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MSME technology adoption, entrepreneurial mindset and value creation: a configurational approach

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Abstract

For micro, small and medium-sized enterprises (MSMEs) technology adoption provides a basis to accelerate their growth ambitions and to enhance their value-creation activities for disruptive and competitive purposes. However, we have a limited understanding of how MSMEs engage in new technology adoption for value-creation purposes. Integrating the determinants of technology adoption and entrepreneurial mindset—*cognition and opportunity recognition*—the purpose of our paper is to examine what factors determine MSME technology adoption. Set in the Danube region of Europe we focus on MSMEs in the automotive, electronics and IT sectors that are traditionally characterized by the relatively rapid uptake of high-performance computing (HPC). As a new technology, HPC combines infrastructure and applications that are highly complex and can be deployed in an array of contexts to address market-based opportunities. Employing fuzzy set qualitative comparative analysis, we find the potential presence of a complementary relationship between the technological, organisational, and environmental factors and the entrepreneurial mindset for technology adoption among MSMEs for value creation. We find that cognition is not a necessary condition for technology adoption and opportunity recognition is. Furthermore, we unveil that opportunity recognition combined with organisational or environmental factors can enable technology adoption among MSMEs.

Keywords Entrepreneurial mindset · Digital technology adoption · Opportunity recognition · Cognition · High-performance computing · Value creation

JEL Classification O30 · O32 · M00

1 Introduction

The emergence of novel and powerful digital technologies is transforming innovation and entrepreneurship in significant ways, by opening new opportunities, and with implications for value creation and capture that has resultant economic and social benefits and impacts (Holzmann et al., 2020; Ibáñez et al., 2022; Nambisan, 2017; Nambisan et al., 2019; Teruel et al., 2021; Zhang et al., 2023). For micro, small and medium-sized enterprises (MSMEs) technology adoption offers several benefits against a background of firm-level knowledge

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and financial constraints. Technology adoption provides MSMEs with the basis to pursue disruptive innovation (Nguyen, 2009) and/or to enhance their product or service offerings in their pursuit of sustained value creation (Vrontis et al., 2022) and is as such understood to deliver benefits across firm's business processes (Cunningham et al., 2022; Modic et al., 2019; Modic & Damij, 2018; O'Kane et al., 2021; Kruger & Steyn, 2020). High-Performance Computing (HPC) is considered to be one such general-purpose (digital) technology (Coscodaru et al., 2019; Lee & Lee, 2021; Cunningham et al., 2022) and to date given the scale of complexity and investment required has mainly been adopted by larger firms and national governments (European Commission, 2021). Some research on HPC technology adoption has highlighted the beneficial value creation impacts it has for firms (Coscodaru et al., 2019). HPC includes infrastructure and applications that are used for complex computational problems and can involve supercomputers and linked clusters (Cunningham et al., 2022). HPC technology supports advanced modelling, simulation and analysis, as well as is a strategic driver of innovation and a source of competitive advantage for firms (Brochard, 2006; Ezell & Atkinson, 2016; Lee & Lee, 2021; Lynn et al., 2020) across various industry sectors (Osseyran & Giles, 2015; Shephard et al., 2013; Wince-Smith, 2009). Nonetheless, the adoption of this complex (digital), emergent and highly specialised technology needs more research that elucidates the role of different factors in HPC adoption (Lynn et al., 2020). The adoption of this digital technology by MSMEs is of particular focus, with the aim to better understand the entrepreneurs' perception of HPC adoption benefits (Lee & Runge, 2001), and entrepreneurial orientation when adopting a technology that has been successfully adopted by multinational firms and national governments within a MSME context (Cunningham et al., 2022).

Technology adoption, particularly in the case of HPC adoption, is usually accompanied by a variety of known and unknown challenges that can significantly influence its adoption. To minimize the unknown ones and the related uncertainties, several technology adoption frameworks have been created, tested and matured. We know from prior literature that technological, organisational and environmental factors seem to influence the adoption of new technologies, with Tornatzky and Fleischer's (1990) theoretical TOE framework being used frequently to explore the adoption of new information technologies supporting business (e.g., Zhu et al., 2003), or information systems and big data analytics (e.g., Nam et al., 2019) and, more recently, the adoption of supercomputing by SMEs (Cunningham et al., 2022). However, another stream of literature points out that information systems literature has suggested intention models from social psychology as potential theoretical foundation perspectives for research related to adoption (Davis et al., 1989; Swanson, 1982). These already emphasized softer elements, under which we could also subsume cognition and opportunity recognition (Hajizadeh & Zali, 2016).

To further our study focus we build upon recent conceptual work on the interplay of technology and mindset for innovation (Ringberg et al., 2019), whereby we extend the factors to all those included in the TOE framework and focus on the adoption of a particular digital technology to explore this interplay. For the entrepreneurial mindset, we focus on two elements thereof, i.e., cognition and opportunity recognition. There is a need to understand how cognition and opportunity recognition change entrepreneurial behaviour (Cutolo & Kenney, 2019), i.e., lead to entrepreneurial action, including that of adopting or not adopting new digital technologies, such as HPC (see Fig. 1).

Our study employs a fuzzy set qualitative comparative analysis (fsQCA) as an empirical testing technique to address the possibility of equifinality (Fiss, 2007), i.e., a situation where several diverse configurations lead to the outcome of interest. The analysis of configurational effects helps to better understand how diverse antecedents

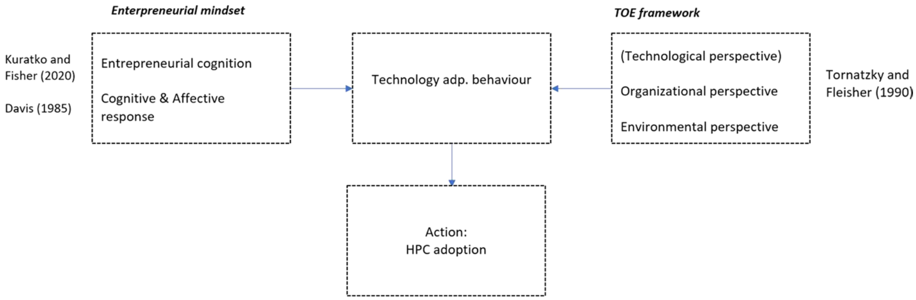

Fig. 1 Conceptual model: entrepreneurial mindset and technology adoption

work together and combine into configurations that indicate an outcome consistently. The advantages of the fsQCA have recently been demonstrated in a variety of applications, including the analysis of configurational paths to technology transfer and innovation (Ganter & Hecker, 2014; Stejskal & Hajek, 2019). The fsQCA method is used to demonstrate the combined paths that determine HPC adoption, as well as the significant role that an entrepreneurial mindset plays for MSME technology adoption. Compared to other studies, the method applied here highlights two key advantages. Firstly, it provides the opportunity to investigate and evaluate the main variables that have either a positive or negative impact on the adoption of HPC. And secondly, this article breaks down the paradigm of earlier research (focusing on a single factor analysis) by performing a multifactor combination path analysis (see Mikalef et al., 2019;), and as such presents a novel approach to the investigation of HPC adoption and expands the entrepreneurial mindset variables. In addition, compared to the method of single-case analysis, the multi-case analysis approach is more universal. fsQCA has also been used to gain a more fine-grained understanding of the outcomes of the new emerging technologies' adoption (Mikalef et al., 2019) as well as the diverse paths leading to their adoption (Gilbert & Campbell, 2015).

Our study makes two main contributions to our understanding of technology adoption among MSMEs for value-creation purposes. First, we address one of the main criticisms of the TOE frameworks that they do not consider specific contextual elements concerning technology adoption (Cunningham et al., 2022). Conceptualisation and definitions of entrepreneurial mindset remain contested (see Daspit et al., 2021). The entrepreneurial mindset has been defined by Haynie et al., (2010: 217) as "the ability to sense, act, and mobilize under uncertain conditions" whilst seeing it as a collective construct in line with the ideas that actions are ultimately simply consequences of aggregations of mindsets (McMullen & Shepherd, 2006). Context and complexity influence the entrepreneurial mindset (Kuratko et al., 2021). When it comes to using existing or new technologies, first and foremost, mindset determinism researchers argue that it is driven by appropriate mindsets (Ringberg et al., 2019). Hence, recognising opportunities on the market influences entrepreneurs to potentially alter their behaviours (Cutolo & Kenney, 2019), thus developing their mindsets further and are therefore able to take advantage of those opportunities such as digital technology/HPC adoption.

By applying a configurational analysis our study illustrates and suggests that technology adoption for MSMEs is complementary in terms of factors potentially building an outcome together (i.e., in combination). Technology adoption combines technological, organisational and environmental factors and an entrepreneurial mindset for value-creation purposes. We address both the current deficits of TOE frameworks and extend our understanding of technology adoption among MSMEs. Our study offers an approach to organize multiple interdependent relationships into a coherent framework explaining variance in pathways to technology adoption for value creation purposes and unveils whether this fundamental complementary relationship between the abovementioned factors is indeed present.

Our second contribution concerns firm-level technology adoption and entrepreneurial mindset for value creation purposes. Taking a configurational approach and linking cognition and opportunity recognition with other factors when adopting digital technologