

Research Article

Exogenous crisis and the resilience of SMEs: exploring Open Innovation in the COVID-19 Pandemic

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ABSTRACT

Open innovation is one of the most discussed themes in managerial literature. However, there are still many questions that scholars have not yet answered. A research question of particular relevance today is: How can open Innovation help SMEs overcome and manage the economic crises caused by a pandemic? In 2020, a global coronavirus pandemic (COVID-19) emerged that has damaged several sectors, particularly by weakening the economy of small and medium-sized businesses. This paper addresses this issue by examining the literature available to date and provides a theoretical answer by investigating the influence of open innovation on the resilience of SMEs during the COVID-19 outbreak. The paper shows that several companies have leveraged open innovation to address the economic crisis caused by the pandemic. Moreover, open innovation can represent a winning strategy for SMEs in surviving extremely uncontrollable turbulences. A collaborative approach and an open mindset can be the right innovative strategy for SMEs to overcome a crisis caused by unpredictable exogenous factors.

Key words: SME, Covid, Pandemic

INTRODUCTION

Open innovation is defined as "...a distributed innovation process based on purposively managed knowledge flows across organisational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organisation's business model." (Chesbrough & Bogers, 2014). Two decades later, it is possible to disprove Huizingh's (2011) prediction that the term "open innovation" would soon vanish.

Open innovation is a constantly evolving paradigm, and its practice has become increasingly significant over the years (Brunswick & Chesbrough, 2018; Chesbrough & Brunswick, 2013). However, despite the exponential growth of the study of open innovation, there are still many gaps in the literature to date. After nearly twenty years of research, many of the questions Chesbrough raised in 2003 have yet to be answered (West & Bogers, 2017). In particular, what is most relevant at this writing is the paucity of solid quantitative studies on the benefits of an open approach to innovation during an economic crisis caused by a pandemic.

As of 2020, the planet has been marked by a global pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The pandemic has damaged several sectors, in particular by weakening the economy of small and medium-sized enterprises. The literature highlights some critical gaps in understanding the fundamental mechanisms through which open innovation is integrated and developed in SMEs and the importance of generating resilience to ensure survival during

economic crises caused by exogenous forces. This literature gap is undoubtedly to be attributed to the novelty of the theme; however, the recursive nature of a pandemic and the previous exogenous crises in history should have left some lessons to be learned.

Therefore, this study aims to investigate the influence of open innovation practices on the resilience of SMEs against extreme market turbulence. Specifically, this paper analyses the literature accessible to date on the subject and critically examines the emergence of the concept of open innovation in identifying a strategic vision to respond to a large-scale system change caused by pandemics, climate emergencies, environmental disasters, and trade wars or other exogenous factors. The gaps in the literature can be translated into a research question that this paper will address: How can open Innovation help SMEs overcome and manage the economic crises caused by a pandemic? This paper will attempt to summarise the literature on the topic and provide a theoretical answer by investigating the influence of open innovation on the resilience of SMEs during the COVID-19 pandemic. This review should provide a solid foundation for future research on open innovation during economic crises caused by unpredictable exogenous factors.

The document is structured as follows. Section 2 describes the methods applied. Section 3 collects and interprets data from the literature on the open innovation path of SMEs during the COVID-19 pandemic. Section 4 comments on the results of the literature review and offer future avenues for research and highlights the limitations of this study.

METHODOLOGY

This study uses an explicit method for review (Pittaway, Robertson, Munir, Denyer, & Neely, 2004). The aim was to select and analyse relevant papers, which dealt with the issues of open Innovation in SMEs during the COVID-19 pandemic. This research provides a review of the current body of knowledge on the intersection of these themes.

The literature review was conducted according to the following inclusion criteria:

- The literature review focuses primarily on papers published in peer-reviewed journals written in English. The period of observation was restricted to the period from 2003 to 2021, considering Chesbrough's 2003 publication a milestone
- The search for related publications was conducted through a structured keyword search constructed into search strings: [(“open innovation”) AND (“SMEs”) AND (“COVID-19”) OR (“pandemic*”) OR (“SARS-CoV-2”) OR (“coronavirus”)]
- The keyword research was limited to abstracts, keywords and titles in order to exclude papers with unsuitable content
- The selected papers were reviewed to verify their effective compatibility with the inclusion criteria and to reduce the number of citations.

