



# Exogenous crises and SMEs resilience: The Dynamic Open Innovation Funnel

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## ABSTRACT

In the fall of 2019, a global coronavirus pandemic (COVID-19) negatively impacted the economy of small and medium-sized enterprises (SMEs) worldwide. It is essential to identify effective resilience strategies to help SMEs overcome economic and financial crises caused by pandemics or other exogenous crises. This paper delves into this aspect by asking the following research question: How can Open Innovation and dynamic capabilities be leveraged by SMEs to develop resilience during an exogenous crisis?. The study employs a mixed methods approach to investigate the experiences of SMEs located in the Free State of Bavaria (Germany). Based on the quantitative and qualitative data collected and analysed, this study proposes an innovative framework, named Dynamic Open Innovation Funnel, which integrates the managerial constructs of Open Innovation and dynamic capabilities to support SMEs resilience during exogenous crises.

## 1. Introduction

The global coronavirus pandemic (COVID-19) represents an exogenous factor causing an economic crisis in our time (OECD, 2020). The (negative) implications of the pandemic are to be identified not only at the human but also at the industrial level. The resulting exogenous economic has hit small and medium-sized enterprises (SMEs) particularly hard, with an average of 40% reduction in employees and significant revenue losses (OECD, 2020). In such threatening contexts, it is crucial for SMEs to find alternative ways to function and develop resilience. According to the literature (e.g. Buyl et al., 2019; Iborra et al., 2020), resilience can be defined as the success of firms in anticipating, coping with and recovering from crises (usually related to financial crises) by means of their capabilities, actions and behaviours. Similarly, Koronis and Ponis (2018) defined resilience as a firm's diverse capabilities to make sense of risks and adverse events, absorb pressure and ultimately protect the organisation's capital and reputation. The European Commission (2021) stresses the need to bolster the resilience of the European industry in order to thrive in uncertain times. Innovation plays a decisive role in developing resilience and in the fight against an economic crisis (Chesbrough, 2020), as it represents a key component of transformative change and renewal for companies (Hillmann and

Guenther, 2021). Scholars have shown that Open Innovation, a more collaborative type of innovation, can support businesses in challenging times (Bertello et al., 2022; Kokshagina, 2022; McGahan et al., 2021) and is particularly beneficial during exogenous crises (e.g. Di Minin et al., 2010; Papadopoulos et al., 2013). In this scenario, firms need to develop their capabilities to survive in adverse times (Bergami et al., 2022). Scholars have shown that dynamic capabilities, a more adaptable type of capabilities, can support businesses in coping with changes in high-velocity markets (Teece et al., 2016). Dynamic capabilities represent a fundamental firm's capability regarding knowledge creation, especially when firms are faced with chaos (Nonaka et al., 2000) that can be generated by exogenous crises.

Even though Open Innovation is one of the most discussed themes in managerial literature (Chesbrough and Bogers, 2014), there are still many questions that scholars have not yet fully answered, especially regarding its implementation in SMEs (Livieratos et al., 2022; Parida et al., 2012; Seo and Park, 2022; Van De Vrande et al., 2009) and its role in exogenous crises (Chesbrough, 2020; McGahan et al., 2021). It is crucial to analyse these aspects as SMEs are key elements in the European industry, constituting 99% of all its businesses (European Commission, 2020), and exogenous crises are recurring events (Guarner, 2020). As such, exogenous crises refer to macro-level (environmental)

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factors critical to the analysis of dynamic capabilities creation (Nonaka et al., 2000). This paper delves into this aspect by asking the following research question: How can Open Innovation and dynamic capabilities be leveraged by SMEs to develop resilience during an exogenous crisis?

This study employs a sequential explanatory mixed methods research to investigate the experiences of SMEs in dealing with the coronavirus pandemic (as a proxy of exogenous crises) by implementing the theoretical lenses of Open Innovation and dynamic capabilities. In detail, the first quantitative phase used a survey strategy on a population of 6113 SMEs located in the Free State of Bavaria (Germany). Then, statistical analyses were performed based on the final sample of 399 SMEs (response rate of 6.5%). These quantitative findings informed the second qualitative phase, which employed a multiple case study of 7 SMEs from the final sample of 399 SMEs. Based on the data analysis, this study identifies a novel practical framework, named Dynamic Open Innovation Funnel, which underlines the need for a new approach for SMEs to ensure resilience during exogenous crises.

This research offers a theoretical contribution to current knowledge in strategic management by addressing the scholars' call for research to investigate the benefits of Open Innovation during an exogenous crisis (Chesbrough, 2020; McGahan et al., 2021). Moreover, this study brings practical knowledge by discussing a framework that SMEs can implement and follow to navigate exogenous crises.

## 2. Background

### 2.1. Open innovation

The literature describes innovation management as a process that takes place in phases, commonly represented by the innovation funnel (Dunphy et al., 1996). An innovation funnel represents the stages an idea goes through to become an innovation (Goffin and Mitchell, 2017): in the first Ideation phase, innovative ideas are collected, selected and filtered; in the intermediate Development phase, ideas become projects that will be implemented; in the last Commercialisation phase, projects become innovations and enter the market. In this model of innovation, innovative ideas can enter the innovation funnel only from one point, the scientific and technological base of the company, and exit only at the end point, the market. Projects deemed unsuitable are discarded and abandoned between the stages (Chesbrough, 2012). For most of the 20th-century, innovation activities were carried out according to this innovation funnel, and companies managed the entire innovation chain internally (Chesbrough, 2003b).

At the beginning of the 21st-century, a series of erosion factors, such as vertical disintegration and technological evolution, led firms to rely on external capabilities to complement their internal capabilities (Brusoni et al., 2001). Thus was born the concept of Open Innovation, 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 and Bogers, 2014, p.17). The innovation funnel thus evolves into an Open Innovation funnel (Chesbrough, 2003a) as represented in Fig. 1. The porosity of company boundaries that characterises this new model allows ideas and innovation to move more quickly and freely between the firm and its surrounding environment (Saura et al., 2023). This is in line with Brusoni et al. (2001), which argue that: "Defining the boundaries of the firm in terms of activities performed in house does not take into account that decisions to outsource production and other functions are different from those to outsource technological knowledge". At any stage of the Open Innovation funnel, external ideas and technologies can enter the firm's innovation processes. Furthermore, unused ideas and technologies in the firm can go outside to be incorporated into other's innovation processes. Companies can share risks and compensate for the lack of internal resources by collaborating with customers, suppliers, and other firms (Abhari and McGuckin, 2023; Van De Vrande et al., 2009).

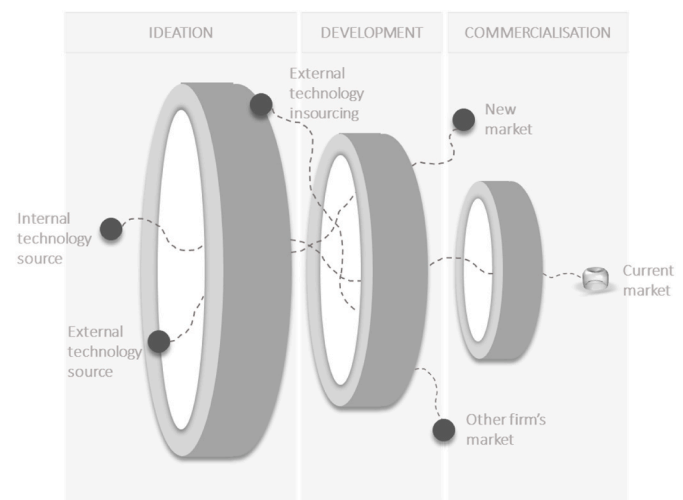


Fig. 1. Open Innovation funnel based on Chesbrough (2003a).

Open Innovation involves several mechanisms categorised into four dimensions (Ogink et al., 2023): (i) governance and policies; (ii) environmental dynamics and interactions; (iii) knowledge, skills, and capabilities; (iv) and learning by doing. The Open Innovation funnel may involve the mechanism related to environmental dynamics and interactions by synchronising and matching activities and processes to accomplish temporal fit between the various actors and their activities. Furthermore, according to Wyrwich et al. (2022), the Open Innovation funnel may involve the mechanism related to knowledge, skills, and capabilities by developing collaborative trust among the actors involved.

Even SMEs implement Open Innovation strategies (Brunswick and Vanhaverbeke, 2015; Lee et al., 2010). Moreover, SMEs are a key player in the economy (Re and Magnani, 2022) as they employ around 100 million people, contribute over half of Europe's GDP and support economic growth (European Commission, 2020). Nonetheless, SMEs are not adequately researched in the Open Innovation literature (Livieratos et al., 2022; Parida et al., 2012; Seo and Park, 2022; Van De Vrande et al., 2009). SMEs often lack the critical resources to conduct innovative activities independently within their firm boundaries (Van De Vrande et al., 2009), and face several challenges such as uncertainty, liability of newness and the lack of entrepreneurial or managerial experience (Barrett and Tsekouras, 2022). As a result, they tend to rely on external knowledge to drive innovation (Brunswick and Vanhaverbeke, 2015). SMEs can implement Open Innovation strategies with large multinational enterprises (Barrett and Tsekouras, 2022) and/or with other organisations. Their willingness to pursue collaborative practices stems from the capabilities to align inbound knowledge flows with innovation practices (Marzi et al., 2023). Open Innovation also represents an effective strategy to adapt to change and maintain competitiveness in a dynamic environment (Barrett and Tsekouras, 2022; Ovuakporie et al., 2021). Therefore, the need for dynamic change in SMEs is a critical condition for survival in hostile environments and for competing in the market (Marzi et al., 2023). The need for the firm to react to rapid market change is the core of the dynamic capabilities paradigm.

### 2.2. Dynamic capabilities

Dynamic capabilities are defined as "... the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997, p.516) through the alteration of the firm's resource base (Helfat, 2022). Dynamic capabilities are constantly evolving and, therefore, require continuous interactions within the firm itself as well as with external stakeholders to manage knowledge processes (Nonaka et al., 2000). Lichtenthaler and

Lichtenthaler (2009) identified six knowledge capacities, which describe a firm's capabilities to dynamically manage the processes of knowledge exploration, exploitation and retention inside and outside the firm: (i) inventive capacity, as a firm's ability to internally explore knowledge; (ii) absorptive capacity, as a firm's ability to externally explore knowledge; (iii) innovative capacity, as a firm's ability to internally exploit knowledge; (iv) desorptive capacity, as a firm's ability to externally exploit knowledge; (v) transformative capacity, as a firm's ability to internally retain knowledge; (vi) connective capacity, as a firm's ability to externally retain knowledge. The literature (e.g. Mikalef et al., 2019) recently highlighted that dynamic capabilities underpin business evolution in our current society. Indeed, dynamic capabilities are crucial for firms as they enable adaptability, foster innovation, provide competitive advantage, enhance resilience, and facilitate collaboration (e.g. Bocken and Geradts, 2020; Linde et al., 2021). By continuously and dynamically developing these capabilities, firms can thrive in a complex business environment and adapt to changing conditions (Lichtenthaler and Lichtenthaler, 2009). In this context, dynamic capabilities can be leveraged to gain a long-term competitive advantage by improving existing resource configurations or to pursue a temporary competitive advantage by creating new resource configurations (Eisenhardt and Martin, 2000). Dynamic capabilities support sensing, seizing and reconfiguring capacities. These have been termed micro-foundations, which represent "... the underlying individual-level and group actions that shape strategy, organisation, and, more broadly, dynamic capabilities" (Eisenhardt et al., 2010, p.1263). Sensing refers to the company's ability to exploit its resources to recognise an opportunity in the market; seizing indicates the firm's ability to mobilise its resources to catch the opportunity and capture value; finally, reconfiguring establishes a continuous adaptation of the firm's resources in order to maintain a sustainable competitive advantage over time. Higher-order dynamic capabilities guide microfoundations, allowing management to sense and seize opportunities for the future, and reconfigure the organisation assets for the best setup (Teece, 2018). Higher-order dynamic capabilities are defined as learning-to-learn capabilities as they are responsible for creating or modifying the firm's dynamic capabilities themselves (Collis, 1994) and provide the most viable route for developing and sustaining a competitive advantage (Reilly and Sharkey Scott, 2009).

