Silva, E., Beirão, G., & Torres, A. (2023). How Startups and Entrepreneurs Survived in Times of Pandemic Crisis: Implications and Challenges for Managing Uncertainty. *Journal of Small Business Strategy*, *33*(1), 84–97. https://doi.org/10.53703/001c.72084

articles

How Startups and Entrepreneurs Survived in Times of Pandemic Crisis: Implications and Challenges for Managing Uncertainty

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Keywords: Startups, entrepreneurship, business process, COVID-19, technology readiness, small business

https://doi.org/10.53703/001c.72084

Journal of Small Business Strategy

Vol. 33, Issue 1, 2023

The recent pandemic crisis has greatly impacted startups, and some changes are expected to be long-lasting. Small businesses usually have fewer resources and are more vulnerable to losing customers and investors, especially during crises. This study investigates how startups' business processes were affected and how entrepreneurs managed this sudden change brought by the COVID-19 outbreak. Data were analyzed using qualitative research methods through in-depth interviews with the co-founders of eighteen startups. Results show that the three core business processes affected by the COVID-19 crisis were marketing and sales, logistics and operations, and organizational support. The way to succeed is to be flexible, agile, and adaptable, with technological knowledge focusing on digital channels to find novel opportunities and innovate. Additionally, resilience, self-improvement, education, technology readiness and adoption, close relationship with customers and other stakeholders, and incubation experience seem to shield startups against pandemic crisis outbreaks.

Introduction

The coronavirus (COVID-19) outbreak profoundly affected individuals, institutions, societies, and nations worldwide (Pak et al., 2020). Several businesses were adversely affected, with many failing to survive the economic challenges posed by the COVID-19 pandemic (Vasiljeva et al., 2020). However, others were able to identify and exploit the emerging opportunities in the turbulent environment and obtain positive financial impacts (Reed, 2022).

The pandemic crisis is especially threatening for small businesses and startups because they have fewer resources, usually have more difficulties maintaining their businesses running, and are more vulnerable to losing customers and investors (Vinberg & Danielsson, 2021). Therefore, the changes in the market significantly affect startups and might even imply a change in their business models (Salamzadeh & Dana, 2021). During the pandemic, startups experienced several difficulties, namely failures in the supply chain (Reuschke et al., 2021; Vorobeva & Dana, 2021) and hiring skilled human resources (Pereira et al., 2021; Shahul Hameed et al., 2022). Despite rapidly emerging forms of online work, several organizations reported significant losses leading to downsizing and other ways to cut costs (Khan et al., 2021).

Hence, this global crisis profoundly affects small businesses and startups (Eggers, 2020; Liguori & Pittz, 2020). However, entrepreneurs usually face many challenges in an uncertain and complex environment to survive and gain a competitive advantage (Breivik-Meyer et al., 2020; Pereira et al., 2021). The surviving ones had to find and quickly implement innovative business processes. Thus, it is very likely that this pandemic will make these firms rethink their business processes. For example, undertaking business process reengineering (BPR) activities (Shahul Hameed et al., 2022) or redesigning and moving their supply chains closer to where they are needed (Reuschke et al., 2021). Also, companies had to embrace digital technologies to keep connected to customers worldwide, do virtual recruit-

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ment, training, and engage in online socialization (Donthu & Gustafsson, 2020; Ivanov, 2020).

Thus, this study explores how entrepreneurs and startups faced and managed this sudden change brought by the COVID-19 crisis. Specifically, this paper aims to understand how startups' business processes were affected and how entrepreneurs adapted and coped with the pandemic crisis. The paper contributes by bringing new insights into how businesses and organizations can overcome difficulties in times of crisis. Therefore, we address the following research questions: What were the positive and negative impacts on the startups' business processes during the COVID-19 pandemic? How did entrepreneurs manage this sudden change brought by COVID-19? How can entrepreneurs' surviving lessons be a benchmark for other businesses to overcome problems and better prepare for uncertainty and future crises?

Although prior research has investigated related issues, many questions remain. Our paper contributes by expanding existing knowledge of the COVID-19 pandemic's relevant impacts, both positive and negative, on startups. Additionally, we explain how entrepreneurs can cope with this crisis. We also propose a research agenda for strategic managers on how organizations can be more prepared to overcome future crises.

The remainder of this article is structured as follows: in the next section, we review relevant research on entrepreneurs' capabilities and the impact of the COVID-19 pandemic on business. Then, we present the qualitative research methodology using in-depth interviews with eighteen startup co-founders from different industries. Next, we present the findings of our empirical work. We conclude by discussing our contributions and the implications of the impacts of the COVID-19 pandemic on startups and entrepreneurs. Finally, we present some limitations of the study and future research directions.

Literature review

Startups are temporary organizations that search for scalable, repeatable, and profitable business models (Salamzadeh & Kawamorita, 2015; Salamzadeh & Kirby, 2017). Research showed that small businesses with fewer resources usually have more difficulty keeping their business running and are more vulnerable to losing customers and investors (Breivik-Meyer et al., 2020; Pereira et al., 2021; Vinberg & Danielsson, 2021). During their lifecycle, the main challenges of startups are financial and bureaucracy issues (Ferreira et al., 2017; Mayr et al., 2021; Pareras, 2021), followed by their lack of ability to find a marketable opportunity (Fini et al., 2020), problems related to human capital (Bendickson et al., 2017), and a lack of crisis management skills, as startups' teams generally have lower levels of experience which makes crisis management even harder (Salamzadeh & Dana, 2021). Thus, these constraints faced by startups emphasize the many challenges they have to cope with in an uncertain and complex environment trying to survive the pandemic crisis and achieve a competitive advantage.

