform established activities or engage in new ones. These include the adaptation of the rotary press at Grafica Veneta to produce filtering devices, or Lamborghini's creative repurposing of yarn, customarily used to manufacture airbags, for sewing certified surgical masks. Another activity was the application of computational fluid dynamics to design a valve capable of turning a snorkeling mask into a CPAP respirator at Dallara. Similarly, to help a medical technology company that was experiencing difficulties in testing ventilators due to accelerated production, Lamborghini's R&D department used CAD modeling competencies and 3D printing technology to produce lung-simulating devices to test the ventilators.

Second, in their response, the organizations deployed *leadership capabilities*: in other words, managers making decisions to reorganize the firm and navigate crises. Such capabilities underlie the paradoxical quality typical of resilient leaders (Giustiniano et al., 2020; Lombardi et al., 2021), who can make decisions that integrate contrasting elements, such as flexibility and clear direction-setting. Every company centralizes critical decisions essential for restoring order, such as developing and enforcing new protocols and procedures to continue operating safely – or shutting down physical operations beforehand – and resetting strategic priorities on new projects to accommodate remote working. However, we found concurrent evidence that some other decisions were decentralized. For example, Dallara's decision-making shifted in both directions: It centralized all decisions related to organizing for the COVID-19 crisis, such as health and safety protocols, as such matters were assigned the highest priority. However, it also decentralized decisions that normally would have been centralized, such as setting the priority in the queue of projects requiring an enormous computational capacity to be launched at the supercomputer. Dallara entrusted its employees with coordinating among themselves in terms of prioritizing, which was surprisingly efficient. Smart working allowed for greater flexibility, and employees self-organized their working shift by coordinating with colleagues on the schedule (for example, working and launching their simulations at night). The statistics of supercomputer usage registered an increase in utilization. As another example of decentralization, Dallara allowed its employees to decide their working days and holidays.

Third, because of the challenge of performing adaptations in isolation, we found that organizations enacted the *relational capabilities* required to open

Table 2. Endowment of resources and capabilities: selected evidence

Second-order themes	Selected evidence on First-order codes
Intangible re-sources ( <i>Cognitive readiness</i> )	<p><b>Already used to apply competencies in other industries</b></p> <p>“We are <i>already used to apply</i> our aerodynamics <i>competencies to other contexts</i>, such as making ovens for drying candies. We study the air, what it can do, and how it should be directed, etc. There was a company in the area of Parma that sells ovens to dry candies all over the world. We performed a study by applying computational fluid dynamics and we saved 40% of energy by doubling the drying speed of candies. So, now they sell super-efficient ovens thanks to the aerodynamics study that we did on the air flows inside their ovens.” (CEO, Dallara)</p>
	<p><b>Used to view hardship as an essential challenge to win</b></p> <p>“Our guys are all competitive; by nature, they are <i>always engaged in competitions where they must win</i>. When they were at home and therefore were not busy from a working point of view <i>they viewed this situation as an important challenge</i>, and in many of them triggered a reaction to do something important” (Head of Ferrari Chassis Area, Ferrari)</p>
Tangible resources	<p><b>Having the availability of in-house technology</b></p> <p>“<i>Having 3D printing technology in-house</i> was key [...]; this minimizes the time to get a three-dimensional object in your hands from the idea, actually in a few hours, right? Because the idea, design, launch of the printing program, and the realization of the object in 3D are phases –performed in the order I told them– so rapid that can be almost thought of as one. So from today to tomorrow, I can already have a prototype in my hands, and maybe in a couple of days, I do the optimization, and then I have the final object.” (Head of CFK Center, Lamborghini)</p>
	<p><b>Having financial slack for autonomous reaction</b></p> <p>“We managed to do everything [reorganize for the new production] so quickly also because we did it with our own resources, a cost we were ready to bear to contribute [to fight the crisis]” (Head of Production, Lamborghini).</p>
	<p><b>Accelerating and optimizing R&amp;D process</b></p> <p>“We relied on our <i>innovation ability</i> to overcome the difficulties of optimizing a product that has proved to be more complex than expected; because the first supplies we gave to the laboratory for testing, for example, had not passed the tests for many reasons. So in the face of laboratory test results, we immediately had to <i>run optimization loops</i>, regarding the material and the production process.” (Head of Production, Lamborghini)</p>
Innovation capabilities	<p><b>Recombining knowledge, resources, and technology</b></p> <p>“We had to <i>adapt all the sewing machines</i> because the airbag yarn that we ultimately found suitable for certified masks is used only by a single sewing machine because normally we make only five pieces a day using that yarn. We had to convert 7 lines of machines for them to support this yarn.” (Head of Production, Lamborghini)</p>
	<p>“To do such work [printing semi-rigid masks] in so little time, we had to set up a new production line by <i>modifying the mold holders and matrixes that we had</i>.” (Owner, SIOM Termoplast)</p>
	<p>“We employed the <i>competencies that we usually employ to reach our objectives</i> to serve the new purpose [development of a respirator], <i>integrating them with the knowledge</i> we lacked in the medical field that we <i>sourced from outside</i>.” (Head of Ferrari Chassis Area, Ferrari)</p>
Leadership capabilities	<p><b>Rapid development of new protocols to restore order</b></p> <p>“We had to <i>develop security protocols beforehand</i> to continue operation, reorganizing everything to respect the distance, gloves, sanitizer, temperature measurement. And here, for example, there was beautiful cooperation between us and other companies of the Motor Valley with which we shared the protocols, we made the protocols together.” (CEO, Dallara)</p>
	<p><b>Redefining decision-making structure to deal with uncertainty</b></p> <p>“We have made a much more precise definition of what decisions needed to be centralized compared to what was to be decided at the peripheral level. [...] Important decision were centralized, but we also had a <i>shift in decision making</i> to the bottom [...]. This was key to deal with uncertainty [...]. Our mathematical models use a lot of computational power and queue up supercomputers. Before the lockdown the scheduling was centralized. When we went in smart working our employees self-organized their activities” (CEO, Dallara)</p>



Table 2. (Continued)