As regards SMEs, ordinary capabilities are not sufficient to guarantee their survival, as it depends on the constant renewal of their capabilities (Tallott and Hilliard, 2016). However, the difficulty lies in recombining, reconfiguring and managing dynamic capabilities with limited resources (Teece, 2011). Indeed, dynamic capabilities can help SMEs reconfigure their industrial structures, customers, rules of competition, and value chains (Heider et al., 2021). The basic idea is that the organisation must have ordinary capabilities that contribute to its success, and it must also develop dynamic capabilities to sense and seize change in the external environment (Weaven et al., 2021). Therefore, dynamic capabilities can be vital for SMEs during exogenous crises as they enable SMEs to collaborate with external entities, mitigate risks and embrace digital transformation, ultimately driving their long-term growth and success.

### 2.3. Exogenous crises

Natural disasters, wars and infectious diseases represent exogenous crises that can undermine the economic and social systems (Miklian and Hoelscher, 2022). These include COVID-19, the global coronavirus pandemic that emerged in 2019, which has similarities to natural disasters in its evolution and consequences (Bacq et al., 2020). Although it is not the first time that a coronavirus outbreak has spread to pandemic levels, as in the cases of SARS and MERS (Guarner, 2020), it is the first time that such a pandemic has a global effect. Its implications are to be identified not only at the human but also at the industrial level. Among the most common challenges arising from a pandemic, it is worth mentioning a shifting in customer needs (Donthu and Gustafsson, 2020).

The fear that accompanies the crisis, as well as the uncertainty associated with it, lead to new consumption trends and norms. It also changes the perception of risk and heightens risk aversion (Eggers, 2020). A further challenge concerns the reduction of available resources (Eggers, 2020), which contributes to operational disruption (Miklian and Hoelscher, 2022). Demand and supply-side interruption, business contraction and labour scarcity are just some of the operational consequences firms face due to exogenous crises. Finally, it is important to mention the legal considerations implemented by governments, such as lockdowns and restrictive movement measures (Sharma et al., 2020). Such directives contribute to the creation of a climate of uncertainty and unpredictability in the market (Sharma et al., 2020).

In such threatening contexts, the development of resilience is crucial (Iborra et al., 2020; Ozanne et al., 2022). Innovation represents a source of resilience (Hillmann and Guenther, 2021). Particularly, Open Innovation practices can support resilience by moving some assets and projects outside the company during exogenous crises, such as during the 90s crisis in Italy (Di Minin et al., 2010) and the Greek debt crisis (Papadopoulos et al., 2013). 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 and Wallin, 2020). Speed is key in the fight against a pandemic, and Open Innovation can help speed things up (Chesbrough, 2020).

Dynamic capabilities also contribute to resilience (Ozanne et al., 2022; Zia et al., 2023). According to Nonaka et al. (2000), exogenous crises represent the environment (macro-level factor) with which firms interact to develop dynamic capabilities. Dynamic capabilities can support businesses cope with changes in high-velocity markets (Teece et al., 2016) leveraging the resources developed and saved during stable periods to innovate during a crisis (Leppäaho and Ritala, 2022), such as during the New Zealand earthquakes (Battisti and Deakins, 2017) and the Greek economic crisis (Kottika et al., 2020). During exogenous crises such as the coronavirus pandemic, for example, dynamic capabilities help B2B distribution firms prevent business failure (Zia et al., 2023). The process characterising dynamic capabilities of continuous re-evaluation of existing premises in the face of chaos favors knowledge creation (Nonaka et al., 2000).

Integrating the concepts of Open Innovation and dynamic capabilities can help companies fully reap the benefits of openness (Bogers et al., 2019) since the two managerial constructs are interlinked (Hutton et al., 2021). Although scholars have associated the theories of Open Innovation and dynamic capabilities (Ahn et al., 2018; Teece, 2020), we need to cover the literature gap on the integration of these two managerial constructs in supporting SMEs during exogenous crises. Indeed, the literature to date is scarce regarding the response of SMEs to external adversities and their resilience (Verreynne et al., 2018). Furthermore, this integration could help address the chaos created by exogenous crises (Nonaka et al., 2000). This research responds to this request by investigating the role that Open Innovation and dynamic capabilities played in the survival of SMEs during the coronavirus pandemic.

### 3. Methodology

Due to the intricate nature of the subject matter and the need to evaluate multiple facets of SME strategies, the mixed methods methodology was deemed the most fitting approach for this research. Eisenhardt (1989) notes that the combination of quantitative and qualitative methods in the same study has two important advantages: it increases certainty about the validity of the results, and it increases the creative potential of the research. Moreover, the application of different methods leads to greater confidence of the findings and a wider diversity of views (Bryman, 2006; Saunders et al., 2019). The sequential research design undertaken in this study is characterised by a quantitative phase of data collection and analysis followed by a qualitative phase of data collection and analysis (Creswell, 2009). This approach exploits the

interactive and iterative aspects of mixed methods, where one phase subsequently informs the next one (Saunders et al., 2019). Specifically, the authors conducted a quantitative study of 399 SMEs in Bavaria, followed by a qualitative study of 7 of those SMEs with semi-structured interviews. To strengthen the link between quantitative and qualitative research, the 7 SMEs are a subsample of the 399 SMEs that agreed to be interviewed for our research study. The qualitative study also included the analysis of secondary data such as reports, articles and documents published by the 7 SMEs on their web pages or in press releases. This provided a basis for data triangulation (Yin, 2018).

### 3.1. Quantitative study

#### 3.1.1. Research design and sample

In the first quantitative phase of this study, an internet-based self-administered survey was adopted which questioned SMEs about their experience with the coronavirus pandemic, Open Innovation, and dynamic capabilities. Survey-based research is a widely used methodology in management studies, for it enables the collection of standardised data from a large target, which can then be analysed using descriptive and inferential statistics (Saunders et al., 2019).

The target population of this study included SMEs located in the Free State of Bavaria (Germany), as this region has a high proportion of the most successful and innovative German companies (OECD, 2022). The population sample for this study was identified from the official database of the Bavarian Ministry of Economic Affairs, Regional Development and Energy called “Key to Bavaria”, which offers comprehensive information on firms operating in the most important sectors in Bavaria (Patzelt and Shepherd, 2008). The database was filtered to extract SMEs from the service, manufacturing, R&D and distribution sectors. A record extraction as of January 19, 2021, resulted in 10566 SMEs. A clean up of the database from duplicates, empty email fields, typos and special characters resulted in a new database of 6888 SMEs.

As suggested by the literature (e.g. Dubé and Paré, 2003; Goffin et al., 2019), we initially discussed the survey content with 6 key SME executives to gather opinions and make improvements to the question structure. Furthermore, a pilot test drawn from the population of 6888 SMEs was sent to 364 firms in September 2021. The feedback from the 19 responses received allowed to revise the survey and refine a final version of 20 questions in German, most of which based on the 5-point Likert scale (1 = strongly disagree; 5 = strongly agree).

The questions derived from the literature review and were divided into 4 sections: (i) Demographics: this section collected general information relating to the firm size and age, the technological level and the reference sector; (ii) Exogenous crises: this section investigated the SMEs’ behaviour during the coronavirus pandemic, the strategies adopted, the losses encountered and the dynamic capabilities exploited; (iii) Open Innovation & dynamic capabilities: this section questioned the participants on their relationship with collaborative innovation before and during the pandemic, as well as on the dynamic capabilities developed and used; (iv) Comments: this section offered participants the possibility to add any comments and to indicate their willingness to participate in the subsequent qualitative phase of this study.

The survey was sent by email in November 2021 to the remaining 6524 SMEs. Net of bounced emails, the survey was received by 6113 firms. In December 2021, out of a population of 6113 firms, we collected 399 responses. In conclusion, the response rate of the quantitative study was 6.5%, in line with the average marketing response rate commonly experienced with internet-based surveys (Cook et al., 2000).

#### 3.1.2. Data analysis

The collected responses were translated into English and subjected to descriptive, reliability and factor analysis using the SPSS software v.28. Factor analysis was chosen as a statistical method for examining the relationships underlying the data collected and for determining whether the information could be condensed into a smaller set of factors. Factor

analysis involves three distinct phases (Pallant, 2020). The first phase verifies the suitability for factor analysis based on the sample size and the strength of the relationship among the case items. To verify the suitability for factor analysis, the sample size is recommended to be more than 150 cases (Tabachnick et al., 2019). Moreover, Pallant (2020) suggests the use of Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett’s test of sphericity (BTS). KMO measure of sampling adequacy was 0.921, above the commonly recommended value of 0.6, and BTS also reached statistical significance (BTS = 0.000,  $p < 0.05$ ).

The second phase, factor extraction, is used to determine the least number of factors that can be extracted to accurately represent the interrelationships between the set of variables. The most used extraction model is principal component analysis (Field, 2013). Using Kaiser’s rule, which selects only factors with eigenvalue of 1.0 or greater, we extracted eleven factors. In cases where the Kaiser criterion extracts too many factors, Pallant (2020) suggests looking at the shape of the plot in a scree plot graph and only considering the points above the “elbow”. Therefore, a Cattell’s scree test was also plotted (Cattell, 1966). The factor analysis was repeated and yielded five factors explaining a total of 54.51% of the variance in the data as displayed in Table 1. The first factor accounted for a significant proportion of the variance (31.55%) compared with the other four factors (9.41%, 5.54%, 4.45% and 3.57%).

Once the number of factors has been determined, the last phase of factor analysis consists of rotating and interpreting them. Field (2013) suggests using both orthogonal and oblique rotations for factor analysis and reporting only the simplest and clearest outputs. Orthogonal rotation in this analysis was suppressed, as it did not provide a clear pattern. Oblique rotation was chosen to review and analyse the data because of the acceptable level of correlation between the variables. The strength of the intercorrelation among items was evaluated through inspection of the correlation matrix for coefficients greater than 0.30 (Tabachnick et al., 2019). The Pattern Matrix showed the loadings of the items on the five factors with twenty-one items loading on Factor 1, seven items loading on Factor 2, seven items loading on Factor 3, three items loading on Factor 4, and ten items loading on Factor 5. Pallant (2020) suggests three or more items loading on each factor as an optimal result, further supporting the researchers’ decision to keep five factors. Interpretation of the factors is reported in section 4.1 of the findings. The quantitative data collected formed the basis and provided the necessary information for the development of the protocol of the subsequent qualitative phase.

### 3.2. Qualitative study

#### 3.2.1. Research design and sample

In the second qualitative phase of this study, SMEs were interviewed about the Open Innovation practices adopted during the coronavirus pandemic and the dynamic capabilities that enabled them. The multiple case study strategy, in particular the semi-structured interview instrument, is specifically suited to this study as it allows to generate interesting insights into a phenomenon in its context, leading to the development of theories and empirical data (Eisenhardt, 1989). Moreover, a multiple case study approach is chosen to allow replication, as well as to produce more evidence (Yin, 2018). In case of mixed methods research, the interview tool is primarily used to explore and explain topics from a survey (Teddlie and Tashakkori, 2009).

We initially discussed the protocol content with 2 SME managers to gather opinions and make improvements to the interview questions. Subsequently, a final protocol of 11 open-ended questions was developed. The questions derived from the factors resulting from the quantitative phase and were divided into 3 sections: (i) Demographics: this section collected additional information on the SMEs, especially regarding the technological level and reference sector; (ii) Exogenous crises: this section investigated the SMEs’ behaviour during the coronavirus pandemic, the strategies adopted, the losses encountered and the dynamic capabilities exploited; (iii) Open Innovation & dynamic capabilities: this section questioned participants about the dynamic

**Table 1**  
Total variance explained (Oblimin).

| Component | Initial Eigenvalues |               |              | Extraction Sums of Squared Loadings |               |              | Rotation Sums of Squared Loadings |
|-----------|---------------------|---------------|--------------|-------------------------------------|---------------|--------------|-----------------------------------|
|           | Total               | % of Variance | Cumulative % | Total                               | % of Variance | Cumulative % | Total                             |
| 1         | 17,035              | 31,546        | 31,546       | 17,035                              | 31,546        | 31,546       | 13,575                            |
| 2         | 5,083               | 9,414         | 40,960       | 5,083                               | 9,414         | 40,960       | 5,003                             |
| 3         | 2,992               | 5,541         | 46,500       | 2,992                               | 5,541         | 46,500       | 5,254                             |
| 4         | 2,402               | 4,449         | 50,949       | 2,402                               | 4,449         | 50,949       | 3,590                             |
| 5         | 1,925               | 3,566         | 54,515       | 1,925                               | 3,566         | 54,515       | 10,283                            |

capabilities needed to progress through the various stages of the Open Innovation funnel during the coronavirus pandemic. The protocol acted as a guide to the interview process and was not rigidly enforced to allow free expression from the interviewees.

Participating firms were purposively sampled based on their expression of willingness, in a field of the survey dedicated to this information, to participate in the later stages of this study. Specifically, out of 399 SMEs who responded to the survey in the quantitative study, 27 SMEs expressed their willingness to be interviewed. Based on their responses to the survey and their secondary resources (e.g. company website and social media), we considered all 27 SMEs to be representative, as these SMEs exhibit three key characteristics for our study: (i) they took concrete actions to respond to the coronavirus pandemic; (ii) they carried out Open Innovation activities; (iii) their activities required dynamic capabilities. Therefore, we contacted all 27 SMEs and 7 of them replied to the contact and agreed to be interviewed. The interviews were carried out in April 2022. Table 2 presents the interviewees' information. The names of SMEs and interviewees are anonymous to respect their privacy.

Each interview lasted between 45 and 70 minutes (average 56 minutes), for a total duration of about 390 minutes, and was recorded and transcribed. The interviews were conducted via Zoom, visually supported by slides representing the Open Innovation funnel, and performed in English. The transcriptions were sent to the respondents for confirmation of accuracy. We also collected information from additional sources to allow for triangulation across different types of data, reviewing reports, articles and documents published by the 7 SMEs on their websites or in press releases. These additional data were used to complement and validate the interview data to build more robust analyses (Yin, 2018).

### 3.2.2. Data analysis

The qualitative data was subjected to thematic analysis using the NVivo software v.12. Thematic analysis allows to identify recurring themes and patterns in a group of data (Saunders et al., 2019). Braun and Clarke (2006) define it as a fundamental method for analysing qualitative data as it offers a flexible yet systematic approach. The thematic analysis process for theory building involves three distinct

**Table 2**  
Selected interviewees.

| Name | Firm size | Firm age             | Firm sector            | Interviewee role  |
|------|-----------|----------------------|------------------------|-------------------|
| SME1 | 50–249    | Older than 20 years  | Service                | Managing Director |
| SME2 | 1–9       | Younger than 5 years | Service                | CEO               |
| SME3 | 10–49     | Older than 20 years  | Manufacturing          | CEO               |
| SME4 | 1–9       | 5–10 years           | Research & Development | Managing Director |
| SME5 | 1–9       | 5–10 years           | Manufacturing          | CEO               |
| SME6 | 50–249    | Older than 20 years  | Manufacturing          | General Manager   |
| SME7 | 1–9       | Younger than 5 years | Service                | CEO               |

phases (Saunders et al., 2019). First, a within-case analysis of each SME was performed where the initial categories of data could emerge through a process of open coding (Corbin and Strauss, 2008). At the end of this phase and after several iterations, twenty-nine first-order codes were identified. Second, a cross-case analysis of SME cases was performed to reveal recurring patterns and identify consistent relationships among data categories (Yin, 2018) through a process of integration (Corbin and Strauss, 2008). At the end of this phase, 6 second-order codes were identified which mainly describe the resilience techniques adopted by SMEs during the coronavirus pandemic. These codes mirror the five factors identified in the quantitative study and have been named accordingly. Finally, closely related themes were combined into three aggregate dimensions (Gioia et al., 2013). Fig. 2 shows the progress from collected data (i.e. first-order codes) to theoretical dimensions (i.e. second-order codes) to building blocks for the final framework (i.e. aggregated dimensions).

Following Eisenhardt's (1989) methodological examples, the analysis process was performed in each case before cross-comparing and pattern matching across and within the cases with an iterative process. Data collection and analysis took place as early as possible after each interview, thus preserving the inter-relational and iterative processes between each interview. The authors took turns engaging in multiple rounds of coding until a strong agreement was reached, leveraging different viewpoints to build a more robust account of data patterns (Eisenhardt, 1989). Furthermore, we triangulated the information derived from the interviews by cross-checking the different data types collected (Yin, 2018). Interpretation of the aggregate dimensions is reported in section 4.2 of the findings.

## 4. Findings

### 4.1. Quantitative study

The factors that condense the quantitative data collected were interpreted and will be defined below.

#### 4.1.1. Factor 1: Pandemic strategies and Dynamic capabilities

Factor 1 represents the strategies and capabilities leveraged by SMEs to survive the coronavirus pandemic. This factor has high factor loadings with the following strategies: digitalisation, collaborations with other firms and redesign of the offer or optimisation of business models, investment in technological innovation, digitalisation and new marketing and distribution channels. Furthermore, this factor has high factor loadings with the following capabilities: ability to innovate, ability to manage technologies and IT systems, ability to learn and absorb knowledge from the outside, ability to open the firm boundaries to external partners, and ability to maintain current functions while adapting to environmental changes. These capabilities are linked to dynamic capabilities as they alter the firm's resource base to address rapidly changing environments (Helfat, 2022). In conclusion, the items clustering on Factor 1 suggest the importance of strategies and dynamic capabilities for survival in an exogenous crisis.

#### 4.1.2. Factor 2: Pandemic effects

Factor 2 represents the effects of the coronavirus pandemic on SMEs.

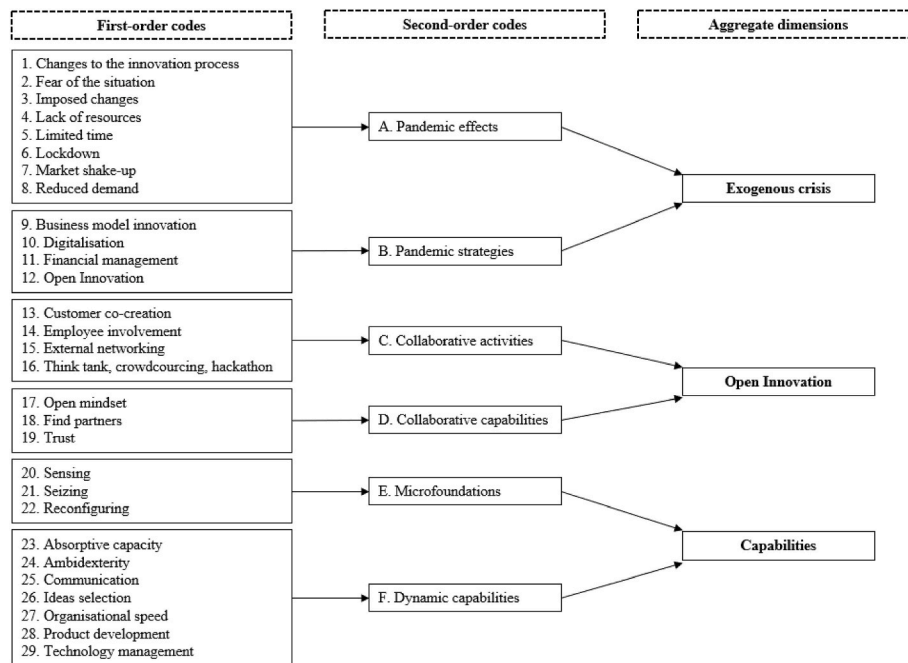


Fig. 2. Data structure.

This factor has high factor loadings with the following pandemic effects: damage in the business functional areas of purchasing, logistics, production, and finance. These effects caused by the coronavirus pandemic negatively impacted SMEs and occurred in a short period of time. In conclusion, the items clustering on Factor 2 show the consequences of an exogenous crisis (such as the coronavirus pandemic) on the functions and activities of SMEs.

#### 4.1.3. Factor 3: Collaborative activities

Factor 3 represents collaborative activities linked to Open Innovation used by SMEs during the coronavirus pandemic, i.e. the deliberate actions and specific activities undertaken by the firms to engage in external collaborations. This factor has high factor loadings with the following collaborative activities: IP out-licensing, IP in-licensing, venturing and spinoffs, crowdsourcing or hackathon. Furthermore, this factor has high factor loadings with the following collaborators: universities or research institutions, and customers, consumers or clients. In conclusion, the items clustering on Factor 3 suggest the importance of adopting Open Innovation practices (e.g. collaboration activities) during an exogenous crisis.

#### 4.1.4. Factor 4: Collaborative capabilities

Factor 4 represents the collaborative capabilities of SMEs before and during the pandemic and their propensity for opening firm boundaries. This factor has high factor loadings with the following elements: the firm has been using collaborations since before the pandemic, and pre-pandemic investments in collaborations. In conclusion, the items clustering on Factor 4 highlight collaborative capabilities and a degree of openness in SMEs already before 2020, as they invested in collaborative practices even before the outbreak of the coronavirus pandemic.

#### 4.1.5. Factor 5: Microfoundations

Factor 5 represents the microfoundations leveraged by SMEs during the coronavirus pandemic to enable Open Innovation practices. This factor has high factor loadings with the following microfoundations: the ability to recognise external sources of knowledge that could be useful internally (i.e. sensing), the ability to seize external opportunities and translate them into innovations (i.e. seizing), the ability to integrate and renew existing resources for innovation (i.e. reconfiguring). In

conclusion, the items clustering on Factor 5 denote an important contribution from microfoundations both to enable collaborations and to counter the pandemic.

This initial quantitative phase provided a broad understanding of the research phenomenon. Through statistical and factor analyses, this phase established a foundation of knowledge regarding the SMEs experience with the coronavirus pandemic, Open Innovation and dynamic capabilities. Building upon this quantitative analysis, the subsequent qualitative phase then delved deeper into how SMEs leverage Open Innovation and dynamic capabilities to develop resilience during an exogenous crisis. This sequential approach allows for a holistic understanding of the research topic, as the quantitative findings provide a context for the qualitative study, while the qualitative insights contribute depth, nuance and a human perspective to the overall research narrative. In more detail, the five factors identified in the quantitative study helped categorise the second-order codes from the qualitative study: Factor 1 *Pandemic strategies and Dynamic capabilities* guided us to define the second-order codes B. *Pandemic strategies* and F. *Dynamic capabilities*; Factor 2 *Pandemic effects* guided us to define the second-order code A. *Pandemic effects*; Factor 3 *Collaborative activities* guided us to define the second-order code C. *Collaborative activities*; Factor 4 *Collaborative capabilities* guided us to define the second-order code D. *Collaborative capabilities*; Factor 5 *Microfoundations* guided us to define the second-order code E. *Microfoundations*.

## 4.2. Qualitative study

The three aggregate dimensions that condense the qualitative data collected were interpreted based on the factors derived from the quantitative phase and will be defined with illustrative quotes below and in Appendix.

### 4.2.1. Exogenous crises

The coronavirus pandemic triggered a severe economic crisis which particularly affected SMEs. The second-order code A. *Pandemic effects* shows that the effects have been many and varied. The restrictive measures imposed by governments put a strain on SMEs, which had to deal with the lack of resources, caused both by the increase in raw material costs and by the staff shortage. Furthermore, the lockdowns

caused a decrease in demand. The difficulties that affected consumers subsequently hit SMEs and their suppliers, thus triggering a chain reaction. However, the pandemic effects also had a positive response. The impossibility for many firms to maintain their current business model or value proposition resulted in a natural and smooth transition to digitalisation and Open Innovation. In line with Nonaka et al. (2000), it is important to lead the creation of order out of chaos as described by SME7: *“At the beginning of the pandemic there was chaos, it was not known whether we could stay open and work or not”*. The changes to innovative processes were felt as imposed by the pandemic, but the transition to digital and interconnected business models was a necessary step to survive the crisis. The changes included the integration of new strategies and processes as well as the acceleration and opening up of innovative processes. SME5 pointed out: *“If it's necessary, things can actually move a lot quicker than they used to... I heard and seen people talk about those changes for years and nothing happens. And then all of a sudden, within two weeks you can do things that you didn't think were possible.”*

SMEs responded to the pandemic effects with different strategies, as shown in the second-order code B. *Pandemic strategies*. The restrictive measures imposed by governments made it impossible for firms to keep in touch with their customers, and SMEs often had to find alternative ways to be present in the market. This caused an almost obligatory transition to digital, which included the use of new advertising channels such as social media, the sale of products via e-commerce and the proposal of new online services. Six out of seven SMEs interviewed adopted a business model innovation strategy, for example by abandoning the classic sales and vertically integrated models for more open and flexible approaches. The transition to digitalisation, as well as the offer adaptation to the new needs related to the coronavirus pandemic, enabled SMEs to continue operating during the crisis. Companies also realised that the lack of resources and time did not allow them to develop solutions on their own, so they started collaborations with their customers, employees and external partners as a survival strategy. SME1 argued: *“Our developers didn't have the capabilities to solve that. So we were reaching out for partners and solutions that could just help us... During a pandemic, I mean, how can you expect to do it all by yourself? There is a lack of resources, time, ideas... Developing new capabilities takes a long time, and during the pandemic, you don't have that time. And if you have to solve something, we can simply integrate people who know what they are talking about and what they are doing... I think that during a pandemic there is a greater need to collaborate and stick together.”*

#### 4.2.2. Open innovation

Open Innovation proved to be a survival strategy for many SMEs during the coronavirus pandemic. Companies leveraged internal and external collaborations to address the ongoing exogenous crisis, as indicated by the second-order code C. *Collaborative activities*. Customer engagement proved to be a successful Open Innovation practice during the pandemic. Customers provided interesting insights for dealing with the pandemic, as well as information on real issues from their point of view and the adaptations that products and services should undergo. Like customer engagement, employee engagement was also an Open Innovation practice widely used by SMEs. During the pandemic, SMEs engaged staff from different departments to come up with new winning ideas. SMEs also started collaborations with external partners, be they competitors, companies of the same ecosystem or suppliers. In particular, online challenges and shared innovation platforms were effective tools for achieving rapid results. SME3 stated: *“We had an online platform... a sort of challenge where people were invited to contribute with ideas... The idea was to share and open source design prototypes for those face shields, ventilators and disinfectants, and making them openly available for user download and 3D printing... Customers have had brilliant ideas, and engineers and manufacturers from the most diverse sectors have worked together to make them concrete.”*. These practices foster the sharing and creation of dynamic knowledge (Nonaka et al., 2000).

The second-order code D. *Collaborative capabilities* determines the

capacities needed to successfully adopt Open Innovation practices. An open mindset was a fundamental requirement for implementing Open Innovation practices. Being open to change and integrating different resources was the key to exploiting the effects of the negative situation. Trust in the collaboration partner was an important concept for practicing openness, as well as communicating boundaries effectively when giving the external partner access to sensitive content. Therefore, finding the right balance between accessing customer resources and integrating external knowledge flows is essential. Finally, firms should have the capability to identify and integrate the right partner for collaborations. In this regard, SME5 highlighted: *“I think the challenge is finding the right partner... You can rely on services for that, but which service really works?... We used our own software to search and we found a company in San Francisco that was doing exactly that.”*

#### 4.2.3. Capabilities

Open Innovation practices are enabled by dynamic capabilities. The microfoundations sensing, seizing and reconfiguring defined in the second-order code E. *Microfoundations* enable SMEs to exploit their dynamic capabilities during an exogenous crisis. During the coronavirus pandemic, firms leveraged the sensing microfoundation to detect the threat's arrival and recognise the need for action through environment scanning. As SME2 described: *“Many companies went bankrupt because... they did not understand in time what was happening”*. The sensing microfoundation proved to be particularly useful in the initial Ideation phase of the Open Innovation funnel, where ideas are screened and filtered. At this stage, the microfoundation sensing allows SMEs to interpret future market needs, both by shaping and recognising opportunities that arise with a changing environment and by anticipating the arrival of external threats. Moreover, once the threat was sensed, firms leveraged the seizing microfoundation to address the emerging opportunity by offering new products and services, moving to digitalisation and developing new business models. As SME4 stated: *“It [the business model] has worked well for 50 years but during a crisis like that of the pandemic it was absolutely not suitable... so we adapted”*. The seizing microfoundation proved to be particularly useful in the intermediate Development phase of the Open Innovation funnel, where ideas are concretised. At this stage, the microfoundation seizing allows SMEs to respond to changing conditions with strategic investments in the development of technologies and projects. Finally, firms leveraged the reconfiguring microfoundation to adapt their processes and resources while maintaining their competitive advantage in the market. As SME1 pointed out: *“We wanted to create that union between what we have already produced and what we could produce from those with our abilities”*. The reconfiguring microfoundation proved to be particularly useful in the final Commercialisation phase of the Open Innovation funnel, where projects are brought to the market. At this stage, the microfoundation reconfiguring allows SMEs to revamp routines and reconfigure assets as the firm grows to come up with solutions that are more likely to gain market acceptance.

While microfoundations enable SMEs to exploit their dynamic capabilities, dynamic capabilities themselves enable Open Innovation practices. The second-order code F. *Dynamic capabilities* names several capabilities that a company should have to practice Open Innovation during an exogenous crisis. Among these, there is the capability to communicate effectively, both within the team and with external partners; the capability to react quickly and firmly to changing conditions; the capability to filter and select winning ideas; and the capability to develop new products and generate innovations. In addition, SMEs particularly highlighted three higher-order dynamic capabilities needed to progress through the various stages of the Open Innovation funnel during the pandemic: absorptive capacity, technology management, and ambidexterity. In the initial Ideation phase, absorptive capacity allows SMEs to understand market changes by absorbing knowledge from the external environment. As SME3 described: *“We looked at what others were doing... we looked up to understand how companies similar to us but*

also our competitors were dealing with it". This shift from a static to a more dynamic view of knowledge relates to the dynamic knowledge creation process presented by Nonaka et al. (2000). During the coronavirus pandemic, firms leveraged absorptive capacity to identify valuable knowledge, select opportunities and scan the behaviour of peer and competitor firms. In the intermediate Development phase, technology management allows SMEs to move towards digitalisation and develop sustainable solutions that can be maintained even after the pandemic. As SME4 stated: "Knowing how to manage information technologies is certainly an advantage. We heard a lot about online sales during the pandemic, and this is thanks to technologies and the digital world". During the coronavirus pandemic, firms leveraged technology management to develop digital business models and keep the core business running. In the final Commercialisation phase, ambidexterity allows SMEs to adapt activities to meet changing environmental needs while maintaining a balance with the firm's current activities. As SME3 described: "We were able to continue doing what we were already doing and at the same time we responded to the situation by doing something new". During the coronavirus pandemic, firms leveraged ambidexterity to take advantage of new opportunities arising in the environment and generate innovation to bring to market. Table 3 presents the definitions of the capabilities mentioned in this section.

5. Discussion

By examining the behaviour of SMEs during the coronavirus pandemic through the conceptualisation of innovation processes, the current study sheds light on the dynamic capabilities needed to progress through the various stages of the Open Innovation funnel during an exogenous crisis. These findings serve as a support for the reinterpretation of the Open Innovation funnel into the Dynamic Open Innovation Funnel.

5.1. Dynamic Open Innovation Funnel

The Dynamic Open Innovation Funnel determines the higher-order dynamic capabilities needed to progress through the various stages of the Open Innovation funnel during an exogenous crisis. Dynamic

capabilities development is constantly evolving, therefore each stage of the Dynamic Open Innovation Funnel involves continuous exchanges within the SMEs and with the external environment (Lichtenthaler and Lichtenthaler, 2009; Nonaka et al., 2000). This new framework tackles the pandemic phenomenon from the point of view of SMEs and combines the constructs of Open Innovation and dynamic capabilities to propose a resilience strategy to exogenous crises. The reshuffle of dynamic capabilities that enable Open Innovation practices during an exogenous crisis identifies an inclination of the funnel in line with higher-order dynamic capabilities. The y-axis refers to the micro-foundations sensing, seizing and reconfiguring that enable SMEs to exploit dynamic capabilities during an exogenous crisis; the x-axis refers to the higher-order dynamic capabilities absorptive capacity, technology management and ambidexterity that enable Open Innovation during an exogenous crisis. Furthermore, for each phase of the innovation process, the most common challenges generated by exogenous crises that an SME can face are mentioned at the top of the Dynamic Open Innovation Funnel. The framework is presented in Fig. 3.

As in the Open Innovation funnel developed by Chesbrough (2003a), arrows crossing the firm boundaries represent the inflows and outflows of knowledge. Knowledge flows that go inside the firm define inbound Open Innovation practices, including IP in-licensing, intermediaries, customer co-creation, crowdsourcing and informal networking (Chesbrough and Brunswicker, 2013). Knowledge flows that go outside the firm define outbound Open Innovation practices, including IP out-licensing, joint-venture activities, selling market-ready products, corporate business incubation and spin-offs (Chesbrough and Brunswicker, 2013). In the Dynamic Open Innovation Funnel, knowledge flows are mediated by the emergence of an exogenous crisis and fed by dynamic capabilities. In the initial Ideation phase of the funnel, SMEs can leverage absorptive capacity to scan the environment and identify valuable knowledge. The generation of new insights and the selection of the most appropriate ideas that characterise the Ideation phase are supported by the knowledge capacities of internal and external exploration processes, respectively inventive capacity and absorptive capacity (Lichtenthaler and Lichtenthaler, 2009). Indeed, an SME with a strong inventive capacity may encourage its employees to brainstorm and explore innovative ideas internally, while a high absorptive capacity can lead to the absorption of external knowledge through market research and industry trend analysis. Typically, in the Ideation phase SMEs seek to identify and address customer demands and unmet needs. However, an exogenous crisis can drastically alter these needs (i.e. shifting customer needs; Donthu and Gustafsson, 2020), requiring SMEs to reevaluate their understanding of customer demands and adapt their ideation processes accordingly. In this context, SMEs can leverage absorptive capacity to actively monitor consumer behaviour and industry trends. The microfoundation sensing enables absorptive capacity at this stage, as it allows SMEs to understand changes in the surrounding environment and recognise opportunities. In the intermediate Development phase, SMEs can leverage technology management to develop sustainable solutions. The conversion of knowledge into new products and services that characterise the Development phase is supported by the knowledge capacities of internal and external exploitation processes, respectively innovative capacity and desorptive capacity (Lichtenthaler and Lichtenthaler, 2009). Indeed, an SME with a strong innovative capacity may establish cross-functional teams comprising employees from different departments exploiting internal knowledge and resources for project development, while a high desorptive capacity can lead to the transfer of internal knowledge and resources to external entities through IP out-licensing to other companies. Typically, in the Development phase SMEs concretise ideas and implement digital projects. However, an exogenous crisis can alter normal business operations (i.e. operational disruption; Miklian and Hoelscher, 2022), causing delays or interruptions in the development process. This can be due to workforce limitations or supply chain disruptions, making it difficult for SMEs to effectively execute their development plans. In this context, SMEs can

Table 3  
Definitions of capabilities.

| CAPABILITIES                | DEFINITIONS                                                                                                                                   |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Microfoundation</b>      |                                                                                                                                               |
| Sensing                     | Firm's ability to exploit its resources to recognise an opportunity in the market (Teece, 2007)                                               |
| Seizing                     | Firm's ability to mobilise its resources to address the opportunity and capture value (Teece, 2007)                                           |
| Reconfiguring               | Firm's ability to recombine and transform its resources to maintain a competitive advantage (Teece, 2007)                                     |
| <b>Dynamic Capabilities</b> |                                                                                                                                               |
| Absorptive Capacity         | Firm's ability to use external knowledge by investing in internal research (Cohen and Levinthal, 1990; Lichtenthaler and Lichtenthaler, 2009) |
| Ambidexterity               | Firm's ability to balance the simultaneous processes of exploration and exploitation in the organisation (Vahne and Jonsson, 2016)            |
| Communication               | Firm's ability to forward new information and exchange views among its members (Gómez and Ballard, 2013)                                      |
| Ideas Selection             | Firm's ability to evaluate and choose the most promising ideas from a pool of potential proposals (Björk et al., 2010)                        |
| Organisational Speed        | Firm's ability to accelerate relevant organisational processes that are the basis of competitive advantage (Dykes et al., 2019)               |
| Product Development         | Firm's ability to combine managers skills and backgrounds to create products and services that generate revenue (Eisenhardt and Martin, 2000) |
| Technology Management       | Firm's ability to manage and implement technological means in order to achieve the firm's objectives (Cetindamar et al., 2009)                |

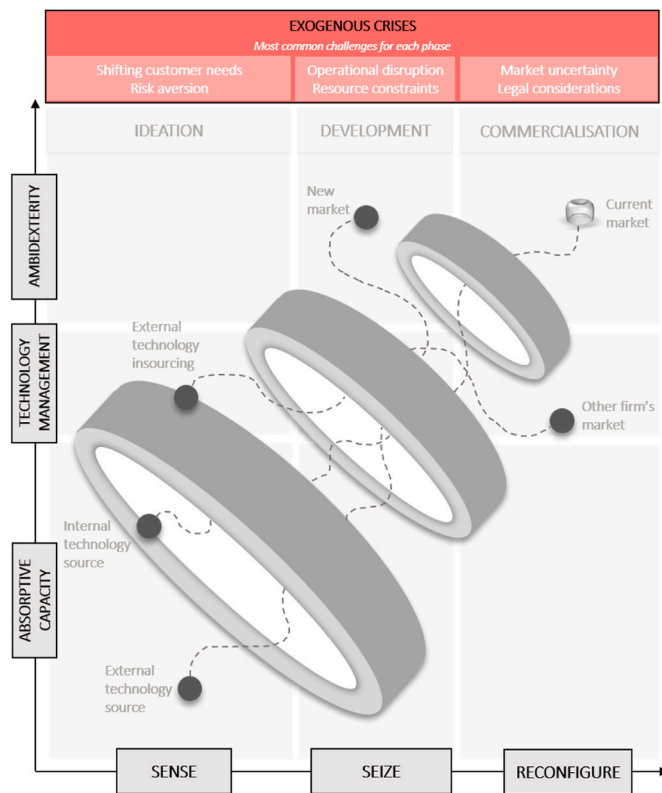


Fig. 3. Dynamic Open Innovation Funnel.

leverage technology management to develop automation technologies that reduce their reliance on manual processes and human intervention. The microfoundation seizing enables technology management at this stage, as it allows SMEs to respond to changes in the surrounding environment with strategic investments in the development of technologies. In the final Commercialisation phase, SMEs can leverage ambidexterity to generate innovation by exploiting new opportunities arising in the environment. The transfer and preservation of knowledge that characterise the Commercialisation phase are supported by the knowledge capacities of internal and external retention processes, respectively transformative capacity and connective capacity (Lichtenthaler and Lichtenthaler, 2009). Indeed, an SME with a strong transformative capacity may transform its internal processes, for example by adopting lean principles, to facilitate successful commercialisation and retain knowledge inside the firm, while a high connective capacity can lead to strategic alliances or partnerships with other organisations. Typically, in the Commercialisation phase SMEs bring to market their new products or services. However, an exogenous crisis can introduce high levels of unpredictability of the market (i.e. market uncertainty; Sharma et al., 2020), making it challenging for SMEs to commercialise their innovations. SMEs may need to reassess their commercialisation strategies, distribution channels, and go-to-market plans in response to the crisis dynamics. In this context, SMEs can leverage ambidexterity to diversify their offering while maintaining a balance with core activities. The microfoundation reconfiguring enables ambidexterity at this stage, as it allows SMEs to adapt to changes in the surrounding environment while maintaining the competitive advantage gained with the firm's current activities. The identification of the dynamic capabilities needed at each stage of an Open Innovation process allows SMEs to consciously address an exogenous crisis and to remain resilient in the face of the resulting difficulties.

## 6. Conclusions

The worldwide economy has been negatively impacted by the coronavirus pandemic, with SMEs being the most severely hit. To survive and thrive in exogenous crises such as those caused by pandemics, SMEs must develop resilience and establish alternative strategies. Companies' transformational change and renewal depend heavily on innovation, especially Open Innovation, as it enables them to develop innovative strategies to solve pressing issues and forge relationships that will be beneficial during and after exogenous crises. Despite the considerable attention given to Open Innovation in the literature, there are still many unanswered questions, especially regarding its implementation in SMEs and its function in exogenous crises. This paper attempted to delve into this aspect by answering the following research question: How can Open Innovation and dynamic capabilities be leveraged by SMEs to develop resilience during an exogenous crisis? With a quantitative study on 399 SMEs located in the Free State of Bavaria (Germany) and a qualitative multiple case study of 7 SMEs, a sequential explanatory mixed methods research design was employed. The integration of the data collected has identified a new framework, the Dynamic Open Innovation Funnel, which proposes a resilience strategy to exogenous crises for SMEs.

From a theoretical perspective, this study contributes to the literature on Open Innovation and dynamic capabilities by examining their role in supporting SMEs during exogenous crises. This study addresses the scholars' call for research on the benefits of Open Innovation during an exogenous crisis (Chesbrough, 2020; McGahan et al., 2021). This research provides evidence that Open Innovation can help SMEs to find alternative ways to function, develop partnerships, and access external resources to support their operations during a crisis. Moreover, the study demonstrates that dynamic capabilities can enable SMEs to adapt to changing market conditions, leveraging the resources developed and saved during stable periods to innovate during a crisis. From a practical perspective, this study provides valuable insights for SMEs, policy-makers, and practitioners on how to navigate economic crises caused by exogenous factors. The findings suggest that SMEs should embrace Open Innovation and develop dynamic capabilities as a means of building resilience during such crises. A practical contribution for SME managers and practitioners to develop resilience strategies is to more explicitly involve aspects of the Dynamic Open Innovation Funnel in their innovation processes. In the Ideation phase of their innovation processes, SMEs can actively scan the environment for valuable knowledge and insights related to the exogenous crisis. For example, they can participate in industry forums, attend market research, and actively monitor consumer behaviour and industry trends. This can help them timely generate innovative ideas that address the crisis and create new opportunities. In the Development phase, SMEs can focus on developing digital business models and solutions that align with the crisis context. For instance, they can identify alternative technology solutions and invest in automation technologies such as robotic process automation or artificial intelligence. This enables them to adapt to changing market conditions and seize emerging opportunities. In the Commercialisation phase, SMEs can complement current activities with innovation generation. For example, they can diversify their offering or explore new markets through collaborations and strategic partnerships. This allows SMEs to adapt quickly to the evolving business landscape. Policymakers should build on these insights to create an enabling regulatory environment. Regulations need to be reviewed and adapted to support Open Innovation practices, such as streamlining IP processes and facilitating technology transfer. By reducing barriers and creating a supportive regulatory framework, policymakers can encourage SMEs to develop dynamic capabilities and engage in inbound and outbound Open Innovation activities. Furthermore, by providing funding, infrastructure and networking opportunities, policymakers can foster Open Innovation ecosystems, encouraging collaboration between SMEs, research institutes and other stakeholders, and facilitating the exchange of

knowledge and resources. This guidance can inform the development of best practices and guidelines for SMEs.

This study has unique strengths, such as the mixed methods research approach. However, we also acknowledge the limitations of our work, which open promising avenues for future research on Open Innovation as a resilience strategy. The choice of selecting the sample from a single German region is one of these limitations. Indeed, [Brusoni et al. \(2001\)](#) state that Open Innovation activities vary among countries. Therefore, the findings of this study should be generalised with a note of caution to SMEs in other regions and countries. Furthermore, the coronavirus pandemic itself can be a limitation as just a particular case of exogenous crisis. Therefore, future research should explore the role of Open Innovation and dynamic capabilities in promoting SME resilience in new contexts and settings. The lack of in-depth analysis of the concepts of tacit and explicit knowledge ([Nonaka et al., 1996](#); [Takeuchi and Nonaka, 1986](#)) represents another limitation of our work. Future studies could address this limitation by investigating if and how tacit and explicit knowledge affects SMEs' Open Innovation activities during exogenous crises. Furthermore, future studies may analyse if and how Open Innovation and dynamic capabilities can be adopted by SMEs for coopetition strategies in response to exogenous crises. Finally, the potential that Open Innovation has in the context of crisis and disaster management can open the doors to a new line of research such as that of Open Social

Innovation, which faces grand challenges and social problems.

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Declaration of competing interest

None.

Data availability

The data that has been used is confidential.

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Appendix

| DIMENSIONS                                     | REPRESENTATIVE DATA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Aggregate dimension: Exogenous crisis          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Second-order code: A. Pandemic effects         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "[We] adopted more agile, less formal processes... We understood that a change needed to be faced and we adopted a mindset more inclined to change" (SME3)                                                                                                                                                                                                                                                                                                                                                      |
| 1. Changes to the innovation process           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "The resistance is great and the change is not welcomed... so anything that is done that is a little different than usual is innovative, and is viewed a little with distrust" (SME1)                                                                                                                                                                                                                                                                                                                           |
| 2. Fear of the situation                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "We had to make some changes, more forced than by will... Whereas before the pandemic we could stall, during the pandemic we had to act and deal with this change... Innovation is usually done when you want, I believe, but here it was a mandatory step, either innovate or die" (SME2)                                                                                                                                                                                                                      |
| 3. Imposed changes                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "We got a lot of inquiries and a lot of projects... we weren't prepared for that. We did not have enough resources, and many employees were absent due to illness... There is a lack of resources, time, ideas, a lot of things are missing under one roof" (SME1)                                                                                                                                                                                                                                              |
| 4. Lack of resources                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "There was a hurry, there was a need to act immediately... At the beginning of the pandemic there was chaos, it was not known whether we could stay open and work or not. In more normal times, things are done more calmly" (SME7)                                                                                                                                                                                                                                                                             |
| 5. Limited time                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "I think the worst part was when Germany imposed the closure obligation for certain categories of businesses... Many of my clients have stopped working. And if they don't work, neither do I... We had to be on site and use the machines, test, try. And this whole part practically skipped during the lockdown" (SME4)                                                                                                                                                                                      |
| 6. Lockdown                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "There is more urgency, more innovation, more collaborative spirit, more digitalisation, more openness to the outside world. In the end, I think it's all good things, we've gained a new approach to the economy" (SME4)                                                                                                                                                                                                                                                                                       |
| 7. Market shake-up                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "What happened, however, was the drastic reduction in demand. If I used to receive a new project every month on average, during the pandemic I will have received about 5 or 6 in total, and half of these from state agencies" (SME4)                                                                                                                                                                                                                                                                          |
| 8. Reduced demand                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Second-order code: B. Pandemic strategies      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "It's like the existing business model is running out. And so you have to work with very limited resources... When those things started, it was immediately clear that we need to change this because the old ways will not be coming back... So we decided to change. It was like rebuilding the company, transform it" (SME5)                                                                                                                                                                                 |
| 9. Business model innovation                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "Everything moved online... Writing a blog is something that we started doing a lot more often during the pandemic... Everything has to be online because it cannot travel and meet people and explain or install anything... That means you have to produce a lot of content that can be consumed in an asynchronous way" (SME5)                                                                                                                                                                               |
| 10. Digitalisation                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "It was really hard and beyond that of course we also started with planning and taking a look at what's riskier... We had of course in mind what will happen, so we planned with numbers and figures and so on" (SME1)                                                                                                                                                                                                                                                                                          |
| 11. Financial management                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "The pandemic has forced to open innovation for us in a way that probably we wouldn't have done otherwise... I can see now there's more openness now for collaboration than there was before... So having the option to do open innovation now has become far more attractive and I think it definitely been accelerated by the COVID... The pandemic had a profound effect on how we think and how we operate. And it has pushed us down to the open innovation route more than it normally would have" (SME6) |
| 12. Open Innovation                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Aggregate dimension: Open Innovation           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Second-order code: C. Collaborative activities |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "We also have that process of automatic generation of ideas in that platform that I said where customers ask questions and solve their problems themselves, they come up with a lot of ideas" (SME1)                                                                                                                                                                                                                                                                                                            |
| 13. Customer co-creation                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| First-order code:                              | "We have cross functional teams that are not reliant on a particular department anymore... there's probably five or six people in a cross functional team and one person in that team will take the lead of it... we assemble these cross functional silos into almost like a collective capability" (SME6)                                                                                                                                                                                                     |
| 14. Employee involvement                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

(continued on next page)

(continued)

| DIMENSIONS                                                           | REPRESENTATIVE DATA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>First-order code:</b><br>15. External networking                  | "The question was do we build it ourselves? Or is there something out there that already existed for years?... We found a company in San Francisco that was doing exactly that... it's a very effective process, because if we had to build it ourselves from scratch, it would have taken us half a year longer" (SME5)                                                                                                                                                                             |
| <b>First-order code:</b><br>16. Think tank, crowdsourcing, hackathon | "So many other people are sharing what they have with us, we are reinventing it right now with so called think tanks, where all those potential partners can show up and offer their knowledge and you recognise that, oh, that's something I need for my project or something that is interesting and could be implemented within our company" (SME1)                                                                                                                                               |
| <b>Second-order code: D. Collaborative capabilities</b>              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>First-order code:</b><br>17. Open mindset                         | "You need more open-mindedness than we SMEs have. We are small and therefore we are afraid to take risks, but perhaps it is being small that is precisely the reason why we need to collaborate with someone else... Costs, risks and responsibilities are shared" (SME2)                                                                                                                                                                                                                            |
| <b>First-order code:</b><br>18. Find partners                        | "I think the challenge is finding the right partner... You can rely on services for that, but which service really works? We found a company... that was doing exactly that" (SME5)                                                                                                                                                                                                                                                                                                                  |
| <b>First-order code:</b><br>19. Trust                                | "You need to be ready to share information and tools with someone outside your company. Trust, maybe? It's not easy at first, you want to be protective, but it's not the right way to go" (SME7)                                                                                                                                                                                                                                                                                                    |
| <b>Aggregate dimension: Capabilities</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Second-order code: E. Microfoundations</b>                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>First-order code:</b><br>20. Sensing                              | "When those things started, it was immediately clear that we need to change this because the old ways will not be coming back... So we decided to change" (SME5)                                                                                                                                                                                                                                                                                                                                     |
| <b>First-order code:</b><br>21. Seizing                              | "We had to exploit the pandemic and its challenges to do something new using the capabilities and skills we already have... The pandemic as well as war and other crises can become an opportunity to be seized to innovate... The pandemic could push us to exploit external situations to adapt internally, to be more dynamic and fluid in some way" (SME1)                                                                                                                                       |
| <b>First-order code:</b><br>22. Reconfiguring                        | "We redirect our offer a bit. What we have done is to direct our offer a little more towards relevant topics during the pandemic... In this way we have used our skills and resources in a different way than usual. We took the opportunity to review our strengths a little and direct them towards other paths... Reinventing oneself, knowing how to transform oneself" (SME4)                                                                                                                   |
| <b>Second-order code: F. Dynamic capabilities</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>First-order code:</b><br>23. Absorptive capacity                  | "We looked around a lot. Kind of like absorbing the knowledge of others... What does our competitor do? What does our colleague do?... It is easier to copy something already done or already thought than to have to do it all over again... We tried to understand how the market and its operators moved, so as not to be left behind" (SME7)                                                                                                                                                     |
| <b>First-order code:</b><br>24. Ambidexterity                        | "We expanded our production line, we continued to produce what we already did but part of the production was adapted to this new line, and everything was faster because we didn't have to do everything from scratch, everything was already there, it was just a little bit modified. How to say, we were able to continue doing what we were already doing and at the same time we responded to the situation by doing something new" (SME3)                                                      |
| <b>First-order code:</b><br>25. Communication                        | "You also need good communication, we communicated our ideas in our own way, you know, like business requirements, and they had to translate them into their technical requirements, with their computer language, so you need to know how to explain yourself well and meet over and over again" (SME3)                                                                                                                                                                                             |
| <b>First-order code:</b><br>26. Ideas selection                      | "There weren't actually many ideas really, there wasn't much more to do than go digital. Of the couple that we did have, I would say that those that had qualities such as speed of development, good price-performance ratio, that possibly didn't disrupt the whole business model of the company that has been working so well for years, went on to the next stage. Of course, it takes filtering and sorting to keep too much crap out of the funnel, because then it becomes expensive" (SME2) |
| <b>First-order code:</b><br>27. Organisational speed                 | "We were quick enough to react. We implemented those digital channels, communication channels very, very fast... There are solutions that could be implemented very quickly, and also communicated very quickly" (SME1)                                                                                                                                                                                                                                                                              |
| <b>First-order code:</b><br>28. Product development                  | "We have implemented the gamification platform for our employees, which still exists for our company, and we have just adopted it for the whole theme of creating innovation... We have some sort of challenges that we need to solve, all of which are related to what could be a possible new product and innovation for the future" (SME1)                                                                                                                                                        |
| <b>First-order code:</b><br>29. Technology management                | "The capabilities we needed were technology management... Our team is very united and young... and therefore they could teach us many things. For example, they taught us how to manage technologies, which certainly benefited us during the pandemic" (SME7)                                                                                                                                                                                                                                       |