Challenges faced by businesses during the COVID-19 pandemic

The COVID-19 crisis has affected the future of all organizations, namely the existing supply chain for some markets, and questioned traditional business models (Humphries et al., 2020; Reuschke et al., 2021; Salamzadeh & Dana, 2021). The cause of these issues was mainly the global lockdown situation (Van Looy, 2021).

The pandemic is also a threat to small businesses, as they are put at risk when a crisis threatens the market, mainly due to a lack of demand. As they understood it, the market changed completely, potentially leading to a need to change small business market penetration strategies (Salamzadeh & Dana, 2021; Vinberg & Danielsson, 2021).

Resource availability and liquidity problems worsen the situation (Eggers, 2020; Guerrero et al., 2021; Liguori & Pittz, 2020). The capital market is highly volatile due to the pandemic, as such, funding is more unstable, as many investors are more cautious now and have become risk-averse (Eggers, 2020; Salamzadeh & Dana, 2021). Also, other financial problems like lower budgets, decreasing orders, and cash flow management makes it harder for startups to survive during this crisis (Kuckertz et al., 2020; Salamzadeh & Dana, 2021).

The management of human resources also remains challenging for startups since it is more difficult to hire talented and skilled people during the pandemic (Pereira et al., 2021; Shahul Hameed et al., 2022). The COVID-19 pandemic also brought profound negative emotional distress and social impacts (Cullen et al., 2020). The lockdown policies and quarantine generate multiple psychological effects, such as anxiety, depression, or burnout (Cullen et al., 2020). Research has found that the fear of unemployment and economic crisis can impact mental health, leading to stress, depression, and anxiety (Khan et al., 2021; Reuschke et al., 2021).

However, during the COVID-19 crisis, while some businesses were struggling, others, such as internet-based businesses (e.g., e-commerce, online entertainment, food delivery, and solutions for remote work), were able to grow as the demand increased as everyone had to stay at home during the lockdown and quarantine period (Donthu & Gustafsson, 2020). This situation has also generated opportunities for small businesses to explore new working processes, offerings, and supply sources (Kang et al., 2021; Kuckertz et al., 2020; Reuschke et al., 2021; Vinberg & Danielsson, 2021).

Innovation opportunities and new business paradigms

Entrepreneurs faced many challenges during the COVID-19 pandemic in different ways. While some chose to end their business activities, others postponed their business goals or compensated for their losses with harder work and adaptation to the changing environment (Vorobeva & Dana, 2021). In this context, innovation can have a vital role in the economic recovery process after the COVID-19

outbreak. Usually, innovating is considered burdensome and expensive, and less costly solutions are often considered (Chesbrough, 2020). However, in a pandemic situation, time is critical, and getting a solution sooner to the market is more important than the cost (Nurhayati et al., 2021).

The market complexity drives the need to fully understand how innovations coming from the frontiers of science should be exploited and commercialized (Fini et al., 2019, 2020). Collaboration between organizations such as university-industry, academic entrepreneurship, and technology-commercialization activities are being studied to understand how science can be effectively commercialized (Fini et al., 2019, 2020). Hence, fostering more openness in science and technology is important since solutions to complex problems often come from non-conventional sources, for example, user innovation (Nurhayati et al., 2021). Open innovation aims to propose new ideas, reduce risks, and speed up the innovation process needed in times of crisis (Davoudi et al., 2018; Teplov et al., 2019). That is, open innovation is a source of competitive advantage, and for many industries, it has become a source of survival in the current crisis, as it can help accelerate the entire process and foster the integration of new ideas to face competition and improve performance (Chesbrough, 2020; Khan et al., 2021).

Even though open innovation has gained interest in research, small and medium-sized enterprises (SMEs) still need research to investigate how the different industries engage in open innovation and the role internal and external sources have in developing new products and services (Santoro et al., 2018). It is important to understand whether and how adopting open-source innovation in startups increases product lunch, thus fostering market entry, highlighting the business paradigm shift: from the producer of the innovation to the user and open, collaborative innovation (Ahn et al., 2015; Santoro et al., 2018).

The pandemic changed and expanded the use of digital technologies across businesses, entrepreneurship, and local economies. Remote working and teleconference enable companies to be more agile and hire employees globally. It allows a shift from high-cost ecosystems to smaller hubs without losing talented people (Reuschke et al., 2021; Van Looy, 2021). The acceleration of the digitization process can increase the companies' effectiveness, market penetration, and the introduction of new services and innovations through digital channels. In this context, organizations with better IT capabilities can be faster and perform better in the process of digital transformation (Nurhayati et al., 2021; Rashid & Ratten, 2021; Shahul Hameed et al., 2022; Ting et al., 2020). In the end, maintaining the strength of mind and endurance that motivates entrepreneurs and adopting a mindset of opportunity pursuit is now more important than ever (Eggers, 2020; Rashid & Ratten, 2021).

Entrepreneurs' characteristics in times of uncertainty

Today's entrepreneurs are mostly younger and highly educated, with a background in sciences or engineering (Ferreira et al., 2017; Gundolf et al., 2017; Noroeste Empreendedor em Números, 2018). The best business and engineering schools are a great source of academic entrepreneurship, with the potential to foster high-impact research to uplift lives by producing knowledge that improves entrepreneurs' results (Eckhardt & Wetherbe, 2016).

In this scenario, incubators can function as a connecter between the community and the industry, enhancing the generation of novel ideas, inspiration, professional support, resilience, and financing sources much needed in times of crisis (Guerrero et al., 2021; Liguori & Pittz, 2020). Incubators are organizations aiming to afford new firms a supportive environment in the initial stages of development so that they can gather the necessary resources and capabilities for development and growth until reaching a viable stage (Breivik-Meyer et al., 2020; Clayton et al., 2018).

Although being integrated into an incubator is very important, the critical success factor for startups is to research and understand customers' needs and desires (Liguori & Pittz, 2020; Rashid & Ratten, 2021; Vaccaro et al., 2020). Small firms may have a competitive advantage if they find and exploit the opportunities created by technological uncertainty during the pandemic. In this context, those who use this uncertain time to connect with the customers and employees, develop stronger community ties, improve their skills, and innovate will overcome the pandemic effects and emerge stronger (Davoudi et al., 2018; Drnevich & West, 2021; Teplov et al., 2019). However, entrepreneurs need to have certain characteristics, such as: being proactive, risk-taking, and innovative (Gundolf et al., 2017; Rashid & Ratten, 2021; Shahul Hameed et al., 2022). Importantly to face and overcome crises, an entrepreneur must believe in their skills, be resilient, identify environmental changes, and seize opportunities timely (Bullough & Renko, 2013; Leonelli et al., 2019; Rashid & Ratten, 2021).

Methodology

The method chosen to address the research questions was motivated by the need to deepen the understanding of the impacts of the COVID-19 pandemic on startups' business processes and how they deal with it. Thus, a case study approach using qualitative methods was chosen since it enables an in-depth understanding of a phenomenon and its context (Dubois & Gadde, 2002). Qualitative analysis is a suitable method for exploratory studies in entrepreneurship, as it is appropriate to comprehend the entrepreneur's actions and relationships with the environment (Dana & Dana, 2005). Data were collected using semi-structured in-depth interviews with startup co-founders. In-depth interviews have the advantage of providing a deeper meaning to the data collected (Adhabi & Anozie, 2017) and were considered appropriate to address the research questions.

Sample criteria and selection

In qualitative research, selecting participants follows a theoretical sampling procedure to maximize the possibility of finding variations within the population (Eisenhardt, 1989). We purposely selected from two startup incubators

Table 1. Sample characteristics (n = 18)

Category		Number
Firm Industry	Electrical systems devices	2
	Medical devices	1
	Tracking devices	1
	Biotechnology	1
	Textile	1
	Financial Service	1
	Information Technology (IT) consulting	5
	Cleaning Service	1
	IOT solutions	1
	Agricultural solutions	1
	Transportation and mobility solutions	1
	Smart building solutions	1
	Water networks solutions	1
Firm establishment period	up to 2 years	4
	3 to 6 years	10
	7 to 12 years	4
Programs participated[a]	Incubation	16
	University spin-off	8
	Acceleration	6
Firm Size	Up to 5 employees	5
	6 to 22 employees	11
	40 to 180 employees	2
Sales Amount per year in Euros	Less than 40k	2
	200k to 300k	4
	1M to 2M	4
	Not answered	8

[a] Some startups participated in more than one program, as such, the sum is more than 18.

Table 2. General characteristics of the co-founders (n = 18)

Category		Number
Gender	Male	16
	Female	2
Number of co-founders	1	3
	2 -3	10
	4 -5	5
Co-founders background	Engineering	9
	Engineering and design	2
	Engineering and management	3
	Management	2
	Science – Biotechnology	1
	International Relations	1
Education Level	Bachelor's degree	3
	Master's degree	11
	Doctoral degree	4

eighteen entrepreneurs that have co-founded startups. The sample covers startups in different sectors and maturity stages to ensure a rich diversity of perspectives. A sample with only startups nested in business incubators can limit the results, but it serves the research aims to explore in-depth startups within its context. The names of the interviewees and startups are excluded from this study due to confidentiality agreements. Table 1 shows the characteristics of the eighteen startups selected, and Table 2 shows relevant information about the co-founders.

Data Collection and analysis

The qualitative study involved semi-structured in-depth interviews. Due to the COVID-19 pandemic, data collection was done online via Google meets platform from April to May 2021. The interview protocol focused on the startup's background and characteristics, the COVID-19 impacts on the business process, and the company's expected future. The eighteen semi-structured interviews lasted, on average 27 minutes. The recordings were verbatim transcribed, and data were analyzed using the qualitative data analysis software NVIVO. The study applies an abductive logic combining inductive and deductive research, which enables an iterative dialogue between theory and empirical data (Dubois & Gadde, 2002). The analysis of the interviews started with breaking down the data into smaller units and attributing codes to them based on the research questions (Saldaña, 2021). By iteratively analyzing each interview and comparing concepts, common patterns gradually emerged, enabling to reshape the initial codes into more abstract, conceptual categories, as shown in Figure 1. After that, data were organized from the particular categories that emerged from the interviews (codes) and extant literature to enable the findings to be structured into comprehensive categories (Reay et al., 2019; Tracy, 2019).

Findings

Data revealed the most relevant positive and negative impacts of the COVID-19 pandemic on startups and the entrepreneur's response to the pandemic crisis. This study focuses on the business process that the respondents mentioned as most exposed to the effects of the COVID-19 outbreak: marketing and sales, logistics and operations, and organizational support. Marketing and sales refer to the activities related to providing the means whereby consumers or users are informed of the product or service and induced to purchase it (Porter, 1998). Operations include the activities associated with transforming the inputs into the final product or service (Porter, 1998). Organizational support includes the activities supporting the other business process, such as general and strategic management, financing, legal, and resource management.

While other startups' processes may also have endured some impacts, they may be less impactful for startups nested in incubators.

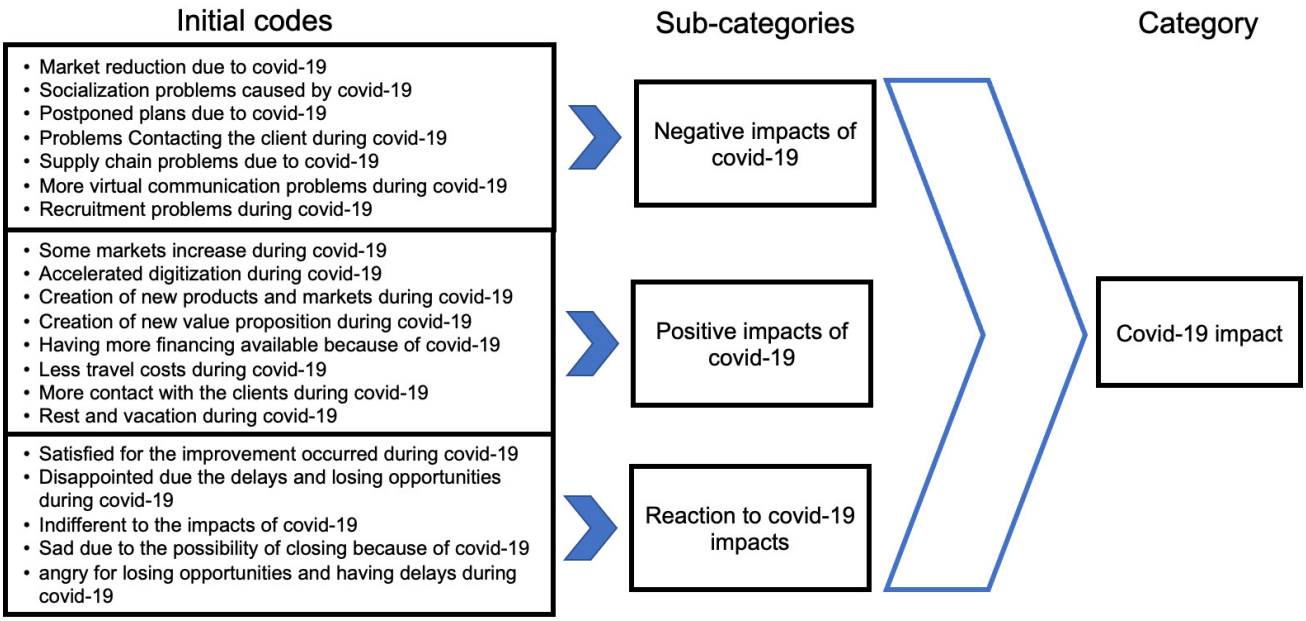

Figure 1. Example of the categorization process

Positive and negative impacts of COVID-19 pandemic on startups' business processes

The three core business processes most affected by the COVID-19 outbreak were: marketing and sales, logistics and operations, and organizational support.

Marketing and sales

Study participants indicated that the COVID-19 pandemic's impacts on marketing and sales processes are mostly related to difficulties in communicating with customers due to travel restrictions that forced contacts to become virtual instead of physical. Talking with customers or potential customers online can damage business since communication is more distant and more difficult to engage and create a closer relationship, as expressed in the following statement:

> The biggest problem is how to communicate with customers [...]. It is challenging to adapt and transmit what we want to customers with different cultures, and even internal communication [is complicated]. (male, IT consulting).

On the contrary, other businesses took advantage of the easiness of scheduling online meetings to contact new customers across the globe. Furthermore, the pandemic changed the business environment worldwide, and startups saw it as an opportunity to change and create new products, services, and novel value propositions adapted to the COVID-19 pandemic. Table 3 shows examples of the impacts (positive or negative) on marketing and sales processes during the COVID-19 outbreak.

The results also show that attracting and maintaining clients is critical, that is, providing good service quality, getting referrals, making a commitment and building trust and credibility with customers, and offering an attractive price for clients. A major negative impact of being an unknown brand is customers' mistrust of startup capacity and survival, as shown in the following quote:

> Our clients [...] do not easily trust [...] a small startup. They do not know if we will be here next year. So, there is previous work to ensure credibility and commitment to get their trust, which is critical in this area. (male, IT consulting);

Marketing research is essential to acquire enough market knowledge that is necessary to understand customers' needs, the best timing for launching, and the offering market fit, as shown in the following examples:

> One success factor is to have well-defined target market profiles. Define the personas we have and whom we want to sell to. [...] See if we can adapt to what the market asks. (male, IT consulting)
> One of the main difficulties is that we often know the need will exist, but we are sooner than [the actual need], and the customers have difficulty absorbing [this new solution]. (male, IOT solutions)

Operations process

Several co-founders indicated that the COVID-19 pandemic impacts on operations processes are related to supply chain problems during the crisis. For example, some startups had delays from suppliers, increasing prices that led to a lack of stock and equipment production issues, which originated delays in delivering the products. Also, problems appeared from difficulties in planning resources and accurately estimating demand due to the instability. Furthermore, some innovation and technological plans had to be postponed. On the positive side, financial aid from governmental programs and technological developments enabled accelerating digitization and pushing innovation.

Table 3. Examples of covid-19 impacts on marketing and sales processes

Positive Impacts	Negative Impacts
Creation of new products, services, and novel value propositions 'It allowed us to focus on other faster and more agile industries, and we were able to bring software to market faster.' (male, IOT solutions) 'We had to launch a new product [during the covid-19 crisis]' (male, textile industry) 'The [covid-19 crisis] created the need to use systems or software that make buildings more flexible and urgently overcome this challenge of managing fluctuating occupancy.' (female, smart building solutions) **Increased virtual contact with clients** 'People accepted more meetings with us for commercial actions or the virtual presentation or realization of our products.' (male, IT consulting)	**Difficulties in contacting the client physically** 'Anything involving commercial travel and presentation was completely suspended. [...] We attended these conferences and did some online presentations, but [...] We did not get the same feedback we would get at a conference and a physical encounter.' (male, medical devices) **Problems in virtual communications** 'The facial expression, the body expression disappeared with COVID.' (male, IT consulting)