Second-order themes	Selected evidence on First-order codes
Relational capabilities	<p><b>Creating new relations to open new channels</b></p> <p>“We required to <i>create new relations to open new channels</i>: for instance, in order to use a medical material, I had to ask not for my supplier but directly to the European distributor for an access code to be allowed to use that particular material. [...] We also <i>involved one competitor</i> that makes molds too. They are two young entrepreneurs, and they gave me a hand. We did the project; we handed it to them so that they also made part of the molds too.” (Owner, SIOM Termoplast)</p> <p><b>Accessing external knowledge and resources</b></p> <p>“Our ability to <i>exploit the external collaboration</i> with the University not only allowed us to <i>gather the knowledge we lacked</i> in the medical field but also it allowed us to <i>access the material we needed</i> by reaching a Swedish supplier from the University collaborative network.” (Head of CFK Center, Lamborghini)</p>
Emotional capabilities	<p><b>Solidarity-based commitment from organizational members</b></p> <p>“Everyone within the organization reacted with the maximum commitment, with a <i>strong emotional push to contribute</i>.” (Owner, SIOM Termoplast)</p> <p>“The <i>solidarity of our people</i> was crucial [to make the reorganization happen] [...] It was for a <i>great emotional push</i> that <i>each of us had given something more</i> to overcome the various small or large difficulties we came across, so to reach the goal in the shortest possible time. When organizations can <i>capitalize on that positive chemistry</i>, difficult things are easier to overcome.” (Head of Production, Lamborghini)</p>

new channels and access the medical supply chain, collaborate with industry-specific knowledge holders, and involve competitors to work with them in the fight against the pandemic. Once sourced through the extended relational network, external competencies, information, or needs are integrated with the firm's in order to feed the recombination process. Relational capacity is also vital to sharing resources within a collaborative ecosystem. For instance, from the first day of the emergency, the three automotive companies involved in this study cooperated with a few other Motor Valley companies to develop a security protocol of the highest standards, which was then made freely available to every other organization.

Fourth, we found that organizational responsiveness to a crisis is facilitated by an organization's ability to support and reinforce positive emotions, also known as *emotional capability* (Huy, 1999). We found multiple examples of strong solidarity among employees, which boosted the organizational response to COVID-19. For example, following the lockdown, Dallara put its personnel on paid leave to keep their salaries, rather than laying them off. When the lockdown persisted beyond its initial 15-day expectation, some people, especially the youngest, ran out of leave days. Some colleagues with more leave days asked the company to donate part of their leave days to those who had less. The company supported this arrangement, which went on for almost two months. Once leave days were depleted and layoffs remained the only option, the company decided

to integrate the layoffs to reach between 80% and 90% of the entire salaries.

Similarly, a positive emotional response was also a determinant of companies' contributions to fighting the crisis beyond organizational boundaries. When every company started reconfiguring its production processes or engaging in innovation activities to mitigate the pandemic, all the employees became enthusiastically committed and many volunteered their involvement. In some cases, such as the Lamborghini surgical mask project, the idea was conceived by a group of people in the production department while in smart working.

**P1:** *There exist an endowment of resources and capabilities that firms relied upon in the face of the COVID-19 crisis, consisting of (i) immaterial and material resources that make an organization ready to react, and (ii) capabilities – innovation, leadership, relational and emotional capabilities – that the organization deployed to respond to adversity.*

#### 4.2. Organizational resilience

All the firms in our study managed to adapt and continue with their operations despite adversity, exhibiting a superior reaction compared to others (see Table 3). We found that all companies could quickly adapt to the 'new normal' imposed by the pandemic to ensure workplace safety. Companies that were permitted to stay open revised their settings and

Table 3. Organizational resilience: selected evidence

Second-order themes	Selected evidence on First-order codes
Adapting to continue operations despite adversity	<p><b><i>Employing smart working to keep working on new projects</i></b></p> <p>“The decision to close the company as a precaution was taken two days before the decree [...] since then, we have <i>always continued to work in smart working, especially on the new projects</i>. By force of circumstances, we had clearly to interrupt the production and all the physical activities, but we continued to work in smart working (Head of Production, Lamborghini)</p> <p><b><i>Quickly adapting processes to continue regular production</i></b></p> <p>“We have <i>always continued to print books</i>, with some slowdown due to the limits imposed by the pandemic. We <i>took all the precautionary measures</i> to ensure all workers’ safety and the work environment with daily disinfection of the premises. In this way, during the crisis, we <i>safely continued our operations</i> and, for example, schooling materials for France were completed.” (Press Manager, Grafica Veneta)</p>
Achieving superior adaptation than others	<p><b><i>Fast adaptation allows to get new work from slower companies</i></b></p> <p>“Our private cloud model allowed us to <i>move people immediately to smart working</i>, allowing colleagues to perform very complex designs even from places where the line was the twisted pair or the personal hotspot. This allowed us to do new business because large customers <i>who have not been able</i> to make such a move immediately <i>have passed some of their business to us</i>.” (CEO, Dallara)</p>

processes to ensure operational safety. In contrast, those who were forced to interrupt their operations managed to shift toward a smart working modality and continue partial operations. Through a quick reorganization, some converted the closure of physical operations into opportunities to revise strategic priorities and accelerate other projects. For instance, Dallara took the chance to focus on ‘esports’ (electronic-sports) and increased sales of its IndyCar virtual machines.

**P2:** *Firms enacted their endowment of resources and capabilities to build organizational resilience to the COVID-19 crisis.*

#### 4.3. Higher-order system’s resilience

All organizations also contributed toward increasing the resilience of the social system in which they were embedded. They did so by leveraging their endowments of resources and capabilities. More specifically, they tried to cope with the shortage of resources to mitigate the outbreak and save lives in two main ways (see Table 4). On the one hand, they developed innovative design solutions and offered them as open-source products for anyone to use. Among these cases, Ferrari’s efforts stand out: the firm leveraged its innovation capabilities to ideate, design, and prototype a new pulmonary ventilator, in just five weeks, and then made it available around the world to help combat the COVID-19 crisis. In the fertile ground of the chassis team, which is used to seeing hardship as an essential

challenge to overcome, Ferrari paired its innovation and leadership capabilities (entrusting its team to self-coordinate with surprising efficiency), relational capabilities (providing ready access to the necessary network), and emotional capabilities (transforming the positive emotion of its human resources into a voluntary, but forceful commitment to the innovation project). On the other hand, other companies reconfigured their production processes to manufacture and donate personal protective equipment or medical devices. The standout among those cases is Lamborghini, who leveraged its analogous endowment of resources and capabilities to repurpose its production processes and manufacture masks and face shields.