## References

- Abhari, K., McGuckin, S., 2023. Limiting factors of open innovation organizations: a case of social product development and research agenda. *Technovation* 119, 102526. <https://doi.org/10.1016/j.technovation.2022.102526>.
- Ahn, J.M., Mortara, L., Minshall, T., 2018. Dynamic Capabilities and Economic Crises: Has Openness Enhanced a Firm's Performance in an Economic Downturn?, vol. 27, pp. 49–63. <https://doi.org/10.1093/icc/dtx048>, 1.
- Bacq, S., Geoghegan, W., Josefy, M., Stevenson, R., Williams, T.A., 2020. The COVID-19 Virtual Idea Blitz: marshaling social entrepreneurship to rapidly respond to urgent grand challenges. *Bus. Horiz.* 63 (6), 705–723. <https://doi.org/10.1016/j.bushor.2020.05.002>.
- Barrett, G., Tsekouras, G., 2022. A tango with a gorilla: an exploration of the microfoundations of open innovation partnerships between young innovative companies and multi-national enterprises. *Technovation* 117, 102561. <https://doi.org/10.1016/j.technovation.2022.102561>.
- Battisti, M., Deakins, D., 2017. The relationship between dynamic capabilities, the firm's resource base and performance in a post-disaster environment. *Int. Small Bus. J. Res. Entrep.* 35 (1), 78–98. <https://doi.org/10.1177/0266242615611471>.
- Bergami, M., Corsino, M., Daoood, A., Giuri, P., 2022. Being resilient for society: evidence from companies that leveraged their resources and capabilities to fight the COVID-19 crisis. *R D Manag.* 52 (2), 235–254. <https://doi.org/10.1111/radm.12480>.
- Bertello, A., Bogers, M., De Bernardi, P., 2022. Open innovation in the face of the COVID-19 grand challenge: insights from the Pan-European hackathon 'EUvsVirus'. *R D Manag.* 52 (2), 178–192. <https://doi.org/10.1111/radm.12456>.
- Björk, J., Boccadelli, P., Magnusson, M., 2010. Ideation capabilities for continuous innovation. *Creativ. Innovat. Manag.* 19 (4), 385–396. <https://doi.org/10.1111/j.1467-8691.2010.00581.x>.
- Bocken, N.M.P., Geradts, T.H.J., 2020. Barriers and drivers to sustainable business model innovation: organization design and dynamic capabilities. *Long. Range Plan.* 53 (4), 101950. <https://doi.org/10.1016/j.lrp.2019.101950>.
- Bogers, M., Chesbrough, H., Heaton, S., Teece, D.J., 2019. Strategic management of open innovation: a dynamic capabilities perspective. *Calif. Manag. Rev.* 62 (1), 77–94. <https://doi.org/10.1177/0008125619885150>.
- Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. *Qual. Res. Psychol.* 3 (2), 77–101. <https://doi.org/10.1191/1478088706qp0630a>.
- Brunswick, S., Vanhaverbeke, W., 2015. Open innovation in small and medium-sized enterprises (SMEs): external knowledge sourcing strategies and internal organizational facilitators. *J. Small Bus. Manag.* 53 (4), 1241–1263. <https://doi.org/10.1111/jsbm.12120>.
- Brusoni, S., Prencipe, A., Pavitt, K., 2001. Knowledge specialization, organizational coupling, and the boundaries of the firm: why do firms know more than they make? *Adm. Sci. Q.* 46 (4), 597–621. <https://doi.org/10.2307/3094825>.
- Bryman, A., 2006. Integrating quantitative and qualitative research: how is it done? *Qual. Res.* 6 (1), 97–113. <https://doi.org/10.1177/1468794106058877>.
- Buyl, T., Boone, C., Wade, J.B., 2019. CEO narcissism, risk-taking, and resilience: an empirical analysis in U.S. Commercial banks. *J. Manag.* 45 (4), 1372–1400. <https://doi.org/10.1177/0149206317699521>.
- Cattell, R.B., 1966. The Scree Test for the Number of Factors, vol. 1, pp. 245–276. [https://doi.org/10.1207/s15327906mbr0102\\_10](https://doi.org/10.1207/s15327906mbr0102_10), 2.
- Cetindamar, D., Phaal, R., Probert, D., 2009. Understanding technology management as a dynamic capability: a framework for technology management activities. *Technovation* 29 (4), 237–246. <https://doi.org/10.1016/j.technovation.2008.10.004>.
- Chesbrough, H., 2003a. *Open Innovation: the New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.
- Chesbrough, H., 2003b. The Era of open innovation. *MIT Sloan Manag. Rev.* 44 (3), 35–41.

- Chesbrough, H., 2012. Open innovation where we've been and where we're going. *Res. Technol. Manag.* 55 (4), 20–27. <https://doi.org/10.5437/08956308X5504085>.
- Chesbrough, H., 2020. To recover faster from Covid-19, open up: managerial implications from an open innovation perspective. *Ind. Market. Manag.* 88, 410–413. <https://doi.org/10.1016/j.indmarman.2020.04.010>.
- Chesbrough, H., Bogers, M., 2014. Explicating open innovation: clarifying an emerging paradigm for understanding innovation. In: Chesbrough, H., Vanhaverbeke, W., West, J. (Eds.), *New Frontiers in Open Innovation*. Oxford University Press, pp. 3–28.
- Chesbrough, H., Brunswicker, S., 2013. *Managing Open Innovation in Large Firms*. Garwood Center for Corporate Innovation at California University. US & Fraunhofer Society in Germany, Berkeley.
- Cohen, W.M., Levinthal, D.A., 1990. Absorptive capacity: a new perspective on learning and innovation. *Adm. Sci. Q.* 35 (1), 128–152. <https://doi.org/10.2307/2393553>.
- Collis, D.J., 1994. Research note: how valuable are organizational capabilities? *Strat. Manag. J.* 15, 143–152. <https://doi.org/10.1002/smj.4250150910>.
- Cook, C., Heath, F., Thompson, R., 2000. A meta-analysis of response rates in web- or internet-based survey. *Educ. Psychol. Meas.* 60, 821–836. <https://doi.org/10.1177/00131640021970934>.
- Corbin, J., Strauss, A., 2008. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. xv, 379, third ed. SAGE Publications, Inc. <https://doi.org/10.4135/9781452230153>.
- Creswell, J.W., 2009. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, third ed. SAGE Publications, Inc.
- Dahlander, L., Wallin, M., 2020. Why now is the time for “open innovation”. *Harv. Bus. Rev.* 5, 8–27.
- Di Minin, A., Frattini, F., Piccaluga, A., 2010. Fiat: open innovation in a downturn (1993–2003). *Calif. Manag. Rev.* 52 (3), 132–159. <https://doi.org/10.1525/cmr.2010.52.3.132>.
- Donthu, N., Gustafsson, A., 2020. Effects of COVID-19 on business and research. *J. Bus. Res.* 117, 284–289. <https://doi.org/10.1016/j.jbusres.2020.06.008>.
- Dubé, L., Paré, G., 2003. Rigor in information systems positivist case research: current practices, trends, and recommendations. *MIS Q.* 27 (4), 597–636. <https://doi.org/10.2307/30036550>.
- Dunphy, S.M., Herbig, P.R., Howes, M.E., 1996. The innovation funnel. *Technol. Forecast. Soc. Change* 53 (3), 279–292. [https://doi.org/10.1016/S0040-1625\(96\)00098-4](https://doi.org/10.1016/S0040-1625(96)00098-4).
- Dykes, B.J., Hughes-Morgan, M., Kolev, K.D., Ferrier, W.J., 2019. Organizational speed as a dynamic capability: toward a holistic perspective. *Strat. Organ.* 17 (2), 266–278. <https://doi.org/10.1177/1476127018804249>.
- Eggers, F., 2020. Masters of disasters? Challenges and opportunities for SMEs in times of crisis. *J. Bus. Res.* 116, 199–208. <https://doi.org/10.1016/j.jbusres.2020.05.025>.
- Eisenhardt, K.M., 1989. Building theories from case study research. *Acad. Manag. Rev.* 14 (4), 532–550. <https://doi.org/10.5465/amr.1989.4308385>.
- Eisenhardt, K.M., Furr, N.R., Bingham, C.B., 2010. Microfoundations of performance: balancing efficiency and flexibility in dynamic environments. *Organ. Sci.* 21 (6), 1263–1273. <https://doi.org/10.1287/orsc.1100.0564>.
- Eisenhardt, K.M., Martin, J.A., 2000. Dynamic capabilities: what are they? *Strat. Manag. J.* 21 (10–11), 1105–1121. [https://doi.org/10.1002/1097-0266\(200010/11\)21:10<1105::AID-SMJ133>3.0.CO;2-E](https://doi.org/10.1002/1097-0266(200010/11)21:10<1105::AID-SMJ133>3.0.CO;2-E).
- European Commission, 2020. *Unleashing the Full Potential of European SMEs*. European Commission.
- European Commission, 2021. *Industry 5.0: towards a Sustainable, Human Centric and Resilient European Industry*. Publications Office. <https://data.europa.eu/doi/10.2777/308407>.
- Field, A., 2013. *Discovering Statistics Using IBM SPSS Statistics*, fourth ed. SAGE Publications, Inc.
- Gioia, D., Corley, K., Hamilton, A., 2013. Seeking qualitative rigor in inductive research. *Organ. Res. Methods* 16, 15–31. <https://doi.org/10.1177/1094428112452151>.
- Goffin, K., Åhlström, P., Bianchi, M., Richtner, A., 2019. Perspective: state-of-the-art: the quality of case study research in innovation management. *J. Prod. Innovat. Manag.* 36 (5), 586–615. <https://doi.org/10.1111/jpim.12492>.
- Goffin, K., Mitchell, R., 2017. *Innovation Management: Effective Strategy and Implementation*. Palgrave Macmillan.
- Gómez, L.F., Ballard, D.I., 2013. Communication for the long term: information allocation and collective reflexivity as dynamic capabilities. *J. Bus. Commun.* 50 (2), 208–220. <https://doi.org/10.1177/0021943612474992>.
- Guarner, J., 2020. Three emerging coronaviruses in two decades. *Am. J. Clin. Pathol.* 153 (4), 420–421. <https://doi.org/10.1093/ajcp/aqaa029>.
- Heider, A., Gerken, M., van Dinther, N., Hülsbeck, M., 2021. Business model innovation through dynamic capabilities in small and medium enterprises—Evidence from the German Mittelstand. *J. Bus. Res.* 130, 635–645. <https://doi.org/10.1016/j.jbusres.2020.04.051>.
- Helfat, C.E., 2022. Strategic organization, dynamic capabilities, and the external environment. *Strat. Organ.* 20 (4), 734–742. <https://doi.org/10.1177/14761270221115377>.
- Hillmann, J., Guenther, E., 2021. Organizational resilience: a valuable construct for management research? *Int. J. Manag. Rev.* 23 (1), 7–44. <https://doi.org/10.1111/ijmr.12239>.
- Hutton, S., Demir, R., Eldridge, S., 2021. How does open innovation contribute to the firm's dynamic capabilities? *Technovation* 102288. <https://doi.org/10.1016/j.technovation.2021.102288>.
- Iborra, M., Safón, V., Dolz, C., 2020. What explains the resilience of SMEs? Ambidexterity capability and strategic consistency. *Long. Range Plan.* 53 (6), 101947. <https://doi.org/10.1016/j.lrp.2019.101947>.
- Kokshagina, O., 2022. Open Covid-19: organizing an extreme crowdsourcing campaign to tackle grand challenges. *R D Manag.* 52 (2), 206–219. <https://doi.org/10.1111/rdm.12470>.
- Koronis, E., Ponis, S., 2018. Better than before: the resilient organization in crisis mode. *J. Bus. Strat.* 39 (1), 32–42. <https://doi.org/10.1108/JBS-10-2016-0124>.
- Kottika, E., Özsoy, A., Rydén, P., Theodorakis, I.G., Kaminakis, K., Kottikas, K.G., Stathakopoulos, V., 2020. We survived this! What managers could learn from SMEs who successfully navigated the Greek economic crisis. *Ind. Market. Manag.* 88, 352–365. <https://doi.org/10.1016/j.indmarman.2020.05.021>.
- Lee, S., Park, G., Yoon, B., Park, J., 2010. Open innovation in SMEs—an intermediated network model. *Res. Pol.* 39 (2), 290–300. <https://doi.org/10.1016/j.respol.2009.12.009>.
- Leppäaho, T., Ritala, P., 2022. Surviving the coronavirus pandemic and beyond: unlocking family firms? Innovation potential across crises. *Journal of Family Business Strategy* 13 (1). <https://doi.org/10.1016/j.jfbs.2021.100440>.
- Lichtenthaler, U., Lichtenthaler, E., 2009. A capability-based framework for open innovation: complementing absorptive capacity. *J. Manag. Stud.* 46 (8), 1315–1338. <https://doi.org/10.1111/j.1467-6486.2009.00854.x>.
- Linde, S., Sjödin, D., Parida, V., Wincent, J., 2021. Dynamic capabilities for ecosystem orchestration A capability-based framework for smart city innovation initiatives. *Technol. Forecast. Soc. Change* 166, 120614. <https://doi.org/10.1016/j.techfore.2021.120614>.
- Livieratos, A.D., Tsekouras, G., Vanhaverbeke, W., Angelakis, A., 2022. Open Innovation moves in SMEs: how European SMEs place their bets? *Technovation* 117, 102591. <https://doi.org/10.1016/j.technovation.2022.102591>.
- Marzi, G., Fakhra Manesh, M., Caputo, A., Pellegrini, M., Vlacic, B., 2023. Do or do not. Cognitive configurations affecting Open Innovation adoption in SMEs. *Technovation* 119, 1–15. <https://doi.org/10.1016/j.technovation.2022.102585>.
- McGahan, A.M., Bogers, M., Chesbrough, H., Holgersson, M., 2021. Tackling societal challenges with open innovation. *Calif. Manag. Rev.* 63 (2), 49–61. <https://doi.org/10.1177/0008125620973713>.
- Mikalef, P., Boura, M., Lekakos, G., Krogstie, J., 2019. Big data analytics capabilities and innovation: the mediating role of dynamic capabilities and moderating effect of the environment. *Br. J. Manag.* 30 (2), 272–298. <https://doi.org/10.1111/1467-8551.12343>.
- Miklikian, J., Hoelscher, K., 2022. SMEs and exogenous shocks: a conceptual literature review and forward research agenda. *Int. Small Bus. J.* 40 (2), 178–204. <https://doi.org/10.1177/02662426211050796>.
- Nonaka, I., Toyama, R., Konno, N., 2000. SECI, Ba and leadership: a unified model of dynamic knowledge creation. *Long. Range Plan.* 33. [https://doi.org/10.1016/S0024-6301\(99\)00115-6](https://doi.org/10.1016/S0024-6301(99)00115-6).
- Nonaka, I., Umemoto, K., Senoo, D., 1996. From information processing to knowledge creation: a Paradigm shift in business management. *Technol. Soc.* 18 (2), 203–218. [https://doi.org/10.1016/0160-791X\(96\)00001-2](https://doi.org/10.1016/0160-791X(96)00001-2).
- OECD, 2020. *Coronavirus (COVID-19): SME Policy Responses*.
- OECD, 2022. *OECD Reviews Of Innovation Policy: Germany 2022: Building Agility For Successful Transitions* (OECD Reviews of Innovation Policy). OECD. <https://doi.org/10.1787/50b32331-en>.
- Ogink, R.H.A.J., Goossen, M.C., Romme, A.G.L., Akkermans, H., 2023. Mechanisms in open innovation: a review and synthesis of the literature. *Technovation* 119, 102621. <https://doi.org/10.1016/j.technovation.2022.102621>.
- Ovuakporie, O.D., Gopalakrishna Pillai, K., Wang, C., Wei, Y., 2021. Differential moderating effects of strategic and operational reconfiguration on the relationship between open innovation practices and innovation performance. *Res. Pol.* 50 (1), 104146. <https://doi.org/10.1016/j.respol.2020.104146>.
- Ozanne, L.K., Chowdhury, M., Prayag, G., Mollenkopf, D.A., 2022. SMEs navigating COVID-19: the influence of social capital and dynamic capabilities on organizational resilience. *Ind. Market. Manag.* 104, 116–135. <https://doi.org/10.1016/j.indmarman.2022.04.009>.
- Pallant, J., 2020. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*, seventh ed. <https://doi.org/10.4324/9781003117452> Routledge.
- Papadopoulos, T., Stamati, T., Nikolaidou, M., Anagnostopoulos, D., 2013. From Open Source to Open Innovation practices: a case in the Greek context in light of the debt crisis. *Technol. Forecast. Soc. Change* 80 (6), 1232–1246. <https://doi.org/10.1016/j.techfore.2012.10.030>.
- Parida, V., Westerberg, M., Frishammar, J., 2012. Inbound open innovation activities in high-tech SMEs: the impact on innovation performance. *J. Small Bus. Manag.* 50 (2), 283–309. <https://doi.org/10.1111/j.1540-627X.2012.00354.x>.
- Patzelt, H., Shepherd, D.A., 2008. The decision to persist with underperforming alliances: the role of trust and control. *J. Manag. Stud.* 45 (7), 1217–1243. <https://doi.org/10.1111/j.1467-6486.2008.00791.x>.
- Re, B., Magnani, G., 2022. Value co-creation in circular entrepreneurship: an exploratory study on born circular SMEs. *J. Bus. Res.* 147, 189–207. <https://doi.org/10.1016/j.jbusres.2022.03.090>.
- Reilly, M., Sharkey Scott, P., 2009. Subsidiaries, competencies and the implementation of dynamic capabilities. *Irish Academy of Management Conference* 37. <https://doi.org/10.21427/D7Z19N>.
- Saunders, M.N.K., Lewis, P., Thornhill, A., 2019. *Research Methods for Business Students*, eighth ed. Pearson Education Limited.
- Saura, J.R., Palacios-Marqués, D., Ribeiro-Soriano, D., 2023. Exploring the boundaries of open innovation: evidence from social media mining. *Technovation* 119, 102447. <https://doi.org/10.1016/j.technovation.2021.102447>.
- Seo, R., Park, J.-H., 2022. When is interorganizational learning beneficial for inbound open innovation of ventures? A contingent role of entrepreneurial orientation. *Technovation* 116, 102514. <https://doi.org/10.1016/j.technovation.2022.102514>.