Table 4. Examples of covid-19 impacts on operations processes

Positive Impacts	Negative Impacts
More funding available 'Last year, during the pandemic, we had support from the state, a program we applied called Covid-19 productive innovation.' (male, cleaning outsourcing) 'This financing program we ended up winning was what allowed us to start. It was funding developed exactly to help startups in the context of Covid.' (female, biotechnology) **Accelerated digitization** 'I have noticed that there has been a huge boom in IT. Because of Covid, digitization has accelerated a lot.' (male, IT consulting) **More time to innovate** 'During the March-April confinement, I could rest my head, as we had been running for one year, unable to breathe, I could put some ideas on paper that were only in my head.' (male, textile)	**Difficulties in demand estimation** 'The first sales are critical for a startup, and no one predicted that there will be a pandemic that takes off 70 percent of the market' (male, transportation and mobility solutions) 'The proof of this is that with an event like Covid, we had customers who had products that depended on physical contact that disappeared completely, and [...] we also had customers who increased a lot, and we ended up increasing the team.' (male, IT consulting) **Supply chain problems** 'For one month, the factory was closed [...] Customers ended up understanding at the time that there was no chance of delivering [the product] and that it was a global health issue.' (male, textile) 'The prices of our components and delivery times have increased, which leads us to constraints regarding having stock and production of our equipment.' (male, tracking devices) **Postponed plans** 'The pandemic has delayed the automobile industry's programs in developing and introducing new technologies.' (male, IOT solution) '[The problem] is decisions standby. In other words, we had clients who were about to decide to move forward and restricted investments due to uncertainty about the future. [...] Therefore, the impact was not so much a direct reduction in sales or customers. It was the delay in these customers' decision process.' (male, agricultural solution)

Table 4 shows some positive and negative impacts on logistics and operation processes.

The results showed that some companies focused on reducing costs, which is especially relevant in a crisis. Thus, some sectors, for example, those focusing on automobile innovation, suffered more during the COVID-19 crisis because their clients were cutting costs and stopped investing in new projects. One of the founders said:

> All innovation projects [...] were the last priority. [...] it was difficult for us to convince them to test our product when they did not have a budget to idealize this type of project.' (male, tracking devices).

Respondents also identified issues that usually affect startups' operations processes, namely: resources (e.g., having or not having enough resources), scalability skills (e.g., the ability to replicate the product or service at a large scale), and technological development (being part of an incubator or spin-off that can deliver value and technology for the startup through partnerships with universities, and patents and intellectual protection). The following testimonials show the importance of accessing resources for startups:

> Money is the most critical resource because money allows you to capture talent and ability. (male, transportation and mobility solutions).
> We have a technological research challenge. We have to adopt unfamiliar technologies on a large scale. (male, IT consulting).

Table 5. Examples of covid-19 impacts on organizational support processes

Positive Impacts	Negative Impacts
Able to work remotely 'We work with technology. So, we do not require everyone to be in the same physical space. That is, what we do can be perfectly done remotely.' (male, IT consulting) With the COVID-19 pandemic, companies realized that they had to work remotely, and [...] it no longer makes sense to hire in your geographic area, which means that companies in North America and Central Europe started looking at [us] as a good talent base at a lower price.' (male, IT consulting)	**Not able to work remotely** We have five employees, [...] and we need to test the hardware and use the material we have here at the company. There was a part that could not be done remotely.' (male, tracking devices) **Recruitment difficulties** 'At the moment, it is very difficult to hire' (male, IT consulting)
Better time and resources usage 'We used to make a lot of trips [...] that was now greatly minimized, [...] and we managed to have the same efficiency level.' (male, IT consulting) 'During the confinement, [...] I could rest, [...] I could put some ideas on paper.' (male, textile)	**Socialization problems** 'Therefore, the impact that we had was socializing. We have a unique culture, very familiar. We are very close. [...] The COVID-19 pandemic ended it. All socialization died.' (male, IT consulting)

> Intellectual property is critical because we cannot move forward without it. (female, biotechnology)

Organizational support

During the COVID-19 pandemic, several organizational support processes related to general management, planning, finance, resource management, and work organization suffered impacts. The pandemic deepened the usual weaknesses of startups regarding organizational support, including lacking the necessary management skills to define strategic directions, deal with bureaucracy issues, and manage human resources. In addition, the geographic location of small startups constrains market growth and access to resources, such as government financial support and human resources. The following quotes highlight this issue.

> It is not the same as being a Startup [here] or a startup in Silicon Valley. They are more developed, have mature markets, have higher purchasing power, and have higher investment. Therefore, geography is an important aspect. (male, transportation and mobility solutions)
>
> It is critical to have access to talent having people available at a much more competitive price. (male, financial service)

Also, difficulties with human resource management (e.g., recruitment difficulties during this period), socialization, and cultural problems appeared during the lockdowns. The impacts differ among startups. Most of them, because they are small companies and rely mostly on information technology to develop their work, were not too affected by the changes in work organization caused by the lockdown. Also, some respondents stated that, although isolation was a problem, they used the time to rest and were more productive due to a fresh mind. Others refer to a more efficient use of time and resources. Table 5 shows some positive and negative impacts on the organizational support process.

Startups' response to the pandemic crisis

Results showed that startups co-founder reactions to the COVID-19 pandemic impacts ranged from satisfaction to anger and frustration. In contrast, some showed satisfaction with the improvement of the startup during the crisis, and others showed indifference if the impacts were negligible. Others felt disappointment or anger due to delays, lost opportunities, and even sadness by facing the risk of closing the startup.

Startups showing positive impacts from the COVID-19 pandemic were mostly from the Information Technology (IT) consulting industry and had at least 3 to 6 years of incubation. The ones with more negative impacts were from sectors like transportation and mobility, medical devices, and tracking devices. Drawing on insights from the co-founders' responses, Table 6 summarizes five major factors that can help overcome a crisis. The factors are resilience, self-improvement and education, flexibility and innovation, close relationship with customers and other stakeholders, and incubation experience.

Resilience

Entrepreneurs must be resilient to maintain and be successful in their businesses. Resilient entrepreneurs usually have a higher-level degree in engineering and science (see table 2) and the know-how to multitask and never stop until reaching their goal. Also, they need to be able to use a trial-and-error method until achieving a solution that creates value for customers. This whole process is cyclical and iterative: receiving feedback, trying to improve, and doing it again and again, requiring several interactions with different customers and, therefore, high resilience, given the constraints imposed by the pandemic crisis (e.g., difficulties in visiting the customers' plants physically, constraints in the value chain).

Self-improvement and education

As small companies struggle for resources, the multitasking capabilities of entrepreneurs are a strong advan-

Table 6. Insights on how to overcome the pandemic crisis through entrepreneurship

Factors	Quotes
Resilience	'We get over all these challenges related to customer value creation with the trial-and-error method. In other words, we talk to the customer, understand, learn, change things, make proofs of concept […] This whole process is cyclical: receiving feedback, trying to improve, and doing it again' (male, tracking devices) 'So, I would say it is a lot of resilience to talk to one client and another. We have to understand where the technology is going. Who are the suppliers? How are we going to create value along the value chain? These are small, not very linear steps (male, Electrical systems devices)
Self-Improvement and Education	'We are very focused on the technical part, and not always the technical component is everything for the organization. There are other skills needed, so we try to combine and complement our skills and look for additional ones. For example, I have already done management training.' (male, IT consulting) 'We often choose people from areas with a good foundation in mathematics, such as mechanical engineering. And convert these people to programming[...] As there are no courses, we have to reinvent ourselves and manage to solve this.' (male, IT consulting)
Flexibility and Innovation	'We show the client the software solution, but we build the hardware, firmware, the cloud, everything. The adaptability and dynamism that we have to provide the solution to the customer […] is something that the customers like a lot.' (male, tracking devices) 'This sector is much more agile with a strong will to innovate [...]. One way in which we managed to mitigate this challenge was through our architecture, our solution, which is much more agile and flexible.' (female, smart building solutions)
Close relationship with customers and other stakeholders	'We have a great partnership with customers, and we constantly listen to them to improve our platform and give more value to the customer.' (male, tracking devices) 'We try to provide as much support as possible to help potential customers work through bureaucracies.' (male, medical devices) 'We overcame the challenges basically by working on brand awareness in terms of communication, staying active in colleges, using the talents we have access to, and having a very large network.' (male, IT consulting) 'Partnerships with car companies to gain access to customers, which accelerates our entry into this market. It also helps to accelerate the sales cycle.' (male, IOT solution) 'We refer clients to companies that work in the same area, but in more specific and technical aspects, and they later identify an opportunity in business development and refer other clients to us' (male, financial services)
Incubation experience	'It helps a lot to talk to other entrepreneurs […]. It is a way of solving the problems, talking with companies already in the market and who have gone through the same experience as you.' (male, electrical systems devices) 'Partnerships with universities and co-financed projects allowed us to accelerate.' (male, medical devices) The incubation helped a lot because it helped us structure the project, the targets, the goals, whom we should ask for investments, and how much we should ask. They were the ones who helped us apply our project for a startup financing program, and we won [the financing]. (female, biotechnology)

tage. Hence, self-improvement and higher education are very important skills of the co-founders to understand the strengths and weaknesses to overcome the problems. Results also show that coaching and training in fields where participants need to improve or acquire other skills are mandatory.

Flexibility and innovation

Several co-founders claim that to succeed in these uncertain times requires flexibility, agility, and adaptability to find and pursue a new opportunity. Results show that most of the startups in this study are from the IT service industry sector (e.g., technological services, see table 1) using digital channels for their business operations. Therefore, they have the necessary technological knowledge to develop innovative and agile solutions, focusing on customers' unique needs dived by crisis and quickly adapting to digital channels to manage the relationship with their customers fully.

Results also demonstrate that flexibility and innovation, related to other business processes, will help create a market proxy, which is difficult and costly to attract, fostering company sales. Networking from past events and conferences to advertise their service and product benefits a starting company with no or minor visibility. Also, using trials and pilot strategies to test technology facilitates sales and increases customer reliability. One of the co-founders said:

> We are regularly testing our products with partners and customers. It is also part of our sales process to do trial and customer testing; we constantly try to demonstrate our product with pilots and trials to the customer. We are always in the process of gathering feedback and adapting based on that. (male, IOT solutions)

Close relationship with customers and other stakeholders

A close relationship with stakeholders is essential to succeed. Most co-founders identified clients and investors as the main stakeholders, followed by partners and suppliers, employees, universities, and the government.

As shown above, startups need flexibility and innovation capabilities to be successful in developing brand awareness; understanding, persuading, and supporting customers; launching additional services to maintain customer relationships; maintaining close partnerships and establishing new ones; and fostering good relationships among employees and other stakeholders, as exemplified in the quotes:

> Nowadays, to get customers to buy and enjoy our service, we have to persuade them. We can only convince them if we have a truly innovative product or service that can create value. Our product has to generate value for the customer and us. If it does not create value for the customer, it is not salvable, and if it does not create value for us, it will not be sustainable. So, I would say that this is the most important. (male, tracking devices)
> It is important mainly price and commercial arguments [that attract the customers] [...] And convince the customer that the product works. The product must work to retain that customer. (male, electrical systems devices)

Incubation experience

Some of the co-founders explained that being incubated was an essential factor for success, especially in a pandemic time, as the incubation could somehow protect them and help them with opportunities in terms of clients and financing, as well as increase the network that could generate tips from other startups which had gone through similar problems.