**P3:** *Firms enacted their endowment of resources and capabilities to build the higher-order system’s resilience to the COVID-19 crisis.*

#### 4.4. Sensitivity to the extreme context

In the face of adversity, it is intuitive that organizations would deploy the abilities needed to address a disturbance that might eventually endanger its survival. However, we found that organizations’ sensitivity to emergency acted as a triggering factor for building on their endowments of resources and capabilities to achieve a broader scope (i.e., higher-order system’s resilience). More specifically, in all the cases, we found that such initiatives were driven by a perceived sense of urgency, stemming from the awareness of human suffering caused by adversity

Table 4. Higher-order system's resilience: selected evidence

Second-order themes	Selected evidence on First-order codes
Fighting adversity outside the firm with innovation/production outputs	<p><b>Realizing innovative solutions and making design open source</b></p> <p>“IIT asked Ferrari for the support of the Formula 1 team to <i>realize a respirator from scratch</i>. [...] Ferrari demonstrated a reaction speed in R&amp;D that would have been unthinkable for them [IIT] in terms of timing and modality. <i>In just five weeks</i>, we started from an initial idea and finished with the realization of the working prototype that we launched on Wednesday [May 13<sup>th</sup>], <i>the design of which has been made open-source to allow Countries all over the world to produce their respirators.</i>” (Head of Ferrari Chassis Area, Ferrari)</p> <p>“with our <i>aerodynamic department</i>, we developed a valve that turns a common Decathlon snorkeling mask into a respirator [...] as it allows the oxygen to arrive directly in the lungs of the patient in overpressure. [...] We made it <i>open source</i> so that anyone with a 300€ 3D printer could make it. We thought about this for the most deprived countries of the world, as a single 3D printer allows you to make a big number of valves.” (CEO, Dallara)</p> <p><b>Designing, producing, and donating scarce items</b></p> <p>“We wanted to do something to help doctors with the shortage of equipment, and we came to know that at [hospital] there was a shortage of face shields. [...] We used cutting machines for two-dimensional materials to cut polycarbonate sheets into screens, while the support part, which allows you to wear and replace the screen, has been done with our R&amp;D using 3D printers. In this way, we were able to <i>design and produce 7000 replaceable face shields that we donated to the hospital</i>”. (Head of CFK Centre, Lamborghini)</p> <p>“at [external company], perhaps the only ventilator producer in Italy, they were dealing with a decupled production of ventilators and, in particular, they were struggling to keep up with the testing. [...] so we <i>helped them engineering and 3D printing lung-simulating devices to test the ventilators.</i>” (Head of CFK Center, Lamborghini)</p> <p>“The <i>conversion of some rotary presses to the printing of filtering face protections</i> [...] allowed for the free distribution of a total of 10 million filtering devices to the population through the Civil Protection. This <i>allowed equipping people with a screen to be able to leave the house for primary needs without purchasing professional surgical masks and thus freeing these essential tools for the use of health professionals.</i>” (Press Manager, Grafica Veneta)</p>
Help to cope with adversity outside the firm with financial support	<p><b>Channeling financial resources to support other organizations</b></p> <p>“We organized a virtual championship with our Dallara Stradale, using the real mathematical models. We managed to involve drivers from all over the world. This idea emerged for COVID-19: as every driver who wanted to participate in the competition had to pay, <i>all the earnings were donated to the hospitals of Bergamo and Parma</i>” (CEO, Dallara)</p>

and the willingness to do something to mitigate it (see Table 5). Such sensitivity triggered the organizations' emotional response to crisis, motivating them to mobilize their resources and capabilities to do something useful for society at large – in this case, increasing the health system's capacity to mitigate COVID-19.

**P4: Firms' sensitivity to the extreme context and effects of the COVID-19 crisis beyond the organizational boundaries pushed them to deploy their endowment of resources and capabilities to increase resilience at the higher-order system level.**

In sum, we uncovered the resource and capability endowments that organizations can mobilize to increase not only their own resilience, but also that of the higher-order system. More specifically, an organization that is sensitive to the extreme context, and thus perceives a sense of urgency to contribute and

mitigate a pain-triggering situation, can deliberately draw on its resources and capabilities to engage in transformative change or innovation activities to cope with the emergency, thereby increasing the resilience of the higher-order system in which it is embedded.

## 5. Discussion

This study investigated how companies managed to offer innovative products and innovation outputs to fight the COVID-19 crisis. Adopting a resilience perspective, we studied five Italian companies that converted their manufacturing processes and deployed their innovation capabilities to produce supplies to fight COVID-19.

Our study underscores the link between innovation and organizational resilience, as well as contributes to the innovation literature by clearly

Table 5. Sensitivity to the extreme context: selected evidence

Second-order themes	Selected evidence on First-order codes
Perceiving a sense of urgency	<p><b><i>Sensibility to the human suffering caused by adversity</i></b></p> <p>“Following the decree imposing the lockdown on productive activities, many companies had to close while, by the nature of our activity, with our Ateco code we could remain open. [...] <i>since there were many people dying and the doctors working 24 hours a day, it didn't seem correct to me to keep working for our interest and do nothing for the community</i>” (Owner, SIOM Termoplast)</p> <p><b><i>Willingness to do something useful to mitigate adversity</i></b></p> <p>“<i>we of the industrial area wondered if it was possible to make ourselves useful, given that the situation of the emergency therapies as we know had become and was becoming more and more critical, especially in Lombardy</i>” (Head of Production, Lamborghini)</p>

positioning innovation capabilities as a fundamental antecedent of resilience-building response to adversity (at both the organizational and community levels). Innovation capabilities allow the recombination of existing resources and technology to find new applications (see combinative capabilities; Kogut and Zander, 1992). External medical-field-specific information was fed into the recombination process, allowing firms to envision new applications of their resources, competencies, and technology. For example, Dallara employed its knowledge of computational fluid dynamics to study and design a valve, turning a commercial snorkeling mask into a CPAP mask suitable for non-invasive ventilation. Similarly, Grafica Veneta deployed combinative capabilities to adapt one of its rotary press lines to produce face-filtering devices, thereby searching and ‘*exploiting the unexplored potential of the technology*’ (Kogut and Zander, 1992, p. 391). In light of our evidence about the commitment and motivation, driven by a sense of urgency, that tremendously impacted innovation timing and outcomes, managers may find our study useful for leveraging the same mechanisms in regular times.