Open Innovation in SMEs and the COVID-19 Pandemic

For most of the 20th-century, innovation activities were carried out in a purely proprietary manner, and companies dealt with the entire innovation chain, from the idea generation to its development up to its distribution (Chesbrough, 2003b). This model, tacitly becoming the rule over the years, was called “closed innovation” by the scholar Henry Chesbrough (2003c), because the innovative projects could only enter the innovation funnel from one point, the scientific and technological base of the company, and only exit from another, the market. This model was considered the right way to approach change for most of the previous century, and it worked pretty well. Edison, IBM, AT&T, Xerox and Merck were successful examples of the closed innovation paradigm (Chesbrough, 2006, 2012).

Nevertheless, at the beginning of the 21st-century, many erosion factors led to the decline of closed Innovation (Chesbrough, 2003a) The evolving context for technological innovation characterised by increasing outsourcing, vertical disintegration, and open standards has brought to light a new phenomenon of strategic management, the antithesis of closed innovation, named “open innovation” by Chesbrough (2003c). This model, treating R&D as an open system (Chesbrough, 2006), is defined as open because projects can enter the innovation funnel from both internal and external technological sources. Moreover, successful projects can be brought to market directly or through licensing and spin-off (Chesbrough, 2012). The porosity of company boundaries that

characterises this model allows ideas and innovation to move more quickly and freely between the firm and its surrounding environment. In addition to eliminating false positives, open innovation can recover false negatives previously devalued in the innovation funnel [Chesbrough, 2003a] Microsoft, Cisco, Intel, Philips, Unilever, and Procter & Gamble are among the successful cases of open Innovation (Chesbrough, 2012).

Open innovation is defined as:

“...the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively.” (Chesbrough, 2006b, p.1)

The concept of openness is based on the evidence that a single organisation cannot innovate entirely on its own in isolation (Dahlander & Gann, 2010). A firm has to engage with different partners to acquire ideas and resources from the outside environment to keep up with the competition. This emphasises the permeability of firms' boundaries where ideas, resources and individuals flow in and out of organisations (Dahlander & Gann, 2010) due to the environmental uncertainty and innovation complexities (Chesbrough, Lettl, & Ritter, 2018)

External resources, such as communities of innovators, ecosystems, alliances and networks, are excellent sources for creating and capturing value (Chesbrough & Appleyard, 2007), thanks to their heterogeneous and multidisciplinary characteristics. For example, partnerships can be science-based (Du, Leten, & Vanhaverbeke, 2014) and involve universities and knowledge institutions (Cassiman, Di Guardo, & Valentini, 2010; Fabrizio, 2009; Laursen & Salter, 2004). Partnerships can also be market-based (Du *et al.*, 2014) and involve suppliers (Li & Vanhaverbeke, 2009; Schiele, 2010), customers (Gassmann, Sandmeier, & Wecht, 2006; Grimpe & Sofka, 2009), competitors (Bez & Chesbrough, 2020; Lim, Chesbrough, & Ruan, 2010) and other partners around the world.

Open innovation is distinguished into two main dimensions (Chesbrough & Crowther, 2006): inbound and outbound. The two concepts differ in the learning path, which can occur along the usual trajectory or along with a new and different one (Gupta, Smith, & Shalley, 2006). The inbound dimension (or technology exploration, or outside-in process) refers to the search strategy that explores external sources of information to complement or accelerate internal competencies and in-house R&D activities (Chesbrough & Bogers, 2014). Activities that fall into this category include IP in-licensing, contracted R&D services, intermediaries, idea & start-up competitions, supplier innovation awards, university research grants, customer co-creation, crowdsourcing, publicly funded R&D consortia, and informal networking (Chesbrough & Brunswicker, 2013).

The outbound dimension (or technology exploitation, or inside-out process) describes external pathways to commercialise unused innovations and ideas to develop new

products or services (Chesbrough & Bogers, 2014). Activities that fall into this category include joint-venture actions, IP out-licensing, selling market-ready products, corporate business incubation, spin-offs, participation in standardisation, and donations (Chesbrough & Brunswicker, 2013). The decision to move the place of exploitation outside the company allows for generating profits by licensing the IP and multiplying the technology, participating in other segments by using licensing fees, joint ventures and spin-offs. In the study by Enkel and Gassmann (2007), it is evident that in-licensing policies are much more widespread than out-licensing ones, the latter almost exclusively applied by large multinational companies.

Gassmann and Enkel (2004) add the coupled process as a third dimension, also called R&D collaboration (Bogers, 2011), referring to co-creation through alliances, cooperation and joint ventures by combining the technology exploration to gain external knowledge with technology exploitation to bring ideas to market (Enkel, Gassmann, & Chesbrough, 2009).

