On the edge of Big Data : drivers and barriers to data analytics adoption in SMEs

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Abstract

Adoption of technological innovations such as data analytics represents a major organizational transformation for small and medium-sized enterprises (SMEs). Literature shows that data analytics can improve the performance of SMEs. However, SMEs face many barriers in adopting this technological innovation. Unfortunately, the literature on data analytics adoption in SMEs is limited. Our goal is to identify the drivers and barriers to data analytics adoption in SMEs. With 35 semi-structured interviews with SMEs in the manufacturing and agricultural industries from France, we establish two comprehensive typologies of drivers and barriers. Our results show that exogenous drivers such as market, competition and the Covid-19 crisis have a stronger influence on data analytics adoption in SMEs than endogenous drivers. Endogenous barriers like lack of strategy, skills and organizational culture have a more negative influence on data analytics adoption in SMEs than exogenous barriers. This article contributes to better understanding of data analytics adoption process in SMEs and to guiding managers in successfully implementing this technology. Our research helps SMEs manage organizational transformation and develop a strategy supporting technology adoption.

1. Introduction

Recent years have seen digital data become increasingly important in the management and digitization of firms (Sestino et al., 2020). Immense volumes of digital data are generated through various sources such as social media platforms, e-commerce and digital technologies (Wedel and Kannan, 2016). Referred to as Big Data, this phenomenon offers opportunities to leverage valuable insights about the organization, the customers and the wider environment firms operate within (Wamba et al., 2015). It motivates businesses, including small and medium enterprises (SME), to adopt technological innovations such as data analytics to create business value from digital data (Chen et al., 2012). Data analytics can improve business strategy (Akter et al., 2016), marketing capabilities (Suoniemi et al., 2020), business competitiveness (Mikalef et al., 2020), and SMEs performance (Maroufkhani et al., 2020b).

SMEs are increasingly interested in data analytics for the potential benefits it offers. Some have even taken great steps forward to cultivate advanced data analytics capabilities (Maroufkhani et al., 2020b). Recent studies show that SMEs which adopt data analytics have better innovation capabilities (Liu et al., 2020) and report better financial and marketing performance (Maroufkhani et al., 2020b). Interestingly, the adoption rate of data analytics in SMEs remains low (Coleman et al., 2016). SMEs seem to face barriers in the adoption of technological innovations like data analytics. Research in information systems (IS) related to SMEs emphasizes on the lack of funds, technical know-how, organizational culture or technological maturity (Bruque and Moyano, 2007).

The literature on data analytics adoption in SMEs remains sparse, with a few notable exceptions like Coleman et al. (2016) and Maroufkhani et al. (2020a; 2022). An abundant literature on data analytics adoption and firm performance already exists, and drivers and barriers are factors commonly analyzed in IS research. However, SMEs possess unique

organizational characteristics which implies that the generalization of previous research on large firms – although insightful – may not exhaustively apply to these organizations (Mohd Salleh et al., 2017). Hence, drivers and barriers may differ in a SME context. Moreover, previous research does not describe exhaustively drivers and barriers to data analytics adoption in SMEs. Drivers and barriers are only explored through the study of determinants or through the conceptualization of data analytics capabilities. They are rarely studied as such, even though it has been demonstrated that they do influence and explain the adoption process of technological innovations (Horváth and Szabó, 2019).

This gap in the literature has great implications since SMEs represent the vast majority of the economy in Europe (Muller et al., 2021). Furthermore, SMEs face the urgent challenges of digital transformation. They also rely on innovative technologies and strategies to develop a stronger competitive advantage (Canhoto et al., 2021). Finally, they require more support from academic researchers to integrate this technological innovation into their organization (Coleman et al., 2016). Therefore, we will focus on the following problem: *What are the drivers and barriers to data analytics adoption in SMEs?*

To investigate this problem, we will draw on preceding literature mobilizing the driver and barrier approach (Dubouloz et al., 2021; Robert et al., 2022; Volkmar et al., 2022). This approach aims to study the nature of drivers and perceived benefits, as well as to identify barriers that complicate the adoption process of technological innovations to the point of severely slowing it down (Yang et al., 2021). To our knowledge, this is the first study on data analytics adoption in SMEs applying a driver and barrier approach.

In order to identify the drivers and barriers to data analytics adoption in SMEs, we use a qualitative methodology. We conducted 35 semi-structured interviews with 32 SMEs in the manufacturing and agricultural sectors. We conducted a thematic content analysis. Our results show that exogenous drivers significantly influence data analytics adoption in SMEs, more

than endogenous drivers. We also show that endogenous barriers like lack of IS strategizing, skills and organizational culture outweigh exogenous barriers related to supply and demand. We contribute to information systems literature by proposing two new comprehensive typologies of drivers and barriers to data analytics adoption in SMEs. Our research provides a unique perspective on the factors governing the adoption of such technological innovations at an organizational level. From a managerial perspective, we provide new recommendations for SMEs managers to better understand their organization and identify the critical success factors to data analytics adoption. Our research can help managers build stronger alignment between business strategy and information systems and avoid the costly consequences of the failure of technological innovation adoption.

2. Theoretical framework: Data analytics and SMEs

2.1. *Defining the attributes of Big Data and data analytics*

Big Data corresponds to the phenomenon of hyper production of digital data on a global scale caused by the digitization of our ways of life and production, and whose complexity surpasses the processing capabilities of traditional information systems (Manyika et al., 2011). Big Data is characterized by three fundamental attributes named the "3 V's". These attributes refer to (i) the magnitude of the volumes of digital data being created, (ii) the speed at which they are created, and (iii) the wide variety of data types (Gandomi and Haider, 2015). As Big Data research progresses, other attributes have been added. Veracity, for example, emphasizes the importance of extracting correct data from a large digital dataset to obtain quality results (Ghasemaghaei, 2021). Value is considered one of the most important attributes in the literature as it refers to the business value of digital data and the performance perspectives for businesses (Côrte-Real et al., 2019). The attributes of Big Data are both an opportunity and a challenge for firms, including SMEs. The latter became increasingly aware

of the emergence of Big Data due to the growing digitalization of their business management methods, processes and software (Gong and Ribiere, 2021). The Covid-19 crisis also had an accelerating effect on Big Data in SMEs (Cugno et al., 2022).

The Big Data phenomenon has fostered the emergence of methods and technologies for analyzing digital data such as knowledge management, business intelligence, and data mining (Mortati et al., 2023). Data analytics refers to "the process by which an organization collects, analyzes, visualizes and transforms digital data into relevant information to better understand its business and market, as well as make more effective or timely strategic and business decisions" (Chen et al., 2012). In practice, data analytics takes the form of software to collect, store, analyze, or visualize digital data. Sheng et al. (2019) define three types of data analytics. First, descriptive analytics provides a detailed view of key indicators through graphs or statistical measures. Second, predictive analysis predicts future effects based on historical data. Finally, prescriptive analysis helps interpret the results of descriptive and predictive analysis for decision-making.

The Resource-based view is a major theoretical framework in data analytics literature (Wamba et al., 2015; Mikalef et al., 2018). In this paradigm, a firm's performance is determined by its ability to exploit the strategic resources it possesses internally (Barney, 1991). Gupta and George (2016) consider digital data, data analytics skills, information systems infrastructure, and organizational culture as strategic corporate resources. Data analytics can be defined as the ability to acquire and leverage these resources to extract relevant information to drive business strategy and operations effectively (Urbinati et al., 2019). Numerous quantitative studies demonstrate the positive impact of data analytics on business strategy (Akter et al., 2016), dynamic capabilities (Mikalef et al., 2020; Gupta et al, 2020), marketing performance (Gupta et al., 2021; Brewis et al., 2022), global performance (Gunasekaran et al., 2017; Elia et al., 2022). Dynamic capabilities are another particularly

relevant theoretical framework in IS research (Steininger et al., 2022) and data analytics research (Mikalef et al., 2019a; Chirumalla, 2021). It takes into consideration ever-changing and uncertain competitive landscapes or high-tension contexts (Teece et al., 1997; Schilke, 2014). It has been demonstrated that data analytics contribute to developing dynamic capabilities and competitive advantage (Mikalef et al., 2021). More recently, the influence of data analytics capabilities on SMEs performance has been at the heart of new studies.

2.2.   *Data analytics adoption in SMEs*

Contrary to expectations, data analytics are well within the reach of SMEs. It is generally accepted that implementing data analytics requires a holistic transformation of the organization (Kache and Seuring, 2017). The characteristics of SMEs enhance their ability to adopt data analytics and extract more business value from their digital data than large firms (Dong and Yang, 2020). SMEs have higher organizational flexibility than large firms due to their small scale and reduced hierarchy. SMEs can act more flexibly and effectively to transform their organization because it is easier for them to adapt their operational processes and business strategy (Terziovski, 2010). SMEs also have fewer established procedural practices for information systems management than large firms (Mikalef et al., 2019b). On the other hand, larger companies have greater financial resources, which give them an advantage in acquiring technological resources and analytical skills (Horváth & Szabó, 2019).

Caldeira and Ward (2003) argues for the applicability of resource-based theory in SME research, especially to study technology adoption. This theoretical framework does contribute to better understanding the impact of data analytics on SMEs performance. Indeed, recent studies show precisely that SMEs are particularly interested in collecting digital data, and that data analytics would improve their product innovation capabilities (Liu et al., 2020). They also have better performance in innovative project management (Mangla et al., 2020). Moreover, SMEs equipped with data analytics report a greater competitive advantage in

operation management (Bhatti et al., 2022). Maroufkhani et al. (2020b) highlight the positive impact of data analytics on SMEs financial and marketing performance. Finally, recent studies show the role of data analytics in the development of dynamic capabilities and competitive advantage of SMEs in uncertain environments (Hassani and Mosconi, 2022).

Surprisingly, the current literature on data analytics adoption is very limited. More research is needed to improve our understanding of the adoption and the benefits of data analytics in SMEs (Maroufkhani et al., 2019). For several reasons, firstly, SMEs represent 98% of firms in Europe. They are also the primary source of skills and innovation, making them a key player in the European economy (Muller et al., 2021). SMEs are particularly relevant for research on data analytics. Not only would it bring great contributions to research in entrepreneurship and information systems, but this technological innovation represents a significant growth driver for a large number of firms. Secondly, SMEs need to address the urgent challenges of digital transformation and Big Data. Indeed, financial management, marketing, business and operational processes are more and more digitalized nowadays (Cannas, 2021). SMEs are increasingly collecting data on their customers or operations through their ERP, CRM, social media and connected objects (Liu et al., 2020). They are wondering what resources and capabilities they need to translate this valuable data into profitable actions (Maroufkhani et al., 2022). Finally, the Covid-19 crisis disrupted markets, customer relationship management and SMEs operations. SMEs are looking for innovative digital strategies and technologies to strengthen their competitiveness and resilience (Krammer, 2022). Consequently, the adoption of data analytics should not be discredited as a new lever for growth and value creation for SMEs, given their role in the economy and the crisis context.

2.3.   *Driver and barrier approach applied to data analytics adoption in SMEs*

Studies have recently investigated data analytics adoption in SMEs (Maroufkhani et al., 2020a, 2020b, 2022; Perdana et al., 2022). These studies mobilize Tornatzky and Fleischer's (1990) Technology-Organization-Environment theoretical framework and identify determinants that condition the successful adoption of this technology in SMEs. Nevertheless, these studies adopt a quantitative methodology which deducts and measures the relationship between determining factors and technology adoption. It does not enable to establish an exhaustive typology of driving and inhibiting factors influencing data analytics adoption in SMEs. Other studies concentrate on the impact of data analytics on firm performance. They suggest that data analytics capabilities development requires a combination of strategic resources, without which a firm cannot generate business value. However, to our knowledge, drivers and barriers are not identified or conceptualized as such. As a result, previous research partially explains why SMEs wish to adopt data analytics or fail to do so.

From a theoretical perspective, investigating data analytics adoption in SMEs is an important subject since large firms and small firms have different organizational characteristics. SMEs are characterized by a limited staff with transdisciplinary competences, limited financial resources, fewer formal procedural practices for IS management, a high involvement of owners in strategy and operations and a high sensitivity to market dynamics. These characteristics do influence the adoption process of technological innovations in SMEs (Rizzoni, 1991; Stock et al., 2002; Robert et al., 2023). Although the resource combination to develop data analytics capabilities remains similar in all organizations, large firms and SMEs may adopt different approaches to data analytics (Mikalef et al., 2019b). SMEs differentiate themselves in the way they acquire resources or reconfigure organizational capabilities for adopting technologies (Bruque and Moyano, 2007) such as data analytics (Persaud and Zare, 2023).

Secondly, research on technological innovation adoption usually draws from theoretical frameworks based on large firms, which cannot always be transferable to SMEs (Mohd Salleh et al., 2017). The majority of research on data analytics studies large firms. IS research has explored contingencies between properties of technologies and anticipated organizational outcomes, without systematically conceptualizing SMEs as unique organizations. This has resulted in a gap between contingencies and SMEs organizational realities (Morgan-Thomas, 2016). SMEs have distinctive economic interests and face different opportunities and challenges in technology innovation adoption compared to large firms (Coleman et al., 2016). Their distinctive perception and approach to technological innovation may influence drivers and barriers to data analytics adoption. SMEs remain rather unstudied in this context, and we lack an exhaustive description of the reasons why SMEs succeed or fail to adopt data analytics.
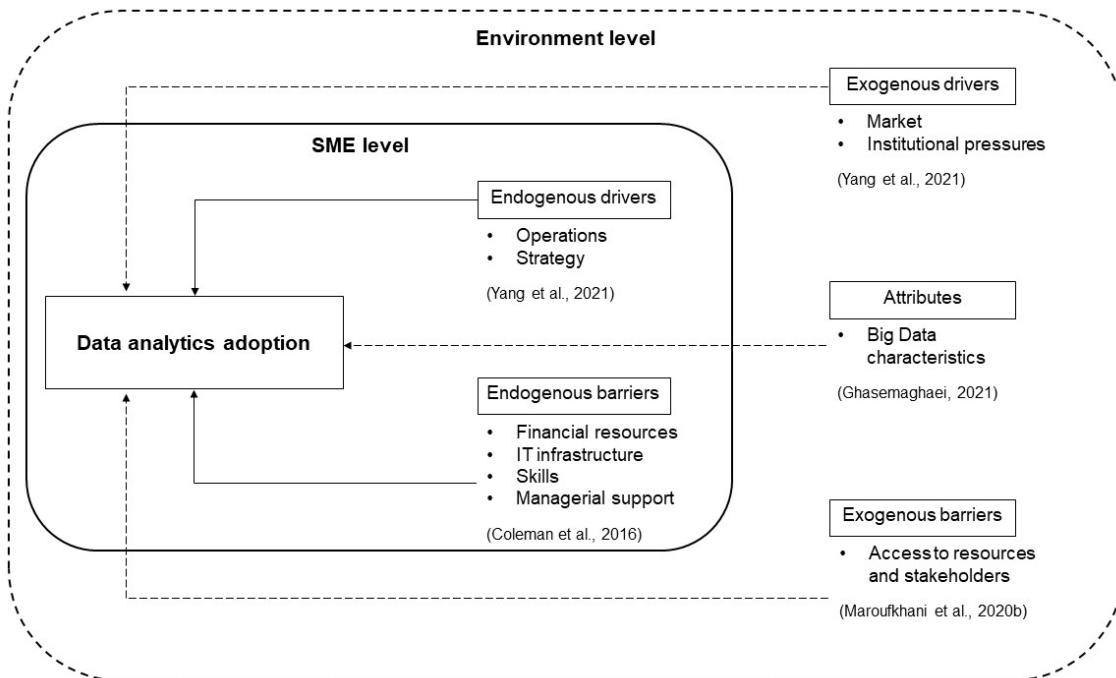
From a managerial perspective, we observe that the adoption rate of data analytics is extremely low in SMEs (Coleman et al., 2016). In 2022, the Ministry of Economy, Finance and Industry of France published a "digital barometer" report which estimates that 81% of SMEs are convinced that digital technologies can create real business value for their company. However, it also shows that 51% of French SMEs have no ongoing data analytics adoption project. The rate even rises to 57% in traditional industries such as agriculture, construction, transport, hotels or tourism. In the same line, the European Commission's 2022 Digital Economy and Society Index (DESI) report, we find that 14% of SMEs successfully adopt data analytics compared to 35% of large firms in Europe on average. Therefore, both this research gap and this assessment demonstrate the relevance and timeliness of a driver and barrier approach. This approach not only identifies the drivers and barriers to adopting a technological innovation, but also helps to understand their nature, importance, and impact (Dubouloz et al., 2021). This approach has been notably adopted in research on the adoption

of non-technological innovations (Dubouloz et al., 2021; Robert et al., 2022), technological innovations (Raj et al., 2020; Cho et al., 2023), or artificial intelligence (Meyer-Waarden and Cloarec, 2020; Volkmar et al., 2022). For this reason, the driver and barrier approach is relevant for studying data analytics adoption in SMEs.

A driver is an organizational state (also described as a need) that activates the implementation of a strategy to achieve a goal. At the organizational level, internal resources and capabilities or external pressures can influence a driver, such as for technological innovation adoption (Horváth & Szabó, 2019). It is important to understand the drivers of firms like SMEs to adopt technological innovations because they can influence the adoption process and its outcomes (Cho et al., 2023). Yang et al. (2021) investigated the driving factors behind the adoption of a new technological innovation. They identified endogenous and exogenous drivers, and established a typology of subcategories, namely operational, strategic, market, stakeholder and competitive drivers.

A barrier is an issue that complicates or blocks the process of technology adoption to the point of seriously slowing down or interrupting it (Raj et al., 2020; Sahu et al., 2022). Piatier (1984) distinguished between endogenous and exogenous barriers. Internal barriers correspond to a lack or absence of strategic resources within the organization. External barriers are characterized by changes or disruptions in the firm's environment, generally related to supply and demand. Finally, we argue that it is important to take into account the attributes of Big Data. They can indeed represent barriers to data analytics adoption in the sense that data are mass produced, rapidly produced or from diverse sources (Ghasemaghaei, 2021). Regarding data analytics and SMEs, Coleman et al. (2016) suggest that inadequate information systems and a lack of skills may be important barriers in SMEs. Maroufkhani et al. (2020b) hypothesize that supply and demand barriers may also hinder data analytics adoption.

On one hand, it has been argued that resources acquisition and environmental dynamics do influence the adoption process of technological innovations in SMEs (Blichfeldt and Faullant, 2021; Battistoni et al., 2023). On the other hand, drivers and barriers are recognized to be factors significantly moderating the outcome in technology adoption (Stornelli et al., 2021), as well as in data analytics adoption (Arunachalam et al., 2018). Mikalef et al. (2021) show "the importance of examining the process which organizations go through to integrate big data analytics into their operations". It is hence important to identify and describe the endogenous and exogenous factors to data analytics adoption and to explore how they may interplay in the process as well. The following framework (Figure 1) illustrates

how the above-mentioned factors are conceptualized based on our literature review. Nevertheless, we need more empirical research to improve our knowledge on data analytics adoption in SMEs since there may be more emerging factors (Coleman et al., 2016). Consequently, we will focus on the following research question in this study: *what are the drivers and barriers to data analytics adoption in SMEs?*

Figure 1. Representation of drivers and barriers to data analytics adoption in SMEs from entrepreneurship and IS research

3. Research methods

3.1. *Research objectives and data collection*

We still lack a comprehensive typology and description of drivers and barriers to data analytics adoption in SMEs. Thus, our goal is to deepen our understanding on this topic in line with research on data analytics in SMEs. In conducting our study, we adopt a qualitative methodology and mobilize a driver and barrier approach. Qualitative methods and interpretivist posture are commonly accepted in entrepreneurship (Packard, 2017) and information systems research (Goldkuhl, 2012). They are particularly suited to answer "what" or "how" research questions (Edmondson and McManus, 2007), which is our case.

Moreover, qualitative methods are intended to understand and interpret a phenomenon and its stakeholders (van de Ven and Huber, 1990). We place great importance on the meaning and understanding of the observed phenomenon, without interfering with it. We seek to better understand what the stimulating and inhibiting factors to data analytics adoption in SMEs are to study how this influences the implementation of this technology. Finally, the literature on data analytics is mostly quantitative. It now needs to be complemented by more in-depth qualitative research on why organizations are adopting this technological innovation to produce a justified theory. Exploratory qualitative methodologies are particularly useful for studying technological innovation adoption (Chau and Tam, 1997; Robey et al., 2002) and SMEs (Peltier et al., 2012).

Our data collection was organized in two steps. We first conducted an initial data collection in 2021 in France. The research field is relevant since the Data Governance Act (DGA), adopted by the European Parliament in April 2022 aims to boost data sharing in SMEs and micro firms for better management and R&D. Building on the DGA, the Parliament also passed the Data Act in March 2023, which will make it easier for small firms to access large amounts of high-quality industrial data. The French government, as an active member of the EU, officially offered its support to this new regulation to facilitate digital transformation in SMEs. The French Ministry of Economy, Finance and Industry estimates in 2022 that 85% of SMEs are aware of the benefits of data analytics adoption, but only 38% actually use such technology. While many government initiatives and investment programs are encouraging and attempting to facilitate the adoption of data-driven technologies, we possess limited empirical data on the reasons why SMEs are driven and simultaneously restrained in data analytics adoption.

The objective of the data collection was to better understand the role of data analytics in SME management. To have access to SMEs contacts, we collaborated with the Vinseo corporate network (Appendix A). It gathers more than a hundred SME suppliers with the particularity of operating in various sectors of activity such as agriculture, industry, service provision and consulting. We collaborated with this corporate network because of its multi-sectoral nature. The literature indicates that small firms have been undertaking a profound digital transformation in their organizations for some years. Historically, they have had significant innovation capabilities (Granata et al., 2018; Granata et al. 2019) and are increasing investments in the digitalization of their operations (Cannas, 2021).

After presenting our research project at the corporate network's general assembly, the board agreed to conduct qualitative interviews with its member SMEs. Indeed, data analytics arouses great interest among SMEs in these sectors, which are becoming aware of the

potential of this technological innovation. We targeted firms that fit the criteria of an SME, i.e., less than 250 employees and less than 50 million in turnover. We conducted a total of 15 semi-structured interviews with 13 SMEs with multi-sector specializations.

Respondents are recruited through snowball sampling, which is a recognized sampling strategy in qualitative research. Study subjects help us recruit other subjects from their contacts or competitors (Patton, 2022). We target those most likely to have information about the firm's digital strategy and data analytics adoption projects. Our sample includes CEO owners, sales and marketing managers and R&D project managers (Appendix B). For data collection, we used an interview guide (Appendix C) organized around theoretical themes from the literature review on digital data, data analytics, and technology adoption.

In the second step, we organized a second and similar data collection in 2022 in France. The objective was to understand more specifically the drivers and barriers to the adoption of data analytics in SMEs. The objective was also to study how SMEs leverage data analytics to create business value for their organization. We refocused our research to explore emerging themes from the first data collection. For this data collection, we collaborated with the Vinseo, Provence Rosé, la Mêlée and Leader Occitanie corporate networks (Appendix A). These corporate networks group respectively between 50 and 500 SMEs with multi-sector activities in agriculture, industry and digital services.

We conducted another 20 semi-structured interviews with 19 SMEs with multi-sector expertise. Respondents were also recruited using snowball sampling. We targeted people in charge of digital strategy or data analytics projects in the organization. The sample includes CEO owners and financial, marketing, sales or R&D operations managers. Similarly, this sample is relevant to the extent that owners or team managers are generally the people most involved in the digital strategy of SMEs (Li et al., 2018; Canhoto et al., 2021). Appendix B shows a summary of all respondents. Respondents are designated by a number to ensure their

anonymity. For data collection, we built on the emerging themes from the first data collection and added new questions to complete our interview guide (Appendix C).

We conducted a total of 35 interviews with 32 SMEs in the manufacturing, agricultural and digital services industries. We acknowledge that the selected SMEs have different sizes and operate in different sectors. This methodological choice is relevant for representativeness, robustness and generalizability reasons. Considering the definition of a small and medium-sized enterprise as formulated in the European legislation, we considered it important to select various profiles in core EU industries to ensure representativeness (Yin, 2018), which supports our choice to open our scope to various corporate networks and SMEs. The generalizability of results also lies in the identification of similarities among various profiles of SMEs. As stated by Martin and Eisenhardt (2010), "the combination of multiple industry segments and organizations should improve the richness, robustness and the generalizability of the results" in qualitative studies.

Moreover, decision makers have a propensity to limit their attention to a narrow set of factors and ignore other endogenous or exogenous factors that directly or indirectly influence transformation in their organization (Ocasio, 1997). Given that interviewees' knowledge is influenced by their environment and business, we conducted only one interview with the person most capable of providing information on data analytics in each organization in order to be consistent across the various organizations studied. Therefore, we aggregated our information on each SME interviewed to improve the reliability and generalizability of our emergent theoretical propositions. The number of cases is appropriate given the context and goal of our study since it allows us to collect a range of practitioner experiences from various industrial sectors and serves as the foundation for developing a comprehensive understanding of data analytics adoption in SMEs, as suggested in qualitative research (Farquhar et al., 2020).

Lastly, we selected various organization profiles because there is no consensus on the influence of firm size or business segment on technology adoption in SMEs in IS and entrepreneurship literature. It has been demonstrated that firm size and business segment have at best a marginal influence on technology adoption in SMEs, whereas for instance owner's attitude, organizational agility, business model or innovation capabilities clearly influence the process (Chan et al, 2019; Lashitew, 2023).

3.2. Data analysis

On average, the interviews lasted between 30 and 90 minutes. Each interview was recorded with the consent of the respondent and manually transcribed for thematic content analysis. The corpus of interviews was analyzed and coded on NVivo software, which is recognized analysis software in qualitative research.

The first step of our analysis consists in systematically listing all references to drivers and barriers to the adoption of data analytics in SMEs. This first reading gave us an overview of the relevant information in our corpus (Miles and Huberman, 1994). We then conducted open coding to identify common statements and to create temporary empirical categories while respecting the interviewees' interpretation. Each category refers to a driving or barrier factor in the process of adopting this technology. Progressively, empirical categories of drivers and barriers were added, deleted, or updated to ensure that each piece of information fit perfectly into its category. This category system led to the emergence of first-order codes (Miles and Huberman, 1994; Miles et al., 2018).

After open coding, the second step consists in conducting axial coding. We connected the temporary empirical categories into more general theoretical categories of driving and barrier factors (Miles and Huberman, 1994; Locke, 2001). These theoretical categories are directly or indirectly inspired from the typologies of Yang et al. (2021) and Piatier (1984)

presented above. Following an iterative approach, we group our data into the theoretical categories associated with drivers (operational, strategic, market, stakeholders and competition) and barriers (technical, managerial, strategic, and cultural, skills, financial, legal, supply, and demand-related) by establishing links between our data and the literature. Drawing from largely recognized theoretical concepts in the literature of data analytics, technology acceptance and operation management, we built a superior ensemble of categories which appropriately illustrate our data. We thus obtained our second-order codes (Miles and Huberman, 1994; Corbin and Strauss, 2014).

Finally, the last step of analysis consists in selective coding to identify two great theoretical categories into which we decompose the second-order theoretical categories (Miles and Huberman, 1994). The aggregated categories are grounded in the driver and barrier approach and are referred to as drivers (endogenous and exogenous) and barriers (endogenous, exogenous, and Big Data attributes). Appendix D shows the analysis grid used for the study of the corpus. This document summarizes the theoretical themes drawn from the literature review, which we used for the coding of the corpus in order to identify the empirical themes. All empirical mentions of drivers and barriers are categorized according to its theoretical theme. Appendix E shows our two data structures of drivers and barriers to data analytics adoption in SMEs. These data structures are at the heart of our empirical study. It should be noted that similar qualitative analysis protocols were used in innovation or technology adoption such as Canhoto et al. (2021), Dubouloz et al. (2021) and Robert et al. (2022).

4. Results

4.1. *The drivers to data analytics adoption in SMEs*

4.1.1. Identification of endogenous drivers

Our results show that data analytics adoption in SMEs is driven by the need to make business management more transparent, rational and accurate. They are looking for data analytics to make better decisions, improve financial management and track operations (Table 1, quote 1).

SMEs operate in dynamic and competitive environments. Financial and industrial predictions are critical to managing production, supply chain and service delivery. They wish to adopt data analytics to develop accurate predictive models or improve operations management (Table 1, quote 2).

Internal process improvement motivates SMEs to adopt data analytics. Indeed, CRM and ERP software help SMEs collect data about their customers and operations. With data analytics, SMEs hope to increase the efficiency of production or marketing processes by estimating the precise number of resources needed or by eliminating unnecessary steps (Table 1, quote 3).

Finally, improving financial performance through data analytics motivates SMEs. They are looking to improve operational costs management and optimize resource allocation to be more profitable. SMEs are convinced that the impact of data analytics on decision-making, financial management and internal processes will result in superior business performance (Table 1, quote 4).

SMEs are also driven to adopt data analytics for their strategy. They are continually looking for the most efficient way to allocate resources to achieve their business objectives. They feel the need to improve their understanding of their business and market issues through data analytics utilization (Table 1, quote 5).

Lastly, SMEs wish to adopt data analytics to develop innovative strategies. They collect data on their products, customers and competitors. With data analytics, they hope to

identify, for example, products whose costs can be optimized to offer lower prices and acquire new customers, or determine new customers' needs to diversify their product and service offer. This information would help SMEs make new strategic business decisions (Table 1, quote 6).

Table 1. Quotes illustrating endogenous drivers

No.	Quotes	Codes
		Operational drivers
1	*"We made the decision to acquire various analytical software primarily to have a more accurate, streamlined and framed management of our business."* (Respondent 17)	Improvement of financial management and reporting
2	*"What drives us is to improve our algorithms to constantly improve our industrial, but also financial and business modeling. And data analytics is essential for prediction."* (Respondent 24)	Improvement of financial and industrial prediction models
3	*"Our motivation is to gain efficiency in our processes. We have the data, but we weren't getting value from it, hence the recent implementation of this analytical software."* (Respondent 18)	Increased efficiency of organizational processes
4	*"The challenge is to maintain competitiveness in all circumstances. So, we hope to improve the profitability of our expenses, the profitability of our customers, and of course improve our financial performance. That's the goal with data analytics."* (Respondent 17)	Optimization of financial and marketing performance
		Strategic drivers
5	*"Today, we need more strategic information to know our issues. Analyzing all this data would help us consolidate our current strategy. It's a real demand from our internal staff."* (Respondent 1)	Better understanding of business challenges
6	*"There are so many things we could learn about our customers or our products with data analysis. All this information is very strategic for us. It would help us know what strategy to take with certain customers or what strategy to take on certain products"* (Respondent 17)	Improvement of strategic decision-making
		Improvement of the industrial or business strategy

4.1.2.   Identification of exogenous drivers

Our results show that the drivers to data analytics adoption in SMEs are related to their market. SMEs have various customer profiles which require different marketing and customer relationship management approaches. SMEs wish to collect more information about their customers to improve customer knowledge and identify the precise characteristics and needs of their customers (Table 2, quote 7).

Moreover, SMEs wish to improve their marketing strategy. Data analytics can help improve market segmentation, customer targeting, and brand positioning. With a more effective marketing strategy, SMEs can build stronger reputation, better understand prospects' needs, retain existing customers, and thus increase revenue (Table 2, quote 8).

Many SMEs are developing their e-commerce platforms, being active on social networks and conducting email campaigns. However, they struggle to establish a digital strategy that allows them to carry out regular, consistent and effective online operations. They are looking to aggregate their customer and marketing data in databases dedicated to digital marketing. The driver to data analytics adoption is to improve business targeting, content personalization and profitability of online operations (Table 2, quote 9).

SMEs wish to adopt data analytics to improve their innovation capabilities. They are looking to continually improve their existing offer and to develop new products or services. They are also driven by developing servitization to provide superior added-value to customers. This could indeed be a new source of revenue (Table 2, quote 10).

Competition is a significant exogenous driver. The increase in SMEs implementing data analytics encourages other small firms in the same sector to adopt this technology. SMEs fear that their competitors will develop a competitive advantage with data analytics adoption. In addition, they wish to gain legitimacy in data analytics utilization with their customers and competitors (Table 2, quote 11, quote 12).

The crisis context plays a decisive role in data analytics adoption among SMEs. During Covid-19 crisis, SMEs relied on technological innovations to manage organizational and operational turbulence and reconfiguration. Today, they are looking for new technological opportunities like data analytics to regain competitiveness, build dynamic capabilities and develop resilience (Table 2, quote 13).

Table 2. Quotes illustrating exogenous drivers

No.	Quotes	Codes
		Market-related drivers
7	*"We don't have a good understanding of our customers. Our CRM is full of information, but we don't always analyze it. Data analytics would help us to know their characteristics and profiles better."* (Respondent 26)	Improvement of customer knowledge
8	*"Our strategy with our customers is not effective enough. Today, the goal is to aggregate our customer data, analyze it to have a more accurate strategy that creates value for customers in each segment."* (Respondent 35)	Better identification of customer needs
		Improvement of segmentation, targeting and positioning
9	*"Before we had no figures, no metrics on our digital marketing operations. That's what motivated us to analyze marketing data. Now we regularly measure our audience and try to adjust the effectiveness of our actions."* (Respondent 29)	Improvement of digital marketing operations
10	*"We have data on how our customers use our products. It helps us to continuously improve. And we see that there is also a real opportunity to develop new digital services for our customers."* (Respondent 14)	Create innovative digital services
		Competition-related drivers
11	*"More and more SMEs are adopting data analytics in our sector. If I don't invest in data analytics, my competitors will. And we can't afford that."* (Respondent 16)	Increased adoption of data analytics in rival SMEs
		Aversion to missing a technological opportunity
12	*"Gaining legitimacy and building a positive brand image by mastering data analytics, that's our motivation. That would send a message to our competitors."* (Respondent 17)	Gain legitimacy on the use of data analytics
		Crisis context-related drivers

| 13 | *"The Covid crisis forced us to reconsider the potential of our digital data and adopt analytics software."* (Respondent 4) | Acceleration of digital transformation due to Covid-19 crisis |

4.2. The barriers to data analytics adoption in SMEs

4.2.1. Identification of endogenous barriers

SMEs suffer from technical barriers especially with inadequate information systems. They have problems mapping data sources within their organization, as well as centralizing the storage of digital data. Developing an efficient IS infrastructure for data storage and analysis can be a technical challenge for small firms (Table 3, quote 14).

SMEs face managerial barriers. Management and employees may not share the same interest in adopting data analytics. If employees initiate this innovation, management may refuse to provide the necessary resources or support employees during the implementation. These disagreements between owners and employees create tensions in the organization and obstruct the adoption process (Table 3, quote 15).

SMEs have difficulty conceptualizing a strategy for data collection and analysis within their organization. They struggle to identify the issues to solve with data analytics or to leverage this technology for their business strategy. This creates a significant misalignment between business strategy and IS (Table 3, quote 16).

SMEs suffer from major cultural barriers within their organization. The lack of data-driven organizational culture generates great sentiments of conservatism, skepticism and rejection against data analytics. Managers are wary of technological trends, and employees

fear that their performance will be constantly monitored. Employees fear that their working methods will change drastically, or that change management will be poorly executed by management. Unless the organizational culture encourages technological innovation, data analytics adoption becomes a challenge for small firms (Table 3, quote 17).

The lack of in-house skills negatively affects data analytics adoption. SMEs suffer from a lack of knowledge on digital technologies and data analytics skills. There are few case studies on data analytics in SMEs. Moreover, small firms fail to engage all their employees in data analytics training programs. Data analytics adoption becomes hardly possible for small firms without skills in data management, IS strategizing and data-driven leadership (Table 3, quote 18).

SMEs may lack financial resources to implement data analytics or to afford the services of an IS consulting firm. The cost of maintaining information systems can also be high for small firms (Table 3, quote 19).

Finally, SMEs lack expertise on the General Data Protection Regulation (GDPR). They do not possess the necessary knowledge to fully comply with the obligations of this legislation. They fear being penalized for poor data protection. (Table 3, quote 20).

Table 3. Quotes illustrating endogenous barriers

No.	Quotes	Codes
		Technical barriers
14	*"One of our biggest challenges with data analytics is the architecture of information systems. We need to rethink our IS to make it more responsive."* (Respondent 27)	Unsuitable IT infrastructure
		Lack of formal data management processes
		Managerial barriers
15	*"Many employees have been asking for data analytics to be installed for a long time. We have started discussions with some software vendors, but we don't have the support or the validation from the management on this IT project."*	Lack of managerial support
		Tensions between top management and

	(Respondent 35)	employees
		Strategic barriers
16	*"We don't always manage to identify the relevant uses of data in our business. We sometimes lack strategic vision and that holds us back terribly."* (Respondent 31)	Inability to identify strategic use cases for data analytics
		Misalignment between business strategy and IS
		Cultural barriers
17	*"Many IT initiatives or projects have been suspended or stopped due to lack of culture. Some employees are wary and afraid of change in their business. Some SMEs, like ours, are sorely lacking in digital culture."* (Respondent 31)	Lack of organizational culture or leadership supporting data analytics use
		Conservatism or skepticism against digital technologies
		Skills barriers
18	*"The lack of people skilled in data analytics is our big challenge. We're having a hard time getting the right skills to integrate this software and use it."* (Respondent 30)	Lack of data analytics-skilled employees and professional training
		Financial barriers
19	*"Beyond the initial investment to integrate analytical software, the cost of information systems and servers can be high for an SME."* (Respondent 6)	High cost of adopting data analytics and maintaining IS infrastructure
		Legal barriers
20	*"The RGPD is a complex legislation for an SME. Compliance can be a real drag on data analysis."* (Respondent 30)	Lack of legal knowledge to comply with GDPR legislation

4.2.2. *Identification of external barriers*

We identified exogenous barriers. From a supply perspective, there are few software editors commercializing software adapted to the organization and information systems of SMEs. These are multinational groups with high expertise in data analytics, and their products require specific configuration to adapt to the organizational characteristics of small firms (Table 4, quote 21).

SMEs are also faced with a shortage of qualified people on the job market. The recruitment process is all the more difficult for small firms because these individuals are generally hired by large firms, and that salary costs are high. Certain SMEs use external recruitment agencies to improve their skills sourcing strategy (Table 4, quote 22).

From a demand perspective, software editors struggle to absorb the fast-growing demand in data analytics from SMEs which causes the economic effect of higher prices for service provision and higher competition among customers (Table 4, quote 23).

Finally, the attributes of Big Data technologies may represent a barrier to data analytics adoption in SMEs. Information systems need to be constantly updated to store the ever-more large volumes of digital data produced (Table 4, quote 24). Moreover, inaccurate and poor quality digital data complexify adoption and negatively impact the outcomes of data analytics utilization (Table 4, quote 25). SMEs also struggle to estimate the financial value of digital data stored internally or to measure the return on investment associated with data analytics adoption (Table 4, quote 26).
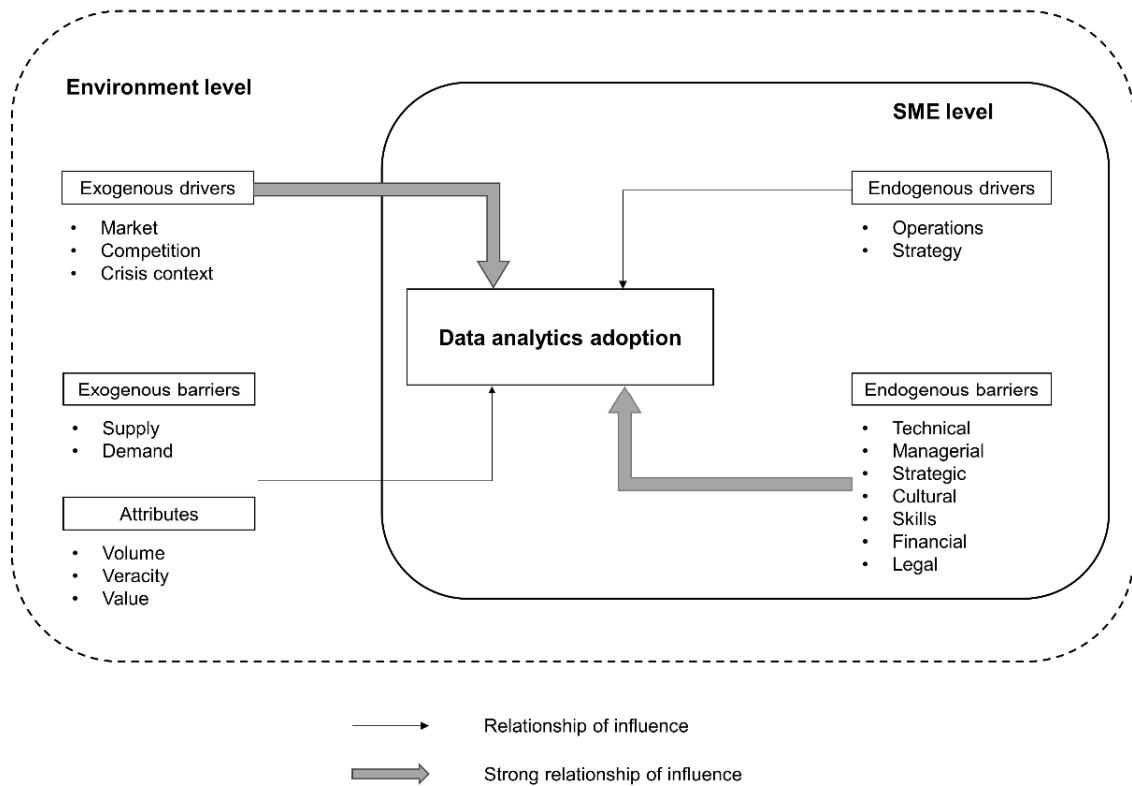
Table 4. Quotes illustrating exogenous barriers

No.	Quotes	Codes
		Supply-related barriers
21	*"There are very few software editors specialized in SMEs. We have tried to work with bigger vendors, but their data analytics aren't designed for small businesses. The programming and the configuration are barely suitable and manageable for SMEs."* (Respondent 19)	Lack of software editors specialized in SME
22	*"There is a real difficulty in finding people with data analytics skills. It's a huge challenge. And these are skills that require higher salaries sometimes."* (Respondent 16)	Shortage in skilled employees on the job market and high cost of salaries
		Demand-related barriers
23	*"Right now, many SMEs are searching for a good service provider. So are we. But it seems that supply isn't able to absorb demand, hence higher price and higher competition among SMEs. The highest bidder always wins."*	Increased competition due to high demand in service providers

	(Respondent 33)	
		Technology attributes
24	*"The volume of digital data is hard to manage at times. We are constantly expanding our storage space. That's a challenge."* (Respondent 28)	Voluminous data
25	*"Having accurate and up-to-date data is a real challenge. Not all employees are equally thorough when entering data. Software doesn't always recognize the types of data. The issue is data quality."* (Respondent 1)	Poor quality of the data
26	*"In our business, we can perceive the value we create for our business or for our customers with data analytics, but it's hard to put a precise number on the performance we create."* (Respondent 4)	Inability to measure the return on investment of data analytics adoption

5. Discussion

We contribute to information systems literature by proposing new typologies of

factors influencing the adoption of data analytics in SMEs. We mobilize an original driver and

barrier-based approach that provides an alternative to traditional theoretical frameworks on

technological innovation adoption. By adopting a qualitative methodology, our research provides new insights into the needs, goals, and issues that SMEs wish to address through data analytics, but also into the organizational challenges related to adopting this technology. The following framework (Figure 2) illustrates the results of our research on the drivers and barriers on data analytics adoption in SMEs. We finally provide recommendations for SMEs to transform their organization, create new synergies between individuals and develop data analytics capabilities.

Figure 2. The drivers and barriers to data analytics adoption in SMEs

5.1. Discussion on drivers to data analytics adoption in SMEs

First, we contribute to information systems literature by proposing a new typology of drivers to data analytics adoption in SMEs. Following Yang et al. (2021), we identify endogenous drivers among SMEs related to improving operational management and business strategy and exogenous drivers related to market, competition, and the crisis context. Specifically, we show that SMEs are internally driven by improving financial management and operations monitoring, as well as optimizing process efficiency, financial performance and business strategy. We also observe that SMEs are driven by improving customer knowledge and marketing strategy, by creating innovative products or services, by competition using data analytics, and by the accelerating effect of Covid-19 crisis on digital transformation.

Moreover, the literature focuses on the impact of data analytics on firm performance (Rialti et al., 2019), suggesting that drivers for adopting this technology are mainly endogenous. On the contrary, our results show that exogenous drivers have a greater influence than endogenous drivers on the adoption of data analytics in SMEs. This implies that, for
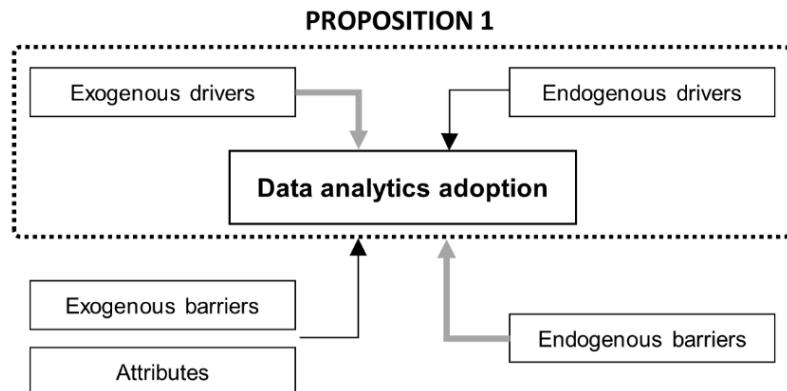
SMEs, external factors stimulate the adoption of this technology more than internal factors. Indeed, one of our main results shows that SMEs are motivated to adopt data analytics because they want to develop stronger marketing capabilities. They are aware of the need to improve their customer knowledge and optimize their marketing strategy. This is because the Covid-19 crisis has changed customer buying behaviors, accelerated the digitalization of sales channels, and forced SMEs to make their marketing investments more accurate and profitable. Liu et al. (2020) studied the application of data analytics in generating customer insights in SMEs, which support our result as a viable driver in these firms.

Our research highlights competition as another important driver for data analytics adoption among SMEs. On one hand, our results show that SMEs are driven to adopt data analytics through mimicry or imitation. Since the Covid-19 crisis, SMEs are indeed looking for technological innovations or digital strategies to regain competitiveness and strengthen their resilience. SMEs apprehend the adoption of data analytics through the technological innovations of their competitors with the objective of maintaining similar digital capabilities. Bresman (2013) calls this approach "vicarious learning" and observes this strategy among firms seeking innovation. On the other hand, SMEs are motivated to adopt data analytics for fear that their competitors will develop a superior competitive advantage through this technology. They fear missing a disruptive technological opportunity as data analytics contributes to performance improvement and the development of innovative products or services. Our research complements the work of Maroufkhani et al. (2020b, 2022) by analyzing in depth the role of competition in data analytics adoption in SMEs.

Our results show that the crisis context is a significant driver for SMEs. The Covid-19 crisis has accelerated digital transformation and forced SMEs to develop strong digital capabilities (Cugno et al. 2022), i.e., the ability to integrate and exploit digital technologies in their business model, operational management and business strategy. In this context, they

have aware of business their data and develop analytics become the value of digital want to their data

PROPOSITION 1

Exogenous drivers → Endogenous drivers

Data analytics adoption

Exogenous barriers

Attributes

Endogenous barriers

capability. This implies that the acceleration of digital transformation caused by crisis context has been an enabler for data analytics adoption in SMEs. Owners have made this technology a strategic priority during and following the Covid-19 crisis in order to sustain their business strategy and resilience. Figure 3 illustrates our first proposition.

Proposition 1: Exogenous drivers such as market orientation, competition and turbulent environmental context will have a greater influence on data analytics adoption in small medium-sized enterprises than endogenous drivers such as improving operation management, business strategy and financial and marketing performance.

Figure 3. Illustration of proposition 1

5.2. Discussion on barriers to data analytics adoption in SMEs

Secondly, we contribute to information systems literature by proposing a new typology of barriers to data analytics adoption in SMEs. Complementing the research of Coleman et al. (2016) and Maroufkhani et al. (2020b), we identify endogenous, exogenous, and inherent barriers to Big Data attributes among SMEs. Internally, SMEs face inadequate information systems, lack of managerial support, lack of strategic alignment, unfavorable organizational culture, skills gap, insufficient funding and complex legal compliance. In their environment, SMEs are hindered by a lack of digital service providers or skilled people in the labor market and a higher demand than available solutions. Finally, SMEs are challenged by volumes of digital data requiring new storage methods, poor quality data, and difficulty in assessing the actual business value creation associated with data analytics.

Our results highlight that endogenous barriers outweigh exogenous barriers and Big Data attributes in data analytics adoption in SMEs. This result is surprising because it is commonly believed that organizational flexibility in SMEs would facilitate technological innovation adoption (Carcary et al., 2014). Instead, we show that, for SMEs, the lack of resources and underdeveloped organizational capabilities are the main inhibiting factors. Gupta and George (2016) suggest that without specific tangible, intangible, and human resources the development of a data analytics capability is infeasible. This theory may be particularly true for SMEs with limited organizational resources. Indeed, our results show that SMEs eminently lack intangible resources such as IS-business strategy alignment, data-driven organizational culture, and data analytics skills. We hypothesize that these are the most strategic resources in the adoption of data analytics in SMEs, which greatly contributes to better understanding how small firms develop data analytics capability.

Specifically, SMEs struggle to identify strategic applications for data analytics in their operations and are at risk of abandoning the adoption of this technology. This is because SMEs are driven to adopt data analytics by competitive pressure and the crisis context and implement this technology in a short period of time. They fail to think deeply about the utilization of data analytics in their organization. This results in a misalignment between business strategy and data analytics capability. Akter et al. (2016) suggests that this misalignment dramatically complicates business value creation through data analytics. We suggest that SMEs managers must identify strategic applications of data analytics in their operations prior to implementation to determine the business strategy and the IS architecture to be adopted to create business value.

In SMEs, the lack of a data-driven organizational culture can generate tensions. In some SMEs, we see strong resistance to technological innovations. The owners or the employees struggle to perceive the value of this technology or refuse to change existing organizational routines. This lack of culture leads to a rise in conservatism or skepticism against data analytics. Yet, it is recognized that organizational culture plays a critical role in data analytics adoption in firms (Martínez-Caro et al., 2020). On the contrary, our results show that SMEs with digital-friendly managers are most successful in adopting data analytics. These SMEs invest in acquiring the resources necessary to develop a strong data analytics capability and manage to generate performance. Finally, some tensions may be less directly conflictual. Dubouloz et al (2021) indicate that lack of time may be a form of passive resistance to technological innovations in SMEs. We did make the same observation. We also observe a voluntary or unconscious lack of synergy between management and employees in SMEs when adopting data analytics. We characterize this as a form of passive resistance. Managerial support is crucial in SMEs where the manager has a strong authority in the decision-making process (Cao et al., 2021).

SMEs recognize that a lack of in-house expertise directly impacts their ability to adopt data analytics. There is little literature on data analytics adoption in SMEs to guide managers. SMEs face difficulties building appropriate IS and identifying data analytics applications due to lack of expertise. Our results also show that the level of data analytics skills is not homogeneous across all business lines in the organization. This implies that SMEs only provide professional training to specific people. Yet, all the trades must be trained in order to amortize the adoption of this technology and maximize business value creation. Yet, professional training seems to contribute greatly to the development of a data-driven organizational culture in SMEs. In their environment, SMEs are also faced with a lack of specialized service providers and a shortage of qualified individuals in the labor market.

Finally, our results show that the above-mentioned barriers significantly outweigh technical, financial and legal barriers and barriers associated with Big Data attributes. On one hand, SMEs with strong strategic alignment and in-house skills perceive the cost of information systems and qualified personnel as less of a barrier. For these firms, it is an investment, even during the Covid-19 crisis. On the other hand, among the attributes of Big Data, SMEs perceive value as a greater barrier than volume, velocity and veracity. Cloud technologies allow companies to better manage the volume and velocity of digital data stored on their servers. In addition, implementing data governance helps SMEs optimize the veracity of digital data in their business analytics. On the other hand, SMEs struggle to accurately measure the real performance gains from data analytics. Figure 4 illustrates our second proposition.

Proposition 2: Endogenous barriers such as lack of IS-business misalignment, skills and data-driven organizational culture will have a more negative influence on data analytics adoption in small medium-sized enterprises than exogenous barriers such lack of service providers, qualified individuals in labor market and Big Data attributes.
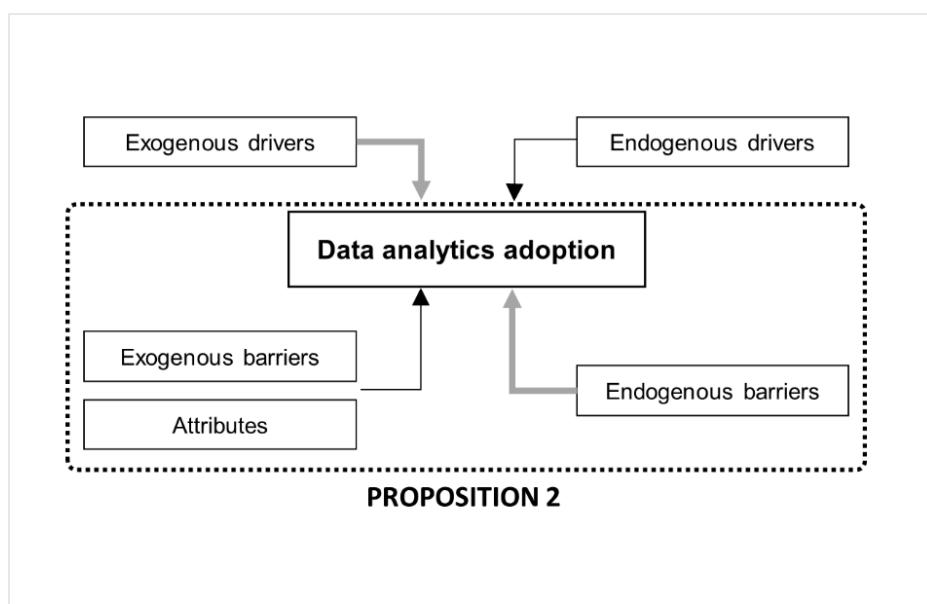
Figure 4. Illustration of proposition 2

It is also pertinent to adopt a more dynamic view of the factors influencing the adoption of data analytics in SMEs. Our research shows that there may be interactions between exogenous and endogenous factors within drivers and barriers. From a theoretical perspective, it is coherent with Johns (2006) who shows how contextual or environmental opportunities and constraints impact the occurrence of organizational capabilities and behaviors. Empirically, it has also been demonstrated that the factors of Technology-Organization-Environment framework are in fact interdependent in data analytics adoption (Maroufkhani et al., 2022). Our results show that exogenous drivers of SMEs may trigger the emergence of endogenous drivers. In certain cases, exogenous drivers may initiate a process

of organizational introspection whereby SMEs become aware of the need to solve specific operational and strategic problems through the adoption of data analytics. Exogenous drivers may support and reinforce endogenous drivers. Similarly, exogenous and endogenous barriers may also interact during data analytics adoption. For instance, SMEs suffer from a lack of data analytics skills, as well as a shortage of qualified people on the job market. Therefore, we call for more research on the interactions between exogenous and endogenous factors in data analytics adoption, especially for SMEs. Figure 5 illustrates our third proposition.

Proposition 3: Exogenous factors will interact with endogenous factors in the process of data analytics adoption in small and medium-sized enterprises, such that environmental, organizational and technological factors may reinforce or reduce the effect of drivers and barriers.
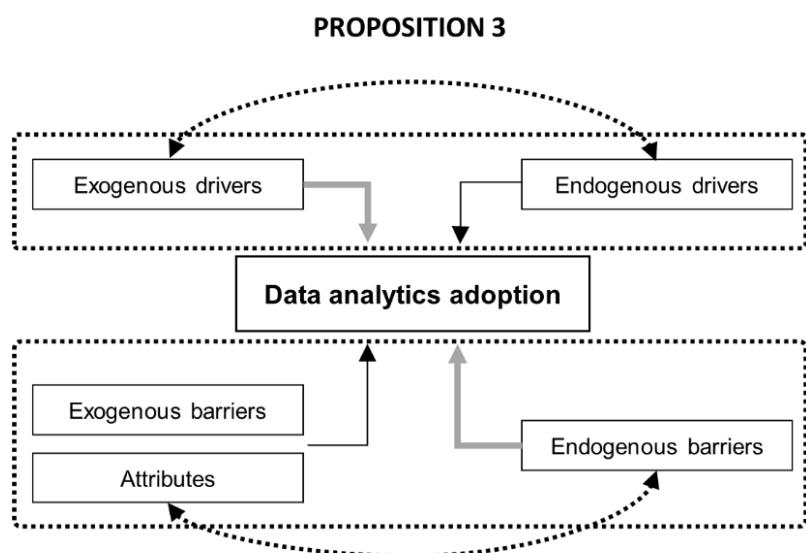
Figure 5. Illustration of proposition 3

5.3. Future research avenues on data analytics in SMEs

Our research opens up some perspectives. Regarding drivers, data analytics have a positive impact on marketing capabilities and value creation. Future research would focus on how SMEs can increase customer knowledge, market orientation and performance through the deployment of data analytics. It might also be interesting to study how SMEs can manage institutional pressures related to data analytics. SMEs are known to adopt collective strategies and to be active members in corporate networks (Moritz et al., 2022; Corbo et al., 2023). Coopetition can help SMEs develop their ability to adopt technological innovations (Gnyawali and Park, 2009). Sharing knowledge and skills in data analytics among SMEs could be a solution to overcome the many barriers to this technology adoption. Lastly, recent studies have analyzed the influence of crisis context on technology adoption (Ardito et al., 2021). We also found that it played a major role in SMEs. Future research could investigate how data analytics contribute to building dynamic capabilities and resilience in SMEs in turbulent environments.

Regarding barriers, data analytics adoption needs a holistic transformation of the organization, and generates learning, leadership and environmental tensions (Meadows et al., 2022). In line with recent literature, we found that it requires a strong strategy for implementation and continued use in operation and strategic management in SMEs. Future research might examine how SMEs can develop a strategy which optimizes organizational readiness to data analytics and leverage business value in the long term. Furthermore, our research shows that SMEs lack relevant skills and experience, and struggle to recruit qualified individuals. It has been demonstrated that data analytics skills strongly moderate the adoption of data analytics in firms (Ghasemaghaei et al., 2018). SMEs are known to use bricolage for technological innovations (Ferneley and Bell, 2006). It would be interesting to study how SMEs manage the scarcity of skills through knowledge transfer or the development of in-

house professional training. Finally, we found that the lack of data-driven organizational culture is a major barrier in SMEs. Organizational culture has been identified as a great facilitator in data analytics adoption in firms (Lunde et al., 2019). Future research could explore how the attitude of the owner influences the organizational culture and acceptance of data analytics from employees.

6. Conclusion

This research explores the drivers and barriers to data analytics adoption in SMEs. On the theoretical level, we contribute to data analytics and SMEs research by mobilizing a driver and barrier approach. We propose two new typologies of drivers and barriers that influence the adoption process in small firms. Thus, we improve our understanding of the nature of these factors in SMEs. From a managerial perspective, we conclude that drivers and barriers determine the level of success of data analytics adoption in SMEs. It is important for managers to identify these factors to better understand this technological innovation. This is because it is difficult for managers to decide on a strategy for leveraging digital data. In addition, SMEs are not always aware of the barriers that can compromise data analytics adoption. Our research offers practical recommendations for implementing data analytics. It can enable managers with data analytics use cases and help them understand the potential impact of technological innovations on their organization.

Like any research, this study has limitations. First, the literature on data analytics and SMEs is nascent. We chose to conduct a qualitative study. Our results could be further explored by following a new research methodology such as cumulative case studies. Thus, we could consolidate the typologies of drivers and barriers to data analytics in SMEs. Second, we could question the choice of sectors studied. We chose manufacturing and agricultural industries because these sectors are particularly confronted with the challenges of

digitalization and Big Data. We collaborated with corporate networks because it is a relevant strategy to access a rich research field and to organize qualitative interviews with SMEs. This research opens up new research perspectives. Future research could investigate the drivers and barriers to data analytics continued use in SMEs.

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References

Akter, S., Wamba, S. F., Gunasekaran, A., Dubey, R., & Childe, S. J. (2016). How to improve firm performance using big data analytics capability and business strategy alignment? *International Journal of Production Economics*, *182*, 113-131. https://doi.org/10.1016/j.ijpe.2016.08.018

Ardito, L., Coccia, M., & Messeni Petruzzelli, A. (2021). Technological exaptation and crisis management: Evidence from COVID-19 outbreaks. *R&D Management*, *51*(4), 381-392. https://doi.org/10.1111/radm.12455

Arunachalam, D., Kumar, N., & Kawalek, J. P. (2018). Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice. *Transportation Research Part E: Logistics and Transportation Review*, *114*, 416-436. https://doi.org/10.1016/j.tre.2017.04.001

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, *17*(1), Article 1. https://doi.org/10.1177/014920639101700108

Battistoni, E., Gitto, S., Murgia, G., & Campisi, D. (2023). Adoption paths of digital transformation in manufacturing SME. *International Journal of Production Economics*, *255*, 108675. https://doi.org/10.1016/j.ijpe.2022.108675

Bhatti, S. H., Ahmed, A., Ferraris, A., Hirwani Wan Hussain, W. M., & Wamba, S. F. (2022). Big data analytics capabilities and MSME innovation and performance: A double mediation model of digital platform and network capabilities. *Annals of Operations Research*. https://doi.org/10.1007/s10479-022-05002-w

Blichfeldt, H., & Faullant, R. (2021). Performance effects of digital technology adoption and product & service innovation – A process-industry perspective. *Technovation*, *105*, 102275. https://doi.org/10.1016/j.technovation.2021.102275

Bresman, H. (2013). Changing Routines: A Process Model of Vicarious Group Learning in Pharmaceutical R&D. *Academy of Management Journal*, *56*(1), 35-61. https://doi.org/10.5465/amj.2010.0725

Brewis, C., Dibb, S., & Meadows, M. (2023). Leveraging big data for strategic marketing: A dynamic capabilities model for incumbent firms. *Technological Forecasting and Social Change*, *190*, 122402. https://doi.org/10.1016/j.techfore.2023.122402

Bruque, S., & Moyano, J. (2007). Organisational determinants of information technology adoption and implementation in SMEs: The case of family and cooperative firms. *Technovation*, *27*(5), 241-253. https://doi.org/10.1016/j.technovation.2006.12.003

Caldeira, M. M., & Ward, J. M. (2003). Using resource-based theory to interpret the successful adoption and use of information systems and technology in manufacturing small and medium-sized enterprises. *European Journal of Information Systems*, *12*(2), 127-141. https://doi.org/10.1057/palgrave.ejis.3000454

Canhoto, A. I., Quinton, S., Pera, R., Molinillo, S., & Simkin, L. (2021). Digital strategy aligning in SMEs: A dynamic capabilities perspective. *The Journal of Strategic Information Systems*, *30*(3), Article 3. https://doi.org/10.1016/j.jsis.2021.101682

Cannas, R. (2021). Exploring digital transformation and dynamic capabilities in agrifood SMEs. *Journal of Small Business Management*, *0*(0), Article 0. https://doi.org/10.1080/00472778.2020.1844494

Cao, G., Duan, Y., Edwards, J. S., & Dwivedi, Y. K. (2021). Understanding managers' attitudes and behavioral intentions towards using artificial intelligence for organizational decision-making. *Technovation*, *106*, 102312. https://doi.org/10.1016/j.technovation.2021.102312

Carcary, M., Doherty, E., Conway, G., & McLaughlin, S. (2014). Cloud Computing Adoption Readiness and Benefit Realization in Irish SMEs—An Exploratory Study. *Information Systems Management*, *31*(4), 313-327. https://doi.org/10.1080/10580530.2014.958028

Chan, C. M. L., Teoh, S. Y., Yeow, A., & Pan, G. (2019). Agility in responding to disruptive digital innovation: Case study of an SME. *Information Systems Journal*, *29*(2), 436-455. https://doi.org/10.1111/isj.12215

Chau, P. Y. K., & Tam, K. Y. (1997). Factors Affecting the Adoption of Open Systems: An Exploratory Study. *MIS Quarterly*, *21*(1), 1-24. https://doi.org/10.2307/249740

Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business Intelligence and Analytics: From Big Data to Big Impact. *MIS Quarterly*, *36*(4), Article 4. https://doi.org/10.2307/41703503

Chirumalla, K. (2021). Building digitally-enabled process innovation in the process industries: A dynamic capabilities approach. *Technovation*, *105*, 102256. https://doi.org/10.1016/j.technovation.2021.102256

Cho, J., DeStefano, T., Kim, H., Kim, I., & Paik, J. H. (2023). What's driving the diffusion of next-generation digital technologies? *Technovation*, *119*, 102477. https://doi.org/10.1016/j.technovation.2022.102477

Coleman, S., Göb, R., Manco, G., Pievatolo, A., Tort-Martorell, X., & Reis, M. S. (2016). How Can SMEs Benefit from Big Data? Challenges and a Path Forward. *Quality and Reliability Engineering International*, *32*(6), 2151-2164. https://doi.org/10.1002/qre.2008

Corbin, J., & Strauss, A. (2014). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (4th edition). SAGE Publications.

Corbo, L., Kraus, S., Vlačić, B., Dabić, M., Caputo, A., & Pellegrini, M. M. (2023). Coopetition and innovation: A review and research agenda. *Technovation*, *122*, 102624. https://doi.org/10.1016/j.technovation.2022.102624

Côrte-Real, N., Ruivo, P., Oliveira, T., & Popovič, A. (2019). Unlocking the drivers of big data analytics value in firms. *Journal of Business Research*, *97*, 160-173. https://doi.org/10.1016/j.jbusres.2018.12.072

Cugno, M., Castagnoli, R., Büchi, G., & Pini, M. (2022). Industry 4.0 and production recovery in the covid era. *Technovation*, *114*, 102443. https://doi.org/10.1016/j.technovation.2021.102443

Dong, J. Q., & Yang, C.-H. (2020). Business value of big data analytics: A systems-theoretic approach and empirical test. *Information & Management*, *57*(1), 103124. https://doi.org/10.1016/j.im.2018.11.001

Dubouloz, S., Bocquet, R., Equey Balzli, C., Gardet, E., & Gandia, R. (2021). SMEs' Open Innovation: Applying a Barrier Approach. *California Management Review*, *64*(1), 113-137. https://doi.org/10.1177/00081256211052679

Edmondson, A. C., & Mcmanus, S. E. (2007). Methodological fit in management field research. *Academy of Management Review*, *32*(4), 1246-1264. https://doi.org/10.5465/amr.2007.26586086

Elia, G., Raguseo, E., Solazzo, G., & Pigni, F. (2022). Strategic business value from big data analytics: An empirical analysis of the mediating effects of value creation mechanisms. *Information & Management*, *59*(8), 103701. https://doi.org/10.1016/j.im.2022.103701

European Commission. (2020). *Flash Eurobarometer 486 (SMEs, Start-ups, Scale-ups and Entrepreneurship)* (NA-03-20-475-EN-N). https://doi.org/10.4232/1.13639

European Commission. (2022, September 16). *The Digital Economy and Society Index (DESI) | Shaping Europe's digital future*. The Digital Economy and Society Index (DESI). https://digital-strategy.ec.europa.eu/en/policies/desi

Farquhar, J., Michels, N., & Robson, J. (2020). Triangulation in industrial qualitative case study research: Widening the scope. *Industrial Marketing Management*, *87*, 160-170. https://doi.org/10.1016/j.indmarman.2020.02.001

Ferneley, E., & Bell, F. (2006). Using bricolage to integrate business and information technology innovation in SMEs. *Technovation*, *26*(2), 232-241. https://doi.org/10.1016/j.technovation.2005.03.005

French Ministry of Economy, Finance and Industry (2022). *Digital barometer of 2022: The role of digital technologies in SMEs (0 to 249 employees)*. Available at https://www.francenum.gouv.fr/guides-et-conseils/strategie-numerique/barometre-france-num-2022-le-numerique-dans-les-tpe-pme-0

Gandomi, A., & Haider, M. (2015). Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management*, *35*(2), 137-144. https://doi.org/10.1016/j.ijinfomgt.2014.10.007

Ghasemaghaei, M. (2021). Understanding the impact of big data on firm performance: The necessity of conceptually differentiating among big data characteristics. *International Journal of Information Management*, *57*, 102055. https://doi.org/10.1016/j.ijinfomgt.2019.102055

Ghasemaghaei, M., Ebrahimi, S., & Hassanein, K. (2018). Data analytics competency for improving firm decision making performance. *The Journal of Strategic Information Systems*, *27*(1), 101-113. https://doi.org/10.1016/j.jsis.2017.10.001

Gnyawali, D. R., & Park, B.-J. (Robert). (2009). Co-opetition and Technological Innovation in Small and Medium-Sized Enterprises: A Multilevel Conceptual Model. *Journal of Small Business Management*, *47*(3), 308-330. https://doi.org/10.1111/j.1540-627X.2009.00273.x

Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European Journal of Information Systems*, *21*(2), 135-146. https://doi.org/10.1057/ejis.2011.54

Gong, C., & Ribiere, V. (2021). Developing a unified definition of digital transformation. *Technovation*, *102*, 102217. https://doi.org/10.1016/j.technovation.2020.102217

Granata, J., Aytaç, B., & Roubaud, D. (2019). Innovation developments in the wine industry: A journey from the amphorae of old to the California wine cluster. *International Journal of Entrepreneurship and Small Business*, *36*(3), 249-255. https://doi.org/10.1504/IJESB.2019.097742

Granata, J., Lasch, F., Le Roy, F., & Dana, L.-P. (2018). How do micro-firms manage coopetition? A study of the wine sector in France. *International Small Business Journal*, *36*(3), 331-355. https://doi.org/10.1177/0266242617740412

Gunasekaran, A., Papadopoulos, T., Dubey, R., Wamba, S. F., Childe, S. J., Hazen, B., & Akter, S. (2017). Big data and predictive analytics for supply chain and organizational performance. *Journal of Business Research*, *70*, 308-317. https://doi.org/10.1016/j.jbusres.2016.08.004

Gupta, M., & George, J. F. (2016). Toward the development of a big data analytics capability. *Information & Management*, *53*(8), Article 8. https://doi.org/10.1016/j.im.2016.07.004

Gupta, S., Drave, V. A., Dwivedi, Y. K., Baabdullah, A. M., & Ismagilova, E. (2020). Achieving superior organizational performance via big data predictive analytics: A dynamic capability view. *Industrial Marketing Management*, *90*, 581-592. https://doi.org/10.1016/j.indmarman.2019.11.009

Gupta, S., Justy, T., Kamboj, S., Kumar, A., & Kristoffersen, E. (2021). Big data and firm marketing performance: Findings from knowledge-based view. *Technological Forecasting and Social Change*, *171*. https://doi.org/10.1016/j.techfore.2021.120986

Hassani, A., & Mosconi, E. (2022). Social media analytics, competitive intelligence, and dynamic capabilities in manufacturing SMEs. *Technological Forecasting and Social Change*, *175*, 121416. https://doi.org/10.1016/j.techfore.2021.121416

Horváth, D., & Szabó, R. Zs. (2019). Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting and Social Change*, *146*, 119-132. https://doi.org/10.1016/j.techfore.2019.05.021

Johns, G. (2006). The Essential Impact of Context on Organizational Behavior. Academy of Management Review, 31(2), 386-408. https://doi.org/10.5465/amr.2006.20208687

Kache, F., & Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management. *International Journal of Operations & Production Management*, *37*(1), 10-36. https://doi.org/10.1108/IJOPM-02-2015-0078

Krammer, S. M. S. (2022). Navigating the New Normal: Which firms have adapted better to the COVID-19 disruption? *Technovation*, *110*, 102368. https://doi.org/10.1016/j.technovation.2021.102368

Lashitew, A. A. (2023). When businesses go digital: The role of CEO attributes in technology adoption and utilization during the COVID-19 pandemic. *Technological Forecasting and Social Change*, *189*, 122324. https://doi.org/10.1016/j.techfore.2023.122324

Li, L., Su, F., Zhang, W., & Mao, J.-Y. (2018). Digital transformation by SME entrepreneurs: A capability perspective. *Information Systems Journal*, *28*(6), 1129-1157. https://doi.org/10.1111/isj.12153

Liu, Y., Soroka, A., Han, L., Jian, J., & Tang, M. (2020). Cloud-based big data analytics for customer insight-driven design innovation in SMEs. *International Journal of Information Management*, *51*, 102034. https://doi.org/10.1016/j.ijinfomgt.2019.11.002

Locke, K. (2001). *Grounded Theory in Management Research* (1st edition). SAGE Publications.

Lunde, T. Å., Sjusdal, A. P., & Pappas, I. O. (2019). Organizational Culture Challenges of Adopting Big Data: A Systematic Literature Review. In I. O. Pappas, P. Mikalef, Y. K. Dwivedi, L. Jaccheri, J. Krogstie, & M. Mäntymäki (Éds.), *Digital Transformation for a Sustainable Society in the 21st Century* (p. 164-176). Springer International Publishing. https://doi.org/10.1007/978-3-030-29374-1_14

Mangla, S. K., Raut, R., Narwane, V. S., Zhang, Z. (Justin), & priyadarshinee, P. (2020). Mediating effect of big data analytics on project performance of small and medium enterprises. *Journal of Enterprise Information Management*, *34*(1), 168-198. https://doi.org/10.1108/JEIM-12-2019-0394

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Byers, A. H. (2011). *Big Data: The Next Frontier for Innovation, Competition, and Productivity*. McKinsey Institute.

Maroufkhani, P., Iranmanesh, M., & Ghobakhloo, M. (2022). Determinants of big data analytics adoption in small and medium-sized enterprises (SMEs). *Industrial Management & Data Systems*. https://doi.org/10.1108/IMDS-11-2021-0695

Maroufkhani, P., Tseng, M.-L., Iranmanesh, M., Ismail, W. K. W., & Khalid, H. (2020b). Big data analytics adoption: Determinants and performances among small to medium-sized enterprises. *International Journal of Information Management*, *54*, 102190. https://doi.org/10.1016/j.ijinfomgt.2020.102190

Maroufkhani, P., Wagner, R., Wan Ismail, W. K., Baroto, M. B., & Nourani, M. (2019). Big Data Analytics and Firm Performance: A Systematic Review. *Information*, *10*(7), 226. https://doi.org/10.3390/info10070226

Maroufkhani, P., Wan Ismail, W. K., & Ghobakhloo, M. (2020a). Big data analytics adoption model for small and medium enterprises. *Journal of Science and Technology Policy Management*, *11*(4), 483-513. https://doi.org/10.1108/JSTPM-02-2020-0018

Martin, J. A., & Eisenhardt, K. M. (2010). Rewiring: Cross-Business-Unit Collaborations in Multibusiness Organizations. *Academy of Management Journal*, *53*(2), 265-301. https://doi.org/10.5465/amj.2010.49388795

Martínez-Caro, E., Cegarra-Navarro, J. G., & Alfonso-Ruiz, F. J. (2020). Digital technologies and firm performance: The role of digital organisational culture. *Technological Forecasting and Social Change*, *154*, 119962. https://doi.org/10.1016/j.techfore.2020.119962

Meadows, M., Merendino, A., Dibb, S., Garcia-Perez, A., Hinton, M., Papagiannidis, S., Pappas, I., & Wang, H. (2022). Tension in the data environment: How organisations can meet the challenge. *Technological Forecasting and Social Change*, *175*, 121315. https://doi.org/10.1016/j.techfore.2021.121315

Meyer-Waarden, L., & Cloarec, J. (2022). "Baby, you can drive my car": Psychological antecedents that drive consumers' adoption of AI-powered autonomous vehicles. *Technovation*, *109*, 102348. https://doi.org/10.1016/j.technovation.2021.102348

Mikalef, P., Boura, M., Lekakos, G., & Krogstie, J. (2019a). Big Data Analytics Capabilities and Innovation: The Mediating Role of Dynamic Capabilities and Moderating Effect of the Environment. *British Journal of Management*, *30*(2), 272-298. https://doi.org/10.1111/1467-8551.12343

Mikalef, P., Boura, M., Lekakos, G., & Krogstie, J. (2019b). Big data analytics and firm performance: Findings from a mixed-method approach. *Journal of Business Research*, *98*, 261-276. https://doi.org/10.1016/j.jbusres.2019.01.044

Mikalef, P., Krogstie, J., Pappas, I. O., & Pavlou, P. (2020). Exploring the relationship between big data analytics capability and competitive performance: The mediating roles of dynamic and operational capabilities. *Information & Management*, *57*(2), 103169. https://doi.org/10.1016/j.im.2019.05.004

Mikalef, P., Pappas, I. O., Krogstie, J., & Giannakos, M. (2018). Big data analytics capabilities: A systematic literature review and research agenda. *Information Systems and E-Business Management*, *16*(3), 547-578. https://doi.org/10.1007/s10257-017-0362-y

Mikalef, P., van de Wetering, R., & Krogstie, J. (2021). Building dynamic capabilities by leveraging big data analytics: The role of organizational inertia. *Information & Management*, *58*(6), 103412. https://doi.org/10.1016/j.im.2020.103412

Miles, B., & Huberman, M. (1994). *Qualitative data analysis: A source book of new methods*. SAGE Publications.

Miles, M. B., Huberman, A. M., & Saldana, J. (2018). *Qualitative Data Analysis: A Methods Sourcebook*. SAGE Publications.

Mohd salleh, N. A., Rohde, F., & Green, P. (2017). Information Systems Enacted Capabilities and Their Effects on SMEs' Information Systems Adoption Behavior. *Journal of Small Business Management*, *55*(3), 332-364. https://doi.org/10.1111/jsbm.12226

Morgan-Thomas, A. (2016). Rethinking technology in the SME context: Affordances, practices and ICTs. *International Small Business Journal*, *34*(8), 1122-1136. https://doi.org/10.1177/0266242615613839

Moritz, A., Naulin, T., & Lutz, E. (2022). Accelerators as drivers of coopetition among early-stage startups. *Technovation*, *111*, 102378. https://doi.org/10.1016/j.technovation.2021.102378

Mortati, M., Magistretti, S., Cautela, C., & Dell'Era, C. (2023). Data in design: How big data and thick data inform design thinking projects. *Technovation*, 102688. https://doi.org/10.1016/j.technovation.2022.102688

Muller, P., Devnani, S., Ladher, R., Cannings, J., Murphy, E., Robin, N., Ramos, I., Aranda, F., Gorgels, S., Priem, M., Smid, S., Unlu Bohn, N., Lefebvre, V., Frizis, I., & Hope, K. (2021). *Annual report on European SMEs 2020/2021: Digitalization of SMEs* (EA-05-21-184-EN-N; p. DOI:10.2826/120209). European Innovation Council and SMEs Executive Agency (EISMEA) - European Commission. https://op.europa.eu/fr/publication-detail/-/publication/849659ce-dadf-11eb-895a-01aa75ed71a1

Ocasio, W. (1997). Towards an Attention-Based View of the Firm. *Strategic Management Journal*, *18*(S1), 187-206. https://doi.org/10.1002/(SICI)1097-0266(199707)18:1+<187::AID-SMJ936>3.0.CO;2-K

Packard, M. D. (2017). Where did interpretivism go in the theory of entrepreneurship? *Journal of Business Venturing*, *32*(5), Article 5. https://doi.org/10.1016/j.jbusvent.2017.05.004

Patton, M. Q. (2022). *Qualitative research & evaluation methods*. SAGE Publications.

Peltier, J. W., Zhao, Y., & Schibrowsky, J. A. (2012). Technology adoption by small businesses: An exploratory study of the interrelationships of owner and environmental factors. *International Small Business Journal*, *30*(4), 406-431. https://doi.org/10.1177/0266242610365512

Perdana, A., Lee, H. H., Koh, S., & Arisandi, D. (2022). Data analytics in small and mid-size enterprises: Enablers and inhibitors for business value and firm performance. *International Journal of Accounting Information Systems*, *44*, 100547. https://doi.org/10.1016/j.accinf.2021.100547

Persaud, A., & Zare, J. (2023). Beyond Technological Capabilities: The Mediating Effects of Analytics Culture and Absorptive Capacity on Big Data Analytics Value Creation in Small- and Medium-Sized Enterprises. *IEEE Transactions on Engineering Management*, 1-13. https://doi.org/10.1109/TEM.2023.3249415

Piatier, A. (1984). *Barriers to innovation* (Frances Pinter).

Raj, A., Dwivedi, G., Sharma, A., Lopes de Sousa Jabbour, A. B., & Rajak, S. (2020). Barriers to the adoption of industry 4.0 technologies in the manufacturing sector: An inter-country comparative perspective. *International Journal of Production Economics*, *224*, 107546. https://doi.org/10.1016/j.ijpe.2019.107546

Rialti, R., Zollo, L., Ferraris, A., & Alon, I. (2019). Big data analytics capabilities and performance: Evidence from a moderated multi-mediation model. *Technological Forecasting and Social Change*, *149*, 119781. https://doi.org/10.1016/j.techfore.2019.119781

Rizzoni, A. (1991). Technological Innovation and Small Firms: A Taxonomy. *International Small Business Journal: Researching Entrepreneurship*, *9*(3), 31-42. https://doi.org/10.1177/026624269100900302

Robert, M., Giuliani, P., & Dubouloz, S. (2022). Obstacles affecting the management innovation process through different actors during the covid-19 crisis: A longitudinal study of Industry 4.0. *Annals of Operations Research*. https://doi.org/10.1007/s10479-021-04457-7

Robert, M., Le Goff, R., Mignon, S., & Giuliani, P. (2023). Decoding the significant role of social context in SMEs' implementation of management innovation during the digital revolution. *Annals of Operations Research*. https://doi.org/10.1007/s10479-023-05292-8

Robey, D., Ross, J. W., & Boudreau, M.-C. (2002). Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change. *Journal of Management Information Systems*, *19*(1), 17-46. https://doi.org/10.1080/07421222.2002.11045713

Sahu, A. K., Padhy, R. K., & Dhir, A. (2022). Determinants and barriers of implementing lean manufacturing practices in MSMEs: A behavioural reasoning theory perspective. *Production Planning & Control*, *33*(12), 1197-1213. https://doi.org/10.1080/09537287.2020.1857449

Schilke, O. (2014). On the contingent value of dynamic capabilities for competitive advantage: The nonlinear moderating effect of environmental dynamism. *Strategic Management Journal*, *35*(2), 179-203. https://doi.org/10.1002/smj.2099

Sestino, A., Prete, M. I., Piper, L., & Guido, G. (2020). Internet of Things and Big Data as enablers for business digitalization strategies. *Technovation*, *98*, 102173. https://doi.org/10.1016/j.technovation.2020.102173

Sheng, J., Amankwah-Amoah, J., Khan, Z., & Wang, X. (2021). COVID-19 Pandemic in the New Era of Big Data Analytics: Methodological Innovations and Future Research Directions. *British Journal of Management*, *32*(4), 1164-1183. https://doi.org/10.1111/1467-8551.12441

Steininger, D., Mikalef, P., Pateli, A., & Ortiz-de-Guinea, A. (2022). Dynamic Capabilities in Information Systems Research: A Critical Review, Synthesis of Current Knowledge, and Recommendations for Future Research. *Journal of the Association for Information Systems*, *23*(2), 447-490. https://doi.org/10.17705/1jais.00736

Stock, G. N., Greis, N. P., & Fischer, W. A. (2002). Firm size and dynamic technological innovation. *Technovation*, *22*(9), 537-549. https://doi.org/10.1016/S0166-4972(01)00061-X

Stornelli, A., Ozcan, S., & Simms, C. (2021). Advanced manufacturing technology adoption and innovation: A systematic literature review on barriers, enablers, and innovation types. *Research Policy*, *50*(6), 104229. https://doi.org/10.1016/j.respol.2021.104229

Suoniemi, S., Meyer-Waarden, L., Munzel, A., Zablah, A. R., & Straub, D. (2020). Big data and firm performance: The roles of market-directed capabilities and business strategy. *Information & Management*, *57*(7), Article 7. https://doi.org/10.1016/j.im.2020.103365

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Terziovski, M. (2010). Innovation practice and its performance implications in small and medium enterprises (SMEs) in the manufacturing sector: A resource-based view. *Strategic Management Journal*, *31*(8), 892-902. https://doi.org/10.1002/smj.841

Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation* (Lexington Books).

Urbinati, A., Bogers, M., Chiesa, V., & Frattini, F. (2019). Creating and capturing value from Big Data: A multiple-case study analysis of provider companies. *Technovation*, *84-85*, 21-36. https://doi.org/10.1016/j.technovation.2018.07.004

van de Ven, A. H., & Huber, G. P. (1990). Longitudinal Field Research Methods for Studying Processes of Organizational Change. *Organization Science*, *1*(3), 213-219. https://doi.org/10.1287/orsc.1.3.213

Volkmar, G., Fischer, P. M., & Reinecke, S. (2022). Artificial Intelligence and Machine Learning: Exploring drivers, barriers, and future developments in marketing management. *Journal of Business Research*, *149*, 599-614. https://doi.org/10.1016/j.jbusres.2022.04.007

Wamba, S. F., Akter, S., Edwards, A., Chopin, G., & Gnanzou, D. (2015). How 'big data' can make big impact: Findings from a systematic review and a longitudinal case study. *International Journal of Production Economics*, *165*, 234-246. https://doi.org/10.1016/j.ijpe.2014.12.031

Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. J., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. *Journal of Business Research*, *70*, 356-365. https://doi.org/10.1016/j.jbusres.2016.08.009

Wedel, M., & Kannan, P. K. (2016). Marketing Analytics for Data-Rich Environments. *Journal of Marketing*, *80*(6), 97-121. https://doi.org/10.1509/jm.15.0413

Yang, M., Fu, M., & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change*, *169*, 120795. https://doi.org/10.1016/j.techfore.2021.120795

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods* (6th Edition). SAGE

Publications.

Appendixes

Appendix A. Description tab of corporate networks

Name	Creation date	Localization	Specialization	Number of members	Types of members
Vinseo	2007	France	Industry Agriculture Research	+ 100 SMEs	Firms Public institutions Cooperatives Research laboratories
Provence Rosé	2014	France	Industry Agriculture	+ 50 SMEs	Firms Public institutions Cooperatives
La Mêlée	2000	France	Digital technologies Industry Research	+ 550 SMEs	Firms Public institutions Research laboratories
Leader Occitanie	2009	France	Digital technologies Industry	+ 200 SMEs	Firms Public institutions

SMEs	Creation	Size	Specialization	Respondent	Status
1	1973	250	Industrial equipment manufacturing	1	Strategy and development manager
				2	Strategy and development manager
2	2018	10	Software editing	3	General manager
3	1996	250	Agricultural equipment manufacturing	4	Financial manager
4	1993	50	Label and poster printing	5	Associate and sales manager
5	2016	10	Software editing - consulting	6	General manager
6	2010	10	Innovative industrial equipment manufacturing	7	General manager
7	2016	50	Software editing	8	Sales manager
8	2017	10	Industrial design and engineering office - consulting	9	Associate and sales manager
				10	Associate and project manager
9	2017	20	Software editing	11	Sales manager
10	2004	50	Equipment distribution - consulting	12	R&D manager
11	2017	10	Software editing - consulting	13	Founder and project manager
12	2016	20	Industrial connected objects manufacturing	14	Founder and general manager
13	1996	20	Industrial design and engineering office - consulting	15	General manager
14	2012	25-50	Industrial equipment manufacturing and distribution	16	General manager
15	2004	250	Control of industrial risks	17	General manager
16	1999	50-100	Industrial equipment manufacturing and maintenance	18	Co-general manager
17	1988	130	Queuing systems development	19	R&D manager
18	2016	20	Engineering software editing	20	General manager
19	2018	20	Business software editing	21	General manager
20	2007	15-20	Digital service provider	22	Associate and general manager
21	2008	15-20	Software editing	23	General manager
22	1985	85	Industrial and agricultural service provider	24	General manager
23	2020	15-20	Queuing systems development	25	General manager
24	1997	55	Industrial and management software editing	26	General manager
25	1950	110	Financial and accounting service	27	IS manager

			provider for industrial SMEs	28	Co-general manager
26	1997	50	Agricultural retail trade	29	General manager
27	2009	150	Agricultural retail trade - consulting	30	Innovation manager
28	1985	50-100	Agri-food distributor	31	General manager
29	2020	15-20	Professional training service provider	32	General manager
30	2012	20	Agricultural connected objects distributor	33	General manager
31	2019	35-50	Agricultural connected objects manufacturing	34	Marketing manager
32	1985	85-100	Industrial equipment distributor	35	General manager

Data collection n°1 - year 2021

Theme 1: data analytics in SMEs

- What do you know about Big Data?

- What types of digital data do you have in your company?

- What types of data analytics do you have in your company?

Theme 2: The role of data analytics in SMEs

- What role does digital data have in your business management?

- What issues are you currently facing that you would like to solve with data analytics?

Theme 3: Use cases for digital data analysis in SMEs

- What are the strategic use cases for digital data in your company?

- How are you using your digital data as part of your business strategy?

- How do you use your digital data in your marketing activities?

Theme 4: The challenges of data analytics in SMEs

- In what ways are you developing your ability to analyze digital data for your business management?

- What obstacles do you face in analyzing your digital data or using your data analytics?

Data collection n°2 - year 2022

Theme 1: data analytics in SMEs

- What do you know about Big Data?

- What types of digital data do you have in your company?

- What is your perception of the value of your digital data as an SME?

- What data analytics do you have to analyze digital data?

Theme 2: SMBs' motivations for adopting software for data analysis

- What are your reasons for wanting to increasingly leverage the potential of your digital data in your business?

- What are the goals your company would like to achieve through data leveraging?

- What do you think are the prerequisites for data analytics for an SME?

Theme 3: Developing digital data analytics capabilities in SMEs

- How have you developed your data analysis capabilities in your company?

- Who drove the development of this data analytics capability in your company?

- Have you fully internalized the development of your data analytics capability, or have you used an external provider?

- Have you put in place collective strategies to develop your data analytics capability? What are the reasons for this?

Theme 4: Use cases of digital data analysis in SMEs

- How do you evaluate your business performance?

- How does data analytics help you perform better now?

- How are you developing your business strategy? To what extent do you rely on data to build that strategy?

- What are the strategic use cases for data analytics in your business?

- How do you use your digital data in your marketing activities?

Theme 5: Barriers to digital data analysis in SMBs

- What are the barriers you face in analyzing your data or using analytics software?

- How do you think you could improve your ability to analyze data? What actions would you put in place to overcome these barriers?

Appendix D. Analysis grid

INTERVIEW	Respondent		
	Position		
	N° SMEs		

Categories	3rd order codes	2nd order codes	1st order codes
DRIVERS	Endogenous	Operational	
		Strategic	
	Exogenous	Market	
		Competition	
		Crisis context	
BARRIERS	Endogenous	Technical	
		Managerial	
		Strategic	
		Cultural	
		Skills	
		Financial	
		Legal	
	Exogenous	Supply	
		Demand	
	Data analytics attributes	Volume	
		Velocity	
		Value	

Appendix E. Data structures and typologies

First order codes	Second order codes	Aggregated dimensions

- Improvement of the company's financial management
- Improvement of industrial and business operations reporting
- Improvement of financial and industrial prediction models
- Increased efficiency of organizational processes
- Optimization of financial and market performance

Operational

- Better understanding of business challenges
- Improvement of strategic decision-making
- Improvement of the industrial or business strategy

Strategic

Endogenous

- Improvement of customer knowledge
- Better identification of customer needs
- Improvement of segmentation, targeting and positioning
- Improvement of digital marketing operations
- Create innovative digital services or business models

Market

DRIVERS

- Increased adoption of data analytics in rival SMEs
- Aversion to missing a technological opportunity
- Gain legitimacy on the use of data analytics

Competition

Exogenous

- Acceleration of digital transformation due to Covid-19 crisis
- Search for innovative strategies or technological solutions

Crisis context

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First order codes	Second order codes	Aggregated dimensions

First order codes

- Unsuitable IT infrastructure for data analytics adoption
- Lack of formal data management processes

- Lack of managerial support in data analytics adoption process
- Tensions between top management and employees

- Inability to identify strategic use cases for data analytics
- Misalignment between business strategy and IS

- Lack of organizational culture or leadership supporting data analytics use
- Lack of trust, conservatism or skepticism against digital technologies

- Lack of knowledge about Big Data and data analytics
- Lack of data analytics-skilled employees and professional training

- High cost of adopting data analytics and maintaining IS infrastructure

- Lack of legal knowledge to comply with GDPR legislation

- Lack of software editors specialized in SME
- Shortage in skilled employees on the job market and high cost of salaries

- Increased competition and price due to high demand in service providers

- Large volume of digital data collected by SMEs

- Lack of quality, accuracy or reliability of digital data

- Inability to measure the profitability from data analytics adoption

Second order codes

Technical

Managerial

Strategic

Cultural

Skills

Financial

Legal

Supply

Demand

Volume

Veracity

Value

Aggregated dimensions

Endogenous

Exogenous

Technology attributes

BARRIERS

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