Our second contribution to the innovation literature joins the conversation on firms’ innovation capabilities deployed for social purposes (e.g., Chesbrough and Di Minin, 2014). Our evidence showcases that, to quickly and meaningfully help society in the face of an extreme emergency, a firm’s innovation capabilities must be paired with leadership, relational and emotional capabilities – which respectively allow for prompt re-organizing, the leveraging and extending of relational networks, and the channeling of organizational members’ positive emotions into extraordinary commitment. Adding to previous research on the capabilities sustaining social innovation (Ahn et al., 2019), we identify a precise set of capabilities that can be harnessed to

build resilience for both the organization itself and the social system it is embedded in.

Our study also paves the way for new links to be explored. From our data, we were able to identify capabilities predominantly for their functional domain (i.e., innovation, leadership, relations, emotions), but some of these exhibit an inherent degree of ‘dynamicity’ – intended as the change-orientation typically attributed to dynamic capabilities (Teece et al., 1997; Lee and Kelley, 2008; Ahn et al., 2018; Bogers et al., 2019). For example, in some instances, an ‘ordinary’ innovation capability was also paired with a dynamic capability, which changed the way the innovation process was carried out (e.g., the FI5 project, carried out entirely via smart working). From our case and analysis, the dynamic character of the innovation capabilities seems to result from their interaction with leadership capabilities that are deployed to set the direction, while still allowing for a distributed and autonomous re-organization. Future research on dynamic capabilities might help to disentangle this aspect.

Additionally, we came across some learning mechanisms resembling those at the base of dynamic capabilities (Zollo & Winter, 2002) that match what the resilience literature refers to as feedback loops (Giustiniano et al., 2018). Most of the firms recognized that the huge commitment to fight COVID-19 beyond their boundaries increased their awareness regarding their ability to accomplish tasks that may have seemed impossible to do in such a short time, thereby reinforcing their positive attitude toward hardship (cognitive readiness). In this respect, future research might explore how the endowment of resources and capabilities can be changed and reconfigured, how ordinary capabilities are changed by the effect of dynamic capabilities to produce effective disaster response.

Overall, our exploratory study provides a basis for future research to sharpen the connection between

innovation and resilience – two concepts that are considered paramount to firm survival. The findings of our case-based research help to identify the gap, but only begin to fill it (Siggelkow, 2007). While we identified some interesting initial elements, additional qualitative investigations will be needed to deepen this link, while new quantitative studies might be used to develop and test hypotheses based on our propositions.

From a resilience standpoint, our study shows that an organization can have a direct and positive role in fostering the broader social system's resilience in which it is embedded. Further, we advance the current discourse by revealing that such a direct effect can be extremely effective when organizations deploy their resources and capabilities for reconversion and innovation. This suggests that organizational efforts toward the ecosystem's resilience can go well beyond minor adjustments to reduce companies' negative externalities. From this angle, our work stresses the importance of adopting a cross-level perspective, which is mostly overlooked (Williams et al., 2019), in order to deepen the reinforcing effects between organizational resilience and the higher-order system resilience.

Granted, our study relied entirely on successful cases. Therefore, it neither provides insights on organizational factors that might hinder resilience, nor allows us to understand whether the absence of one or more fundamental constituents of firm endowments might jeopardize the resilience response. For instance, is an organization with limited resources or capabilities equally able to respond resiliently to adversity? Also of note, our study concentrated on adaptive resilience. We did not find particular evidence of proactiveness to adversity (Giustiniano et al., 2018): our cases were instantiations of reacting to a sudden, unexpected adverse event that did not allow for developing adversity-specific pre-adaptations. Similarly, our cases lack elements of 'restoration' or 'recovery', which are recognized as essential elements of the resilience concept (Williams et al., 2017).

Our cases are taken from an in-crisis context that did not reach the post-disaster phase, where restoration and recovery usually unfold. Moreover, the timing of our study and the specific private initiatives constituting the case at hand did not allow us to capture the role of government policies in incentivizing private businesses' innovation to help society, as witnessed in subsequent phases of the pandemic in many countries (Liu et al., 2021), including Italy. Likewise, we could not observe governments' active role as orchestrators (Chesbrough et al., 2020), leaving these issues open to future investigation.

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**Massimo Bergami** is Professor of Organizational Behavior at the University of Bologna and Dean of Bologna Business School. His interests include organizational identity and organizational participation. He is a member of the Board of EFMD, founding Chair of the EMBA Consortium and Honorary Professor at Nankai University (Tianjin) and of Mirbis (Moscow). He served as non executive director in a number of public companies. He was a Visiting Scholar at the University of Michigan, Post-Doctoral Associate at the University of Florida and Visiting Professor at the Bocconi University. Massimo holds a PhD in Management from the University of Bologna and attended the International Teachers Program (ITP) at the Stern School of Business (NYU).

**Marco Corsino** is Assistant Professor at the Department of Management, University of Bologna. He received his PhD from the St'Anna School of Advanced Studies in Pisa (Italy). His research interests include the economics and management of innovation, technology strategy, and entrepreneurship. His research has been published in *Strategic Management Journal*, *Industrial and Corporate Change*, *Journal of Technology Transfer*, *Economics of Innovation of New Technology*, *European Management Review*.

**Antonio Daood** is Research Fellow at the Department of Business and Management, Luiss University. He

received his Ph.D. in Management from Sapienza, University of Rome. His current research interests are focused on organizational change, business model innovation, and made-in-Italy industries.

**Paola Giuri** is Full Professor of Management at Bologna University, and currently vice president of the School of Economics and Management at Rimini Campus. At Bologna Business School she serves as Associate Dean for Faculty and Research. Her research focuses on economics and management of innovation, entrepreneurship, university-industry technology transfer, economic and strategic uses of patents, social innovation and organizational change. She coordinated and had responsibilities in several international research projects funded by the European Commission and the European Investment Bank. She has published articles in several journals, including *Research Policy*, *Review of Economics and Statistics*, *R&D Management*, *Technological Forecasting and Social Change*, *International Journal of Industrial Organization*, *Industrial and Corporate Change*, *Journal of Technology Transfer*, *Industry and Innovation*. She was recipient of the 2010 Richard R. Nelson Prize Award and the Best Paper Award, Druid Summer Conference 2007. Paola Giuri got her PhD in Economics and Management of Innovation at Sant'Anna School of Advanced Studies, Pisa. In her career, she was visiting Study Fellow for two years at the Science Policy Research Unit (SPRU), University of Sussex.

APPENDIX 1

INTERVIEW PROTOCOL

**1. Opening premise**

1.1 Our study focuses on firms' responses to COVID-19 emergency (from now on also referred to as "crisis"). The study aims to explore firms react to such an unprecedented crisis and how they deploy their innovative capacity to cope with it by rethinking their processes and reorganizing

We remind you that all information disclosed during this interview or throughout other documents will remain confidential, and it will be used only for research purposes

We ask for your permission to record this interview to facilitate the note-taking process and ensure we capture all the information by transcribing it with due time

We seek your perspective on the following questions

**2. Organizational resilience**

We are interested in understanding how your organization has dealt with the crisis to safeguard its business, therefore, how it organized itself to ensure business continuity during the lockdown (or how it has prepared for the restart).

2.1 During the COVID-19 emergency, did your organization stop production or continue its operation?

2.2 What are the changes that your company has introduced to cope with the crisis? (Could you please distinguish between changes related to health security/distancing measures and those related to business?)

2.3 Regarding each aspect, how did your company managed to change quickly? In your opinion, what are the factors that made it possible? (If any, which were the main challenges, and how did you resolve them?)

2.3 To ensure a rapid response to the emergency in "Phase1," was there a greater decision-making centralization? With "Phase2," has there been a change in the decision-making process, for example, toward a greater sharing of decisions?

2.4 Do you envision any future changes required by the crisis and why (e.g., technological, organizational, related to the market)? (Which are the actions deployed in order to prepare for such change?)

**3. Organization's role in resolving the crisis beyond its boundaries**

We saw that your organization had reconverted its processes to help the health system cope with the lack of Personal Protective Equipment (PPE)/medical devices

3.1 Why did your company decide to do that?

3.2 From where did this idea come from? (externally or internally to your organization)

3.3 How did the change/transformation process occur? (e.g., reconfiguration of resources already existing in the company, access to new resources and skills sourced externally, internal innovation, collaborative innovation)

3.4 How much was this conversion process new to your organization for the "business as usual"? In particular, which new competencies did you have to develop?

3.5 To what extent was your company supported in doing so by its R&D and innovation competencies?

3.6 What are the organizational competencies that you deployed to do so?

3.7 Which of the newly developed competencies you think might be useful for your organization in the future (technological, production-related, organizational)?

3.8 Do you expect this reconverted production might be pursued in the future?

**4. Closing question**

4.1 Would you like to add something else that you feel important for exploring your company's adaptation to COVID-19 emergency?

Thanks

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## APPENDIX 2

## DETAILED LIST OF SECONDARY DATA SOURCES

Case	Type	Title/Description	Source
Ferrari	Press Article	COVID-19, il Cavallino della Ferrari sulle valvole dei respiratori	<a href="https://www.corriere.it/economia/aziende/20_aprile_17/covid-19-cavallino-ferrari-valvole-respiratori-0d5ef094-80ac-11ea-ac8a-0c2cb4ad9c17.shtml">https://www.corriere.it/economia/aziende/20_aprile_17/covid-19-cavallino-ferrari-valvole-respiratori-0d5ef094-80ac-11ea-ac8a-0c2cb4ad9c17.shtml</a>
	Press Article	Coronavirus: arriva F15, il ventilatore creato da Ferrari e Istituto Italiano di Tecnologia	<a href="https://www.gazzetta.it/Formule-1/13-05-2020/coronavirus-arriva-f15-ventilatore-creato-ferrari-istituto-italiano-tecnologia-370941034843.shtml">https://www.gazzetta.it/Formule-1/13-05-2020/coronavirus-arriva-f15-ventilatore-creato-ferrari-istituto-italiano-tecnologia-370941034843.shtml</a>
	Press Article	Ferrari e Istituto Italiano di Tecnologia contro il coronavirus: nasce il ventilatore polmonare F15	<a href="https://www.lastampa.it/motori/tecnologia/2020/05/13/news/ferrari-e-istituto-italiano-di-tecnologia-contro-il-coronavirus-nasce-il-ventilatore-polmonare-f15-1.38839589">https://www.lastampa.it/motori/tecnologia/2020/05/13/news/ferrari-e-istituto-italiano-di-tecnologia-contro-il-coronavirus-nasce-il-ventilatore-polmonare-f15-1.38839589</a>
	Press Article	Coronavirus, Ferrari e Marelli pronte ad aprire le fabbriche alla produzione di respiratori	<a href="https://www.ilsole24ore.com/art/ferrari-e-marelli-pronte-ad-aprire-fabbriche-produzione-respiratori-AD2YKHE?refresh_ce=1">https://www.ilsole24ore.com/art/ferrari-e-marelli-pronte-ad-aprire-fabbriche-produzione-respiratori-AD2YKHE?refresh_ce=1</a>
	Online Article	Harvard Business School – “Back on Track: What Leaders Can Learn from Ferrari’s Approach to the Pandemic”	<a href="https://www.hbs.edu/covid-19-business-impact/Topics/Leading-Through-a-Crisis/Back-on-Track-What-Leaders-Can-Learn-from-Ferrari-s-Approach-to-the-Pandemic">https://www.hbs.edu/covid-19-business-impact/Topics/Leading-Through-a-Crisis/Back-on-Track-What-Leaders-Can-Learn-from-Ferrari-s-Approach-to-the-Pandemic</a>
	Industry Magazine	La Ferrari e l’IIT presentano l’F15: il respiratore prodotto a maranello	<a href="https://www.formularace.it/la-ferrari-e-l-iit-presentano-l-f15-il-respiratore-prodotto-a-maranello/">https://www.formularace.it/la-ferrari-e-l-iit-presentano-l-f15-il-respiratore-prodotto-a-maranello/</a>
	Press Video (01:16)	La Ferrari si rimette in moto	<a href="https://www.raisport.rai.it/video/2020/05/motori-la-ferrari-si-rimette-in-moto-29546d05-b2c4-4e9b-a624-50fe722924dc.html">https://www.raisport.rai.it/video/2020/05/motori-la-ferrari-si-rimette-in-moto-29546d05-b2c4-4e9b-a624-50fe722924dc.html</a>
	Press Video (01:25)	Coronavirus/ Modello Ferrari	<a href="http://www.rai.it/dl/RaiTV/programmi/media/ContentItem-8c01e067-276b-49e7-9d76-c1e3fd47264d-tg1.html">http://www.rai.it/dl/RaiTV/programmi/media/ContentItem-8c01e067-276b-49e7-9d76-c1e3fd47264d-tg1.html</a>
	Press Video (02:25)	Ferrari, dalla velocità alle valvole per respiratori polmonari: il Cavallino contro il Coronavirus	<a href="https://video.repubblica.it/dossier/l-italia-riparte/ferrari-dalla-velocita-alle-valvole-per-respiratori-polmonari-il-cavallino-contro-il-coronavirus/358613/359169">https://video.repubblica.it/dossier/l-italia-riparte/ferrari-dalla-velocita-alle-valvole-per-respiratori-polmonari-il-cavallino-contro-il-coronavirus/358613/359169</a>
	Press Video (01:34)	La Ferrari riparte dai respiratori	<a href="https://www.raisport.rai.it/video/2020/03/ferrari-riparte-dagli-autorespiratori-cf2b47f2-e03a-4fb5-9112-24285010100c.html">https://www.raisport.rai.it/video/2020/03/ferrari-riparte-dagli-autorespiratori-cf2b47f2-e03a-4fb5-9112-24285010100c.html</a>
	Video (37:27)	Interview Senior Vice president HR Ferrari BBS Quarantalks	<a href="https://www.bbs.unibo.it/quarantalks/michele-antoniazzi/">https://www.bbs.unibo.it/quarantalks/michele-antoniazzi/</a>
	TV program (12:00)	Extract on Ferrari from “Report”	<a href="https://www.raiplay.it/video/2020/04/Report---Dio-Patria-Famiglia-Spa-850ab2dc-3f12-4aba-8d37-fd33547f30c69.html">https://www.raiplay.it/video/2020/04/Report---Dio-Patria-Famiglia-Spa-850ab2dc-3f12-4aba-8d37-fd33547f30c69.html</a>
Lamborghini	Press Article	Lamborghini ferma la fabbrica fino al 25 di marzo	<a href="https://www.ilsole24ore.com/art/lamborghini-ferma-fabbrica-tutti-ferie-ADKfivC">https://www.ilsole24ore.com/art/lamborghini-ferma-fabbrica-tutti-ferie-ADKfivC</a>
	Press Article	Coronavirus: Lamborghini avvia la produzione di mascherine e visite	<a href="https://www.ansa.it/canale_motori/notizie/attualita/2020/03/31/coronavirus-lamborghini-avvia-la-produzione-di-mascherine_75ab5db5-a233-4dda-69587-48ea574bac2c.html">https://www.ansa.it/canale_motori/notizie/attualita/2020/03/31/coronavirus-lamborghini-avvia-la-produzione-di-mascherine_75ab5db5-a233-4dda-69587-48ea574bac2c.html</a>
	Press Article	Coronavirus, Lamborghini avvia la produzione di mascherine a Sant’Agata	<a href="https://www.ilsole24ore.com/art/coronavirus-lamborghini-avvia-produzione-mascherine-sant-agata-ADTFmFH">https://www.ilsole24ore.com/art/coronavirus-lamborghini-avvia-produzione-mascherine-sant-agata-ADTFmFH</a>

Appendix 2. (Continued)