Closed and open innovation models differ substantially in their operating principles due to some variables (Chesbrough, 2003b) discussed below. In the context of open innovation, companies realise that it is no longer possible to hire and keep the best scientists in the field for themselves. The horizon represented by the 21st-century abounds with knowledge. Suppose an open and flexible innovative model is used. In that case, it is possible to draw on the expertise and skills of smart people who work for other companies, be they collaborators, rivals or other sectors, thus filling the internal gaps incompetence. Therefore, it is important to leverage collaborations, alliances, and networks with other market players, maintaining an equal importance of both internal and external knowledge (Chesbrough, 2006).

Furthermore, open innovation attributes a whole new interpretation to IP, which is seen in this model as a value that can be bought and sold for the greatest benefit (Chesbrough, 2003b). In the closed model, most IPs were never used by the company that held them. In open Innovation, IP can provide additional revenues to the current business model directly or through licenses or other inside-out means (Chesbrough, 2012).

Another important aspect concerns the selection criteria for innovative projects and Type I and Type II evaluation errors (Chesbrough, 2006). The ability to eliminate “false positives”, i.e. projects that are not as promising as they initially seemed, is a characteristic of both models. Still, open innovation also integrates the ability to recognise “false negatives”, i.e. ideas that are revealed only later to be of some utility, initially discarded due to the lack of fit with the firm’s business model (Chesbrough, 2004, 2012). While the closed model, only represent a cost to the firm, false negatives are the heart of the inside-out process of open innovation and are seen here as an opportunity to expand the business model or spin-off a technology outside the company (Chesbrough, 2012).

Elements that were of central importance in closed innovation, such as ownership, barriers to entry, custody of

IP and rivalry between and within industrial sectors, are being replaced in the universe of open innovation by previously ignored forces such as participation of users, communities, innovation ecosystems and the building of innovation networks (Chesbrough & Appleyard, 2007).

The business model is the most incisive variable that concretely distinguishes the open innovation paradigm from the pre-2003 literature on the use of external sources of Innovation (West & Bogers, 2014). To take full advantage of this new innovation system, companies must open up their business models by tapping into external resources and leaving internal ideas and projects “waiting on the shelf” free to flow outside, allowing other companies to take advantage of it (Chesbrough, 2007b).

Some trends can be identified in the development of open Innovation (Gassmann, Enkel, & Chesbrough, 2010). The main research areas relate to firm-centric aspects, management of networks, and users’ role in open innovation contexts (Randhawa, Wilden, & Hohberger, 2016). In Chesbrough’s debut book, the evidence provided in support of the open model concerns the case studies of large American high-tech companies (Chesbrough, 2003a). The interest that has arisen in scientists and entrepreneurs over time has made it possible to affirm the success of the open approach to innovation on other targets, such as less technological companies (Chesbrough & Crowther, 2006; Grimpe & Sofka, 2009; Spithoven, Clarysse, & Knockaert, 2010), European industries (Chesbrough & Vanhaverbeke, 2011), emerging countries (Bogers, Burcharth, & Chesbrough, 2019; Fu, Li, Xiong, & Chesbrough, 2014), and smaller companies (Barge-Gil, 2010; Lee, Park, Yoon, & Park, 2010; Van De Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009; Zeng, Xie, & Tam, 2010).

OPEN INNOVATION IN SMES

According to EU recommendation 2003/361, small and medium-sized enterprises (SMEs) are defined by their number of employees (< 250) and turnover (≤ 50 € million) or balance sheet total (≤ 43 € million). Despite their small size, SMEs are the engine of the European economy. SMEs provide jobs and ensure economic stability for the continent. Nine out of ten firms in Europe are SMEs. SMEs promote competitiveness and employment, offering two out of three jobs (European Commission, 2020b).

SMEs are the backbone of the European economy. They represent 99% of all businesses in the EU, with 25 million SMEs in Europe (European Commission, 2020a). They employ around 100 million people, represent more than half of Europe’s GDP and contribute to the growth and support of the economy.

Although representing the largest number of companies in the economy, SMEs are not sufficiently studied in the open innovation literature (Gassmann *et al.*, 2010; Van De Vrande *et al.*, 2009). Studies on open Innovation in SMEs

are mostly performed on the basis of panel data, neglecting statistical analysis. Research is primarily conducted in Europe, with some studies in the Chinese and Korean context, while studies on SMEs from emerging countries and America are scarce (Hossain, 2015). Still, most open innovation research concerns the case studies of large multinational enterprises (Brunswick & van de Vrande, 2014).

The literature highlights substantial structural shortcomings of SMEs that pose barriers to innovation. SMEs often have to overcome structural barriers such as a lack of managerial and technical competencies, markets rigidities and limited knowledge of international expansion opportunities (European Commission, 2020b). The financial resources at their disposal are the key point, preventing the support of cooperative innovation and value acquisition projects (Chesbrough, 2010; Vanhaverbeke, 2017). The lack of financial resources and skilled workers hinders innovation activities in SMEs (Van De Vrande *et al.*, 2009). The study by Shekar *et al.* (2021) recognises the main internal and external challenges facing SMEs. Among the former, the study cites resources management, entrepreneurial behaviour, internal capabilities, problem solving, decision making, and leadership; among the latter, the study emphasises the business environment and social influence.

One of the main problems of SMEs is the lack of digital mentality (Rusly, Taliba, Abd Mutaliba, & Hussina, 2020). The adoption of technologies improves the functioning of businesses in the long run, and significantly affects open Innovation (Valdez-Juárez & Castillo-Vergara, 2021), as well as the adoption of absorptive capacity (Cuevas-Vargas, Aguirre, & Parga-Montoya, 2022). Adapting to a digital model requires changes in business strategy, organisational structure and firm mindset. Scholars highlight the importance and need for SMEs to develop internal digital capabilities to respond quickly to market changes (Scuotto, Nicotra, Del Giudice, Krueger, & Gregori, 2021). SMEs are characterised by a poor mastery of technology (Surya *et al.*, 2021). This is due to several factors, including limited internal capabilities, high operating costs and the absence of market guarantees for developing technology-based businesses.

Their absorptive capacity, in terms of dedicated structures and personnel to the identification and exploitation of external knowledge and technologies, is weak, making it difficult for SMEs to exploit the potential of external resources (Chesbrough, 2010; Cosh & Zhang, 2011; Vanhaverbeke, 2017). In this regard, Cuevas-Vargas *et al.* (2022) argue that the adoption of absorptive capacity has a significant influence on open innovation. Another barrier to the acquisition of external knowledge is represented by the “not-invented-here” syndrome and the lack of internal commitment (Chesbrough & Crowther, 2006).

The lack of IP protection and complementary assets complete the picture of weaknesses of SMEs (Vanhaverbeke, 2017). Poor knowledge and weak IP protection mechanisms limit and prevent the SMEs openness (Drechsler & Natter,

2012). All these aspects prevent small firms from carrying out innovative activities independently and exclusively within their firm boundaries.

It is clear that SMEs are looking for partners to support their innovative goals and realise business model changes. SMEs do not always manage to meet customer needs and have difficulty in involving them in the product development process. Cooperation with innovation partners can support them in this aim (Asgari, Zakery, & Pishvae, 2021). Consequently, Innovation in SMEs has an open footprint by default (Brunswick & van de Vrande, 2014), and the use of external knowledge is their normal role model (Van Der Meer, 2007). Spithoven *et al.* (2013) argue that SMEs are more dependent on open innovation than large companies. SMEs recognise their strategic approach, conditioned by their organisational context, in the principles of open Innovation (Brunswick & Vanhaverbeke, 2015). They do not have sufficient skills and resources to manage the entire innovation process themselves, and this encourages them to open up to collaboration (Edwards, Delbridge, & Munday, 2005; van de Vrande, Vanhaverbeke, & Gassmann, 2010).

As stated by Vanhaverbeke (2017), “innovations start small”. While SMEs face many challenges, they also enjoy some structural advantages over large firms that offer them unique opportunities to thrive in an open innovation environment (Chesbrough, 2010).

The firm size can be seen in its positive aspect. Smaller and niche markets are attractive to SMEs, while they are not cost-effective for larger enterprises (Vanhaverbeke, 2017). This advantage allows SMEs to exploit new trends earlier when entry costs are still relatively low (Chesbrough, 2010).

Small businesses are extremely focused. Their focus allows them to operate very effectively against larger companies with more widespread objectives, generating a sustainable competitive advantage in sectors where customers value the expertise, knowledge or service that this type of SME offers (Chesbrough, 2010).

SMEs can specialise their activities more deeply in narrow fields, so that these companies can sell their capabilities to a wider range of customers and markets (Chesbrough, 2010). Furthermore, their ability to offer extreme customisation allows them to become a preferable supplier to large companies (Vanhaverbeke, 2017).

Small businesses are made up of entrepreneurs. SMEs attract more entrepreneurial R&D employees, as product and market orientation are higher than in the research departments of big companies (Chesbrough, 2010). This makes it possible to exploit resources that are second choice for large companies.