- Sharma, P., Leung, T.Y., Kingshott, R.P.J., Davcik, N.S., Cardinali, S., 2020. Managing uncertainty during a global pandemic: an international business perspective. *J. Bus. Res.* 116, 188–192. <https://doi.org/10.1016/j.jbusres.2020.05.026>.
- Tabachnick, B.G., Fidell, L.S., Ullman, J.B., 2019. *Using Multivariate Statistics*, seventh ed. Pearson.
- Takeuchi, H., Nonaka, I., 1986. The new new product development game. *Harv. Bus. Rev.* 64 (1), 137–146.
- Tallott, M., Hilliard, R., 2016. Developing dynamic capabilities for learning and internationalization. *Baltic J. Manag.* 11 (3), 328–347. <https://doi.org/10.1108/BJM-02-2015-0060>.
- Teddlie, C., Tashakkori, A., 2009. *Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences*. SAGE Publications, Inc.
- Teece, D.J., 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strat. Manag. J.* 28 (13), 1319–1350. <https://doi.org/10.1002/smj.640>.
- Teece, D.J., 2011. Dynamic capabilities: a guide for managers. *Ivey Bus. J.* 75 (2), 29–32.
- Teece, D.J., 2018. Business models and dynamic capabilities. *Long. Range Plan.* 51 (1), 40–49. <https://doi.org/10.1016/j.lrp.2017.06.007>.
- Teece, D.J., 2020. Hand in glove: open innovation and the dynamic capabilities framework. *Strategic Management Review* 1 (2), 233–253. <https://doi.org/10.1561/111.00000010>.
- Teece, D.J., Peteraf, M.A., Leih, S., 2016. Dynamic capabilities and organizational agility: risk, uncertainty, and strategy in the innovation economy. *Calif. Manag. Rev.* 58 (4), 13–35. <https://doi.org/10.1525/cmr.2016.58.4.13>.
- Teece, D.J., Pisano, G.P., Shuen, A., 1997. Dynamic capabilities and strategic management. *Strat. Manag. J.* 18 (7), 509–533. [https://doi.org/10.1002/\(SICI\)1097-0266\(199708\)18:7<509::AID-SMJ882>3.0.CO;2-Z](https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z).
- Vahlne, J.-E., Jonsson, A., 2016. Ambidexterity as a dynamic capability in the globalization of the multinational business enterprise (MBE): case studies of AB Volvo and IKEA. *Int. Bus. Rev.* 26 <https://doi.org/10.1016/j.ibusrev.2016.05.006>.
- Van De Vrande, V., de Jong, J.P.J., Vanhaverbeke, W., de Rochemont, M., 2009. Open innovation in SMEs: trends, motives and management challenges. *Technovation* 29 (6–7), 423–437. <https://doi.org/10.1016/j.technovation.2008.10.001>.
- Verreynne, M.L., Ho, M., Linnenluecke, M., 2018. Editorial for the special issue on: organizational resilience and the entrepreneurial firm. *Int. J. Entrepreneurial Behav. Res.* 24 (7), 1122–1128. <https://doi.org/10.1108/IJEBR-11-2018-533>.
- Weaven, S., Quach, S., Thaichon, P., Frazer, L., Billot, K., Grace, D., 2021. Surviving an economic downturn: dynamic capabilities of SMEs. *J. Bus. Res.* 128, 109–123. <https://doi.org/10.1016/j.jbusres.2021.02.009>.
- Wyrwich, M., Steinberg, P.J., Noseleit, F., de Faria, P., 2022. Is open innovation imprinted on new ventures? The cooperation-inhibiting legacy of authoritarian regimes. *Res. Pol.* 51 (1), 104409 <https://doi.org/10.1016/j.respol.2021.104409>.
- Yin, R.K., 2018. *Case Study Research and Applications: Design and Methods*, sixth ed. SAGE Publications, Inc.
- Zia, N.U., Shamim, S., Zeng, J., Awan, U., Chromjakova, F., Akhtar, P., Orel, M., 2023. Avoiding crisis-driven business failure through digital dynamic capabilities. *B2B distribution firms during the COVID-19 and beyond. Ind. Market. Manag.* 113, 14–29. <https://doi.org/10.1016/j.indmarman.2023.05.015>.