Most co-founders reported no previous business experience, although they participated in (at least one or more) incubation, University spin-off, and acceleration programs (see table 1), which shows the support received from the community (e.g., incubator members) that can help young startups. For example, helping project strategies to enter the market and create investment plans and finance programs. This support is even more valuable during a crisis like the pandemic. It helps to face the many challenges involved by providing a space for cooperation, sharing experiences and socialization, and coping with entrepreneurs' loneliness that impacts their mental health and well-being.

> It has been UPTEC [incubator] that has given strong support here. Our first customer and another customer that we will have in two weeks will be due to UPTEC contacts. (female, smart building solutions)

Discussion and implications

The COVID-19 pandemic led to tremendous challenges for startups and entrepreneurs. This research aimed to identify and characterize the impacts on business processes and operations of startups and their market challenges to overcome the crisis driven by the pandemic's early stages.

Regarding the negative impacts, the results show a decrease in several market sales, difficulties in attaining fuller customer support from physical assistance at customer plants; constraints in controlling logistics and disruptions affecting the existing supply chain for several industries worldwide; troubles in maintaining operations pushing startups to postpone contracts negotiations or close their business, and lack of organizational support to deal with bureaucratic issues and limitations to hiring skilled people caused by the lockdown.

These results are in line with recent studies reporting that some companies were mostly affected by sales decreasing in some markets and could not handle the market change (Donthu & Gustafsson, 2020; Salamzadeh & Dana, 2021; Vinberg & Danielsson, 2021). Also, startups had to overcome other challenges like difficulties in logistics and operations processes, as the COVID-19 pandemic has dramatically affected the existing supply chain for several industries worldwide (Reuschke et al., 2021; Salamzadeh & Dana, 2021), constraining resources planning and demand estimation due to uncertainty and instability of market contingencies (Donthu & Gustafsson, 2020). Additionally, the effects of the COVID-19 outbreak and the policies of lockdown and quarantine generated many psychological impacts, which seem to affect socialization (Cullen et al., 2020) and difficulties in hiring talent in this moment of crisis (Pereira et al., 2021; Shahul Hameed et al., 2022). However, this crisis has also generated opportunities for startups to exploit new products, markets, and customer value propositions (Kuckertz et al., 2020; Reuschke et al., 2021).

The positive effects are mainly driven by challenges that startups have to cope with to survive and manage the sudden market change with fewer resources. Startups' survival was more challenging due to financial issues (Eggers, 2020; Salamzadeh & Dana, 2021) and for some startups, financial aid from governmental programs was critical to accelerate digitization and foster innovation. Companies that innovate and invest in the digitization process seem to overcome the pandemic easier (Drnevich & West, 2021; Khan et al., 2021; Nurhayati et al., 2021).

Startups showing positive impacts from the COVID-19 pandemic were mainly from the IT consulting industry. Most of them were already involved in the digitalization journey, which made them increase their sales during this period. Moreover, some startups already used digital channels to communicate before the COVID-19 pandemic. Also, the government's financial aid and help from incubators benefited the startups, which might explain why some did not feel the pandemic's negative impact so highly.

Results also show that some co-founders felt disappointment or anger due to delays and lost opportunities during this period and sadness due to the possibility of closing the startup. Others handled the pandemic with determination and resilience to exploit the opportunities that arose during this moment. For that, close relationships with the customers, self-improvement/education, flexibility, and innovation were essential to survive the COVID-19 outbreak.

This study's findings underscore the relevance of startups' response to the pandemic crisis facilitated by technology-intensive adoption, highlighting an essential conclusion of this study. That is, technology-based and technology-readiness businesses leveraged by the resilience of highly educated, skilled, and multitasking entrepreneurs are critical to keeping business ongoing. Extant literature showed that the lack of online technology readiness and the disruption transitioning to online are the main challenges in adopting technology for small businesses in digital environments (Nurhayati et al., 2021; Rashid & Ratten, 2021; Shahul Hameed et al., 2022; Ting et al., 2020). Our results confirmed that startups' readiness for fast transitioning to digital environments and IT adoption during a crisis could help small companies be prepared for future

crises. Resilience to adopt new technologies is crucial to providing continuous support and maintaining close customer relationships. Importantly, to succussed in digital transformation is critical to have agile leadership followed by strategic flexibility originating from a firm internal adoption of technology (Fachrunnisa et al., 2020).

The entrepreneurs in this study believe that resilience is essential for their businesses. Most of the time, this ability is related to how they can multitask and never stop until reaching their goal. It involves hard work, effort, dedication, research, testing, and continuous iterations to improve solutions and always keep trying. Also, resilience capacities can mitigate the psychosocial impact of crises and disasters by providing a sense of routine, stability, structure, and hope for the future. Research showed that "personal and business experience of crises, positive mindset, personal faith, learning and leading, and relationships" enhance entrepreneurial resiliency (Hutchinson et al., 2021).

Therefore, another important conclusion of this study arises from the link between entrepreneurs' profiles and their resilience, that is, their ability to endure and overcome the challenges driven by the pandemic crisis. Education lies at the heart of their skills – high degrees in sciences and engineering – enabling flexibility and multitasking, innovation capacities, and resilience. Education empowers and transforms people's lives.

Our empirical results generally encompassed previous findings revealing that the entrepreneurs' human capital is a significant predictor of entrepreneurial persistence and survival (Caliendo et al., 2020). It has been argued that small businesses are more vulnerable now. They have less cash and asset reserves. However, entrepreneurs are predisposed to adapt to changing environments (Rashid & Ratten, 2021).

Startups may be more naturally adaptable and resilient as they are always in "crisis mode", even without a pandemic. Paradoxically, they may be more crisis ready than other firms while also more vulnerable.