Lastly, SMEs are agile. They make and implement decisions faster due to their less rigid structures, and react more quickly to customer and market inputs and to competitive challenges (Vanhaverbeke, 2017), so they have a competitive advantage in fast-changing markets (Chesbrough, 2010). SMEs can benefit

more from open innovation than larger companies thanks to reduced bureaucracy, greater risk appetite and quicker reaction to change (Parida, Westerberg, & Frishammar, 2012). Still, large companies have the advantage of being able to benefit from internal R&D labs, and the consequent absorptive capacity (Cohen & Levinthal, 1990), to create new products.

To be successful, the open innovation process requires complementary contributions from different types of actors (Christensen, Olesen, & Kjær, 2005). In the innovation process, cooperation with customers, suppliers and other companies plays a more important role for SMEs than cooperation with research institutions, universities and government agencies (Zeng *et al.*, 2010).

The open innovation practices most adopted by SMEs include customer and employee involvement, and external networking (Van De Vrande *et al.*, 2009). More advanced practices such as IP licensing, R&D outsourcing and venturing are conducted to a lesser extent. SMEs prefer non-monetary inbound open innovation activities (Van De Vrande *et al.*, 2009). This confirms that SMEs' lack of financial resources affects their adoption and choice of open innovation practices (Santoro, Ferraris, Giacosa, & Giovando, 2018). In particular, micro and small enterprises transfer knowledge externally for free more frequently than medium-sized enterprises (Cosh & Zhang, 2011). On the other hand, outbound activities, both monetary and non-monetary, are not widely adopted by the SME sector.

SMEs also create and participate in innovative ecosystems (Radziwon & Bogers, 2019; Radziwon, Bogers, & Bilberg, 2017). Innovation ecosystems have a multilevel structure (Radziwon & Bogers, 2019), and their development is correlated to the process of acquiring value, which also takes place at an inter-organisational level (Radziwon *et al.*, 2017). Membership in an ecosystem allows stakeholders to co-evolve and co-develop through the joint learning process by exploiting geographical proximity (Radziwon & Bogers, 2019). Due to interdependencies at the interorganisational level, the decisions taken by firms can affect the entire ecosystem to which they belong (Radziwon & Bogers, 2019).

Ecosystems offer SMEs the opportunity to cooperate with both private and public institutions. To derive maximum value, it is important that SMEs have an adequate internal absorptive capacity and are motivated by the will to develop partnerships (Love & Roper, 2015). An ecosystem works if partners are linked by common goals, financial support and commitment to the joint initiative (Radziwon *et al.*, 2017). Ecosystems create value opportunities within and across value chains, and thus are the key to success with open Innovation (Lipp, Marshall, & Dencik, 2021).

The most important reasons that push SMEs to pursue open innovation practices are market-related (Van De Vrande *et al.*, 2009). SMEs are motivated to undertake outbound open innovation to sell additional products and services and to generate license revenues, along with being able to improve

their professional reputation (Cosh & Zhang, 2011). SMEs use external resources, among other things, to shorten innovation times and increase the flexibility of their operations (Lee *et al.*, 2010).

Small firms form networks in particular when they face strong competitive pressures from the market (Huggins & Johnston, 2009). As summarised by Lee *et al.* (2010), in the exploration phase SMEs use external partnerships, preferring networking with research institutes and universities rather than with large firms. In the exploitation phase, SMEs market their products by creating supplier-customer relationships with large companies, outsourcing agreements or strategic alliances with other small firms.

Open innovation networks allow SMEs to deliver new and attractive value to its customers and to build a reputation (Vanhaverbeke, 2017). Alliances are not only useful for exchanging resources. Alliances make it possible to transmit social status and recognition, two aspects of particular value for small and young businesses (Stuart, 2000). The alliance in this case acts as an endorsement to build customer confidence in the value of an organisation's products and services.

Collaborations for SMEs often arise in inbound processes with large companies. Large companies produce many, sometimes too many IPs, often unused and left dormant on the shelf. SMEs cannot produce them due to the high costs involved. These patents represent a potential external source of great value for SMEs (Vanhaverbeke, 2017). The benefits exist for both partners. SMEs enjoy support, reputation and learning and growth opportunities, while large companies benefit from learning agile and entrepreneurship techniques from SMEs. Large companies can even create accelerators and incubators to learn from smaller companies. However, alliances with large firms can bring disadvantages to SMEs (Lee *et al.*, 2010). Smaller firms may lose their comparative advantage and opportunity to compete with large enterprises, and delay their innovative processes.