Case	Type	Title/Description	Source
	Online article	Lamborghini Means Passion For Life: Production Of Medical Masks And Face Shields Begins	<a href="https://www.forbes.com/sites/markewing/2020/03/31/lamborghini-means-passion-for-life-production-of-medical-masks-and-face-shields-begins/#4973a0b016b3">https://www.forbes.com/sites/markewing/2020/03/31/lamborghini-means-passion-for-life-production-of-medical-masks-and-face-shields-begins/#4973a0b016b3</a>
	Industry Magazine	Lamborghini Is Hand Stitching Masks and 3D Printing Face Shields	<a href="https://www.caranddriver.com/news/a32010210/lamborghini-masks-face-shields-coronavirus/">https://www.caranddriver.com/news/a32010210/lamborghini-masks-face-shields-coronavirus/</a>
	Industry Blog	Lamborghini Produces Face Masks, Shields For Healthcare Workers	<a href="https://www.motor1.com/news/407435/lamborghini-face-mask-shield-production/">https://www.motor1.com/news/407435/lamborghini-face-mask-shield-production/</a>
	Industry magazine and Video (05:02)	Dalle mascherine ai tester per respiratori, così a Sant'Agata si reagisce al lockdown	<a href="https://www.quattroruote.it/news/industria-finanza/2020/04/14/coronavirus_lamborghini_avviata_la_produzione_di_simulatori_polmonari.html">https://www.quattroruote.it/news/industria-finanza/2020/04/14/coronavirus_lamborghini_avviata_la_produzione_di_simulatori_polmonari.html</a>
	Online video (34:02)	Interview Chairman & CEO BBS Quarantalks Automobili Lamborghini	<a href="https://www.bbs.unibo.it/quarantalks/stefano-domenicali/">https://www.bbs.unibo.it/quarantalks/stefano-domenicali/</a>
	Online video (04:07)	Lamborghini Factory – masks and medical shields production for COVID-19	<a href="https://www.youtube.com/watch?v=YYLNbbIZJgs">https://www.youtube.com/watch?v=YYLNbbIZJgs</a>
	Online video (02:22)	Lamborghini production of surgical masks and medical shields for use in Coronavirus pandemic	<a href="https://www.youtube.com/watch?v=NQNse3JrGHw">https://www.youtube.com/watch?v=NQNse3JrGHw</a>
	Company website	COVID-19: Lamborghini is producing surgical masks and medical shields	<a href="https://www.lamborghini.com/es-en/noticias/covid-19-lamborghini-is-producing-surgical-masks-and-medical-shields">https://www.lamborghini.com/es-en/noticias/covid-19-lamborghini-is-producing-surgical-masks-and-medical-shields</a>
	Company website	Automobili Lamborghini's commitment to making lung simulators	<a href="https://www.lamborghini.com/en-en/news/automobili-lamborghini-commitment-to-making-lung-simulators">https://www.lamborghini.com/en-en/news/automobili-lamborghini-commitment-to-making-lung-simulators</a>
Dallara	Press Article	Coronavirus, con Dallara le maschere sub-respiratorie le stampi in 3D a casa	<a href="https://www.igcom24.mediaset.it/tgcomlab/focus/coronavirus-con-dallara-le-maschera-sub-respiratore-le-stampi-in-3d-a-casa_17020689-202002a.shtml">https://www.igcom24.mediaset.it/tgcomlab/focus/coronavirus-con-dallara-le-maschera-sub-respiratore-le-stampi-in-3d-a-casa_17020689-202002a.shtml</a>
	Press Article	La maschera da sub che diventa respiratore grazie al progetto Dallara e una stampante 3D	<a href="https://www.gazzetta.it/motori/la-mia-auto/06-04-2020/maschera-sub-che-diventa-respiratore-grazie-progetto-dallara-stampante-3d-37012875768.shtml?refresh_ce-cp">https://www.gazzetta.it/motori/la-mia-auto/06-04-2020/maschera-sub-che-diventa-respiratore-grazie-progetto-dallara-stampante-3d-37012875768.shtml?refresh_ce-cp</a>
	Press Article	Dalla start up di Bari nuova speranza per gli ospedali	<a href="https://www.ilsole24ore.com/art/dalla-start-up-bari-nuova-speranza-gli-ospedali-AD71cuF">https://www.ilsole24ore.com/art/dalla-start-up-bari-nuova-speranza-gli-ospedali-AD71cuF</a>
	Online article	Valvole e stampanti 3D La corsa delle aziende innovative per salvare gli ospedali	<a href="https://www.linkestia.it/2020/03/italia-coronavirus-valvole-stampanti-3d-ospedali/">https://www.linkestia.it/2020/03/italia-coronavirus-valvole-stampanti-3d-ospedali/</a>
	Online article	L'esperienza di Dallara, nella produzione di respiratori.	<a href="https://motorvalley.it/lesperienza-di-dallara-nella-produzione-di-respiratori/">https://motorvalley.it/lesperienza-di-dallara-nella-produzione-di-respiratori/</a>
	Industry Magazine	Dallara sceglie la strada delle ferie solidali	<a href="https://www.formulapassion.it/automoto/mondoauto/dallara-punta-sulle-ferie-solidali-coronavirus-produzione-487379.html">https://www.formulapassion.it/automoto/mondoauto/dallara-punta-sulle-ferie-solidali-coronavirus-produzione-487379.html</a>
	Industry magazine	Coronavirus Dallara: un progetto per stampare in 3D valvole per respiratori	<a href="https://www.quattroruote.it/news/industria-finanza/2020/04/06/coronavirus_dalla_dallara_un_progetto_per_stampare_in_3d_valvole_per_respiratori.html">https://www.quattroruote.it/news/industria-finanza/2020/04/06/coronavirus_dalla_dallara_un_progetto_per_stampare_in_3d_valvole_per_respiratori.html</a>
	Company Website	Lotta al COVID-19: l'Ospedale di Parma e la Dallara Automobili uniscono le forze	<a href="https://www.dallara.it/it/news/news/Lotta%20al%20Covid">https://www.dallara.it/it/news/news/Lotta%20al%20Covid</a>

Appendix 2. (Continued)

Case	Type	Title/Description	Source
SIOM Termoplast	Press Article	Azienda ferma, si mette a produrre mascherine da regalare	<a href="https://giornalenordest.it/azienda-produce-mascherine-da-regalare/">https://giornalenordest.it/azienda-produce-mascherine-da-regalare/</a>
	Press Article	Il dono dell'imprenditore fiumano: 20 mila mascherine riutilizzabili	<a href="https://www.ilgazzettino.it/pay/pordenone_pay/la_siom_avvia_la_produzione_di_20mila_mascherine-5153415.html">https://www.ilgazzettino.it/pay/pordenone_pay/la_siom_avvia_la_produzione_di_20mila_mascherine-5153415.html</a>
	Press Article	La Siom avvia la produzione di 20mila mascherine	<a href="https://messaggeroveneto.gelocal.it/udine/cronaca/2020/04/26/news/siom-dona-al-municipio-300-mascherine-speciali-1.38767227">https://messaggeroveneto.gelocal.it/udine/cronaca/2020/04/26/news/siom-dona-al-municipio-300-mascherine-speciali-1.38767227</a>
	Press Article	Siom dona al municipio 300 mascherine speciali	<a href="https://www.ilfruli.it/articolo/salute-e-benessere/termoplast-dona-mille-mascherine-al-comune-di-pordenone/12/218601">https://www.ilfruli.it/articolo/salute-e-benessere/termoplast-dona-mille-mascherine-al-comune-di-pordenone/12/218601</a>
	Press Article	Termoplast dona mille mascherine al Comune di Pordenone	<a href="https://www.comune.pordenone.it/it/comune/comunicazione/comune-informa/stampa/area-stampa/donate-mascherine-alla-polizia-locale">https://www.comune.pordenone.it/it/comune/comunicazione/comune-informa/stampa/area-stampa/donate-mascherine-alla-polizia-locale</a>
	Company social media channel	Facebook post	<a href="https://m.facebook.com/siomtermoplast/photos/a.1512769052378743/2564654737190164/?type=3&amp;source=57&amp;__tn__=EH-R">https://m.facebook.com/siomtermoplast/photos/a.1512769052378743/2564654737190164/?type=3&amp;source=57&amp;__tn__=EH-R</a>
	Local administration website	VALVASONI ARZENE (PN) – Atti amministrativi (Determine) – ACCETTAZIONE DONAZIONE DI N. 300 MASCHERINE SIOMITALIA DALLA DITTA SIOM TERMOPLAST SRL. IMMEDIATA ESEGUITA.	<a href="http://sac4.halleysac.it/ae00813/zf/index.php/atti-amministrativi/delibere/dettaglio/atto/GT0RFN9UBPT0-F/provvedimenti/1">http://sac4.halleysac.it/ae00813/zf/index.php/atti-amministrativi/delibere/dettaglio/atto/GT0RFN9UBPT0-F/provvedimenti/1</a>
	Local administration website	Comune di Sesto al Reghena – Atti amministrativi (Determine) – Impegno di spesa per pagamento IVA SPLYT per la fornitura di mascherine da parte della ditta SIOM Termoplast s.r.l. iume Veneto	<a href="https://www.comune.sesto-al-reghena.pn.it/c093043/zf/index.php/atti-amministrativi/determine/dettaglio/atto/GTVRRReEEIWT0-H">https://www.comune.sesto-al-reghena.pn.it/c093043/zf/index.php/atti-amministrativi/determine/dettaglio/atto/GTVRRReEEIWT0-H</a>
Grafica Veneta	Press Article	Grafica Veneta stampava Harry Potter: ora produce mascherine	<a href="https://www.ilsolo24ore.com/art/grafica-veneta-stampava-harry-potter-ora-produce-mascherine-ADuehGE">https://www.ilsolo24ore.com/art/grafica-veneta-stampava-harry-potter-ora-produce-mascherine-ADuehGE</a>
	Press Article	Imprese per l'emergenza: Grafica Veneta "stampa" mascherine (e ne dona 2 milioni)	<a href="https://barbaraganz.blog.ilsolo24ore.com/2020/03/18/impres-e-lemergenza-grafica-veneta-stampa-mascherine-ne-dona-2-milioni/">https://barbaraganz.blog.ilsolo24ore.com/2020/03/18/impres-e-lemergenza-grafica-veneta-stampa-mascherine-ne-dona-2-milioni/</a>
	Press Article	Coronavirus: Grafica Veneta converte la produzione e dona 2 milioni di mascherine	<a href="http://www.trevisotoday.it/cronaca/mascherine-grafica-veneta-coronavirus-2020.html">http://www.trevisotoday.it/cronaca/mascherine-grafica-veneta-coronavirus-2020.html</a>
	Press Article	Coronavirus, Grafica Veneta riconverte produzione: 1,5 milioni di mascherine al giorno "gratis alla popolazione"	<a href="https://www.ilfattoquotidiano.it/2020/03/18/coronavirus-grafica-veneta-riconverte-produzione-4-milioni-di-mascherine-al-giorno-gratis-alla-popolazione-e/5740755/">https://www.ilfattoquotidiano.it/2020/03/18/coronavirus-grafica-veneta-riconverte-produzione-4-milioni-di-mascherine-al-giorno-gratis-alla-popolazione-e/5740755/</a>
	Press Article	Coronavirus, lo stampatore di libri che dona mascherine: "Ho conosciuto la morte, non potevo sottrarmi"	<a href="https://www.repubblica.it/economia/2020/03/22/news/coronavirus_mascherine-252001308/">https://www.repubblica.it/economia/2020/03/22/news/coronavirus_mascherine-252001308/</a>

Appendix 2. (Continued)

Case	Type	Title/Description	Source
	Press Article	COVID-19 e le mascherine di Grafica Veneta	<a href="https://www.metaprintart.info/notizie-in-breve/37409-covid-19-e-le-mascherine-di-grafica-veneta/">https://www.metaprintart.info/notizie-in-breve/37409-covid-19-e-le-mascherine-di-grafica-veneta/</a>
	Press Article	Coronavirus, Grafica Veneta dona altri 2 milioni di mascherine	<a href="https://www.corriere.it/cronache/20_marzo_28/coronavirus-grafica-venet-a-dona-altri-2-milioni-mascherine-1fda3bc8-70f5-11ea-a7a2-3889c819a91b.shtml">https://www.corriere.it/cronache/20_marzo_28/coronavirus-grafica-venet-a-dona-altri-2-milioni-mascherine-1fda3bc8-70f5-11ea-a7a2-3889c819a91b.shtml</a>
	Press Article	«Certificate da laboratori»: le precisazioni di Grafica Veneta sulle mascherine filtranti prodotte	<a href="https://www.padovoaggi.it/attualita/coronavirus-precisazioni-mascherine-grafica-veneta-18-aprile-2020.html">https://www.padovoaggi.it/attualita/coronavirus-precisazioni-mascherine-grafica-veneta-18-aprile-2020.html</a>

All the secondary sources were screened for reliability. One of the authors performed the initial search for secondary data, but to avoid single-screener bias, two of the other authors participated in the screening and selection process to avoid improper selection (no discrepancies emerged among the authors in selecting the sources of data to include in the analysis).

Although the reliability was self-evident for most of the sources (national and local newspapers, news TV programs, official sites, official social media profile, public announcements, video-interviews of key people in the companies, famous industry magazines), all the records underwent a reliability check aimed at finding indicative content (e.g., featuring an interviewee, containing referenced information). It was not particularly difficult to discard most of the information coming from less affirmed sources, not really because of their reliability, but because of their content, as these articles were essentially restatements of what already found in the top news.