The findings showed a trinomial relationship between education, business capabilities, and resilience and highlighted technology importance for startups. Figure 2 visually depicts the interlinkages between education, entrepreneur's capabilities, and resilience and adds technology readiness and adoption as a proxy that leverages the former third dimension. By doing so, the pyramid model emphasizes the need for infusing technology in the linkages – education-technology, entrepreneur's capabilities–technology, and resilience–technology. This denotes that it is more likely that more educated and technology-ready entrepreneurs were more able and skilled to find and quickly implement innovative business processes. They have the necessary technological knowledge to develop innovative and agile solutions, focusing on customers' unique needs derived by crisis and quickly adapting to digital channels to manage the relationship with their customers fully. Besides, entrepreneurs usually are proactive, willing to take risks, able to identify environmental changes, and seize opportunities timely, which enables them to adapt and overcome crises.

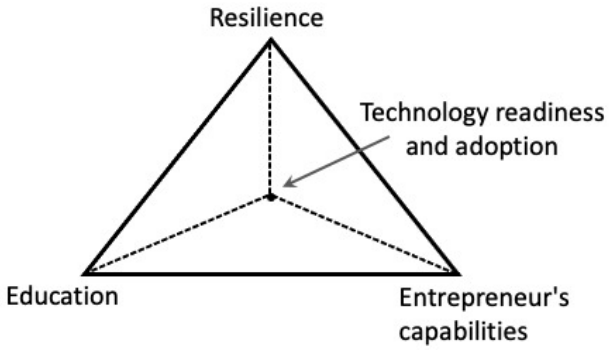

Figure 2. Pyramid model linking education, entrepreneur's capabilities, and resilience together with technology readiness and adoption

That is, technology fosters entrepreneurs' resilience by providing the tools that help to convert adversity into resilience, for example, through easier connection with customers and employees, coping with social loss, developing stronger community ties, improving skills, and innovating to overcome the pandemic effects and emerge stronger (Davoudi et al., 2018; Drnevich & West, 2021; Teplov et al., 2019).

Our findings are in line with technology readiness (TR) theory, defined as a trait-like individual difference variable that captures people's general attitude toward accepting and using new technologies for accomplishing goals in home life and at work (Parasuraman, 2000) and is related to several sociodemographic aspects such as age, education, and experience (Blut & Wang, 2020). Extant literature also showed that the lack of online technology readiness and the disruption of transitioning to online are the main challenges in adopting technology for small businesses in digital environments (Nurhayati et al., 2021; Rashid & Ratten, 2021; Shahul Hameed et al., 2022; Ting et al., 2020).

Therefore, technology readiness and intensive adoption are critical to entrepreneurs' skills, capabilities, and resilience to succeed in turbulent and highly competitive markets.

The proposed pyramid model is in line with extant research. Studies have shown that successful academic entrepreneurship (with a background in sciences and engineering) has the potential to foster high-impact research into the market (Eckhardt & Wetherbe, 2016). Furthermore, the entrepreneur's skills, resilience, capabilities to identify environmental changes, and ability to seize opportunities timely are vital to overcoming crises (Bullough & Renko, 2013; Leonelli et al., 2019; Rashid & Ratten, 2021), combined with better IT capabilities enables startups to be faster and perform better in the process of digital transformation (Nurhayati et al., 2021; Rashid & Ratten, 2021; Shahul Hameed et al., 2022; Ting et al., 2020).

As previous studies highlight, small firms may have a competitive advantage if they find and exploit the opportunities created by technological uncertainty during the pandemic. In this context, those who use this uncertain time to connect with customers and employers, develop

stronger community ties, improve their skills, and innovate will overcome the pandemic effects and emerge stronger (Davoudi et al., 2018; Drnevich & West, 2021; Teplov et al., 2019).

Importantly, incubation is an essential hotbed for academic research and networking, helping startups get support from the incubator community, partnership, and collaborative action. Moreover, incubation promotes networking as a proxy for the complex and expensive market to attract.

The study extends extant research and claims that factors inherent to startups seem essential for their survival during pandemic times. Results suggest that the characteristics of small companies (e.g., startups), such as agility and flexibility due to their focus on digital transformation, highly skilled, multitasking human resources, and less complex management due to fewer employees seem to be better prepared to face crises. Finally, other businesses can learn from digital-infused startups how they survived and overcame adversities.

Limitations and future research

This work has limitations that provide opportunities for further exploration. First, further research exploring how startups from different industries and countries react to the crisis may confirm and extend our results. Second, all startups were nested in business incubators, which provide a structured and supportive environment. Future research could explore the differences between incubated and non-incubated startups. Third, while our sample includes startups from several industries, they are only based in one country. Thus, our sample of 18 case firms may have limitations, and larger-scale studies, including startups with a broad mix across industries, maturity, size, and geographies, could further deepen and validate our findings. Fourth, most of the sample is composed of male co-founders. Future research should explore gender differences in entrepreneurship management to uncover if there are gender differences when managing crises.

Several topics that relate to our research remain unexplored. First, researchers could compare post-COVID-19 impacts on business processes and the initial concerns at the beginning of the pandemic to understand how the business world is changing and how to survive in this ever-changing world. Lessons emerging from these studies could be useful for organizations to be more prepared and resilient for future crises. Second, entrepreneurial skills are critical during this period. Hence, future researchers could investigate the most effective and efficient practices to help startups and other organizations survive. Finally, the pandemic brought new working methods, and studying changes in work organization and collaboration is necessary. For example, how will remote work be organized? How can other working methods (home and office) be implemented? How will these changes impact companies and workers? Another interesting topic is the impacts of the COVID-19 pandemic on employees' socialization, interactions, collaboration, and company culture. How can companies promote a learning, creative, innovative culture without "physical" contact? It is especially important for entrepreneurs starting new ventures with a critical collaborative, innovative culture.

Submitted: August 26, 2022 CDT, Accepted: January 09, 2023 CDT

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