Adopting an open approach has a positive influence on the innovative performance of SMEs (Parida *et al.*, 2012), in particular with regard to new offerings (Spithoven *et al.*, 2013). To improve business performance, SMEs should invest both in the development of internal competencies, and therefore in absorptive capacity, and in open innovation practices (Crema, Verbano, & Venturini, 2014). A positive correlation between innovation, exporting and performance in terms of productivity and growth motivates SMEs to keep the open approach for a long time (Love & Roper, 2015). Business success increases when companies use collaboration to support their innovation (González-Benito, Muñoz-Gallego, & García-Zamora, 2016).

Opening business boundaries through open innovation mechanisms such as licensing, technology transfer agreements and collaborations can help SMEs develop resilience and grow in the global marketplace (Crema *et al.*, 2014).

THE COVID-19 PANDEMIC

It is not the first time that a coronavirus outbreak has spread to pandemic levels, as for instance, in the cases of SARS and MERS (Guarner, 2020). However, it is the first time that such a pandemic has had a global effect. For example, Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has damaged several sectors, notably by weakening the economy of small and medium-sized businesses. Indeed, the implications of a pandemic are to be identified at the human and at the industrial level. The resulting economic crisis is characterised by the arrest of industrial production, the collapse of consumption, and the stock exchanges' negative responses (OECD, 2020).

On the supply side, this translates into a reduction in the supply of labour due to illness, lockdowns or quarantines, and disruption of supply chains. On the demand side, the loss of revenue causes severe liquidity shortages, which affects the population with a loss of income and reduction in consumption. Although the impact has also been recorded on large companies, SMEs suffer from more severe consequences. As detailed by the OECD (2020), more than half of SMEs have suffered severe loss of revenue, reducing their employees by 40% on average. The biggest damages include the risk of permanent closure, disruptions in supply chains, and reduced cash reserves.

In threatening contexts, lean times or crises, it is crucial to find alternative ways to function and manage business resources. One of the critical points is developing resilience. A recent study identified four elements of COVID-19 crisis resilience: preparedness, agility, elasticity and redundancy (Rapaccini, Saccani, Kowalkowski, Paiola, & Adrodegari, 2020). When a sector is hit by a crisis, usually the first cost cuts take place with regard to innovative projects. In many cases, the potential of open innovation has unfortunately often been misunderstood, and the paradigm is exploited as a method to reduce, if not eliminate, internal R&D costs (Chesbrough, 2019).

But the possibilities offered by innovation go far beyond that. Innovation plays a decisive role in the fight against the economic crisis and in the recovery from the consequences of the coronavirus (Chesbrough, 2020; Van Auken, Ardakani, Carraher, & Avorgani, 2021), as it represents a key component of transformative change and renewal for companies to be resilient (Hillmann & Guenther, 2021). Firms implement their innovation capabilities both to overcome competitive adversity in ordinary times, and to survive in adverse times. Indeed, innovative firms enjoy several advantages in the face of a pandemic over non-innovative companies: the former are endowed with dynamic capabilities that support them in high-velocity markets (Teece, Peteraf, & Leih, 2016), and sense changes in the external environment to a greater extent (Krammer, 2021).

McGahan *et al.* (2021) wonder what open innovation can add to the conversation about the use of business capabilities,

resources, and ideas in the face of societal challenges. Over time, several studies have demonstrated the success of open innovation during economic and exogenous crises, such as during the 90s crisis in Italy (Di Minin, Frattini, & Piccaluga, 2010), the Greek debt crisis (Papadopoulos, Stamati, Nikolaidou, & Anagnostopoulos, 2013), the case of water contamination in India (Schimak, Havlik, & Pielorz, 2015), and the environmental disaster scenario in South Korea (Yun, Park, & Avvari, 2011).

In a crisis, open innovation can help organisations find new ways to solve pressing problems, build positive reputations, and establish partnerships that will be useful through and beyond unpredictable turbulence (Dahlander & Wallin, 2020). Open innovation can be seen as a bifocal strategy to be exploited in lean times, which can enhance operational efficiency and also preserve and improve the effectiveness of R&D (Di Minin *et al.*, 2010). Although some scholars argue that companies that rely on internal resources have a greater chance of adapting to the consequences of the pandemic than those that depend on external sources (Krammer, 2021), openness is recognised by the literature as a tool that can support businesses in difficult times (Bertello, Bogers, & De Bernardi, 2021; Chesbrough & Garman, 2009; Kokshagina, 2021; McGahan *et al.*, 2021; Pillmayer, Scherle, & Volchek, 2021). In the fight against a pandemic, speed is key, and open innovation can help speed things up (Chesbrough, 2020). Companies with a fast innovation reaction, in fact, are able to adapt and combine internal production capabilities with the external skills of other companies (Puliga & Ponta, 2021).

The application of open innovation practices during a pandemic offers several advantages, including accessing external knowledge, supporting the presentation of the brand externally and intensifying the engagement between the stakeholders (Pillmayer *et al.*, 2021). The study carried out by Puliga and Ponta (2021) reveals how fast innovation reactions were possible during the COVID-19 emergency. By integrating dynamic capabilities with the characteristic properties of open innovation, the firms questioned were able to reconfigure their assets and processes to develop new products necessary during the pandemic, like masks and sanitising gels. The simultaneous orchestration of internal and external resources was critical for the fast innovation reaction to and survival of the exogenous crisis.

The inside-out process can support business resilience by moving some of the resources and projects outside the company boundaries. This allows to reduce internal R&D costs and generate revenue from external licenses (Chesbrough & Garman, 2009). Some of the open innovation moves suggested by Chesbrough and Garman (2009) include becoming customer or supplier of former internal projects, engaging with the ecosystem and licensing unused technologies to others. Regarding the latter point, patents can be sold or licensed, or abandoned to save costs during an economic crisis (Guderian, Bican, Riar, & Chattopadhyay, 2021). Considering the four dimensions of COVID-19

crisis resilience, Fombella *et al.* (2021) find that business preparedness is supported by processes, even those not specifically designed to fight a pandemic; agility receives a great contribution from technology in supporting employees in home working and from high-level leadership; elasticity arose from negotiations with customers and suppliers, as well as from the trusting relationships established with the parties; finally, the redundancy of the storage of greater quantities of inventories and local resources has supported business resilience.

Opening company boundaries has supported firms during the COVID-19 outbreak (Bertello *et al.*, 2021; Kokshagina, 2021; Mcgahan *et al.*, 2021; Pillmayer *et al.*, 2021; Puślecki, Dąbrowski, & Puślecki, 2021; Vermicelli, Cricelli, & Grimaldi, 2020). Even at the macroeconomic level, an analysis of innovation policies adopted during the coronavirus pandemic suggests that countries promoting open innovation have reacted more effectively to the crisis (Patrucco, Trabucchi, Frattini, & Lynch, 2021).

The literature cites several examples of open collaborations and projects that emerged during the pandemic. For example, the collaboration between Ford, United Auto Workers, GE Healthcare and 3M for the construction of ventilators, or between Scania and the Karolinska University Hospital to supply personal protective equipment to healthcare workers (Dahlander & Wallin, 2020). Other giants, Siemens, has opened its manufacturing network for the design of medical devices (Dahlander & Wallin, 2020). Some organisations such as Philips, Velo3D, Signature Brew and Zoom have employed the process of innovative crisis management using innovations to optimise their readiness, informed excellent focus, smart strategic changes, strategic collaborations, resilient implementation and consolidation that helped them survive and even thrive during the pandemic (Abubakar & Garko, 2020).

In the b2b context, the White House Office of Science and Technology Policy published all of the relevant research on SARS-CoV-2 virus, to encourage collaborators from around the world to work together on solutions. For the same reason, Medtronic has opened up its ventilator design for anyone, waiving its IP rights to the product. These mechanisms can be extended to the b2c context, where many companies are converting part of their manufacturing processes to produce scarce supplies such as hand sanitiser and masks (Chesbrough, 2020).

Among the crisis-driven innovations amidst the COVID-19 pandemic were technology-driven, frugal and social innovations (Dahlke *et al.*, 2021). A particularly successful tool was the hackathon, used to exploit sources of distributed knowledge with the aim of solving specific problems in the short term. Bertello *et al.* (2021) identify the key dimensions for leveraging hackathons as an open innovation crowd sourcing tool: broad scope, participatory architecture, online setting, and community creation. In general, crowd sourcing activities have been endorsed by the literature as collaborative

models for tackling a pandemic (Vermicelli *et al.*, 2020). There are few studies on the effectiveness of open innovation during the coronavirus epidemic and even fewer that focus on SMEs.

SMEs have been heterogeneously affected by the crisis, thus generating a categorisation of firms that enjoy growth during a crisis (crisis exploiters), firms that do not undergo changes (crisis immunes), and firms that suffer the consequences of a crisis (crisis victims) (Klyver & Nielsen, 2021). The impact of the pandemic on SMEs is inversely proportional to their size and age (Van Auken *et al.*, 2021), i.e. micro-enterprises have suffered a more severe impact than medium-sized enterprises (Paunović & Aničić, 2021). Other factors affecting the response of SMEs to the crisis include the negative impacts of the crisis, and participation in formal and informal networks (Haneberg, 2021). As noted by Razumovskaia *et al.* (2020), the state support system for SMEs provides slow life support. Such aid includes tax holidays, insurance premium reduction, a moratorium on bankruptcy filings and public funding. Considering that a pandemic implies an exogenous risk with a high level of uncertainty, the state support should switch in this case to the activation and development of open innovation in the SME sector. As stated by Razumovskaia *et al.* (2020, p.5), "Only this approach can ensure the balanced development of this sector of the economy in the current situation." State support has been successful in Iran, whose government has encouraged SMEs to create new products, resisting the crisis (Van Auken *et al.*, 2021).

Open innovation, especially business-to-business collaboration, has proven to be an effective approach for SMEs to address the consequences of the COVID-19 pandemic (Markovic *et al.*, 2021), subcontracting strategy, and international operations (Harel, 2021). The pandemic has forced SMEs to develop an open approach, and this confirms the assumptions of Maciel and Fischer (2020) that a shared cause drives a collaborative mindset. Urgency thus becomes a key attribute for the selection of SMEs partners in times of crisis (Markovic *et al.*, 2021). While some studies argue that SMEs' revenues have not been negatively impacted by the pandemic and have not had to adapt their innovation processes or the extent of use of open innovation tools (Harel, 2021), small firms that have suffered the most severe impact from the COVID-19 crisis have applied digitalisation to a greater extent and engaged in collaborative networks with other partners (Paunović & Aničić, 2021), as well as staff training and commitment to R&D (Van Auken *et al.*, 2021).

Business model innovation is another strategy for SMEs to consider, which is positively influenced by open Innovation (Ibarra, Bigdeli, Igartua, & Ganzarain, 2020). As defined by Chesbrough, a business model performs two essential functions: "First, it defines a series of activities, from procuring raw materials to satisfying the final consumer, which will yield a new product or service in such a way that there is net value created throughout the various activities. Second, a business model captures value from a portion of those activities for the firm developing and operating it." (Chesbrough, 2007a, p.12).

Business model innovation enables SMEs to respond quickly to market changes and significantly improve their competitive advantage (Ibarra *et al.*, 2020). These considerations are of particular importance for the post-pandemic management agenda.

CONCLUSION

Although scholars are increasingly arguing that open innovation might be the right strategy for addressing pressing societal challenges (Bogers *et al.*, 2017; Chesbrough & Di Minin, 2014; Kohler & Chesbrough, 2019), so far very little research has linked open innovation to exogenous crises before the coronavirus outbreak. This study attempts to summarise the body of knowledge of the most important studies on the impact of open innovation practices during the COVID-19 pandemic.

The empirical studies concerning the management of open innovation are mainly focused on large organisations and multinational companies. The level of analysis needs to be extended to small and medium-sized enterprises, which constitute 99% of all enterprises in the European Union (European Commission, 2020a). In particular, this study highlights the need for future research to investigate the role that open innovation plays in the survival of small businesses during economic crises caused by pandemics or other exogenous factors.

The literature confirms that knowledge transfer and alliance building are involved in supporting business resilience (Chesbrough, 2020). If the firm successfully exploits the advantages of open innovation, it can formulate a winning strategy of survival from uncontrollable events. The body of literature agrees with the need for such insight to be a fundamental contribution to the company's success (McGahan *et al.*, 2021). Companies that implemented open innovation practices during the COVID-19 pandemic managed to survive the serious economic crisis that ensued.

It is clear from the literature that the challenges SMEs face are broad and varied. The current tensions in the paradigm have been well illuminated in the discussion of the literature. However, a collaborative approach and an open mindset can represent the right innovation strategy for SMEs to overcome a crisis caused by exogenous factors.

As any research effort, this study is not exempt from limitations. The main limitation of the nature of this study concerns the attention purely to the positive aspect of the open innovation strategy, as well as the limited selection of the reviewed papers. Future research will focus on a deeper exploration of open innovation in relation to the exogenous crises that can affect SMEs.

A strategy is needed to get businesses prepared for unforeseen turbulences, thereby reducing the risk of failure and bankruptcy. These aspects constitute the scientific priority for future research. Scholars could also undertake a quantitative

assessment of the relationships caused by the COVID-19 pandemic and study the effects of such relationships on innovation outcomes in the post-COVID-19 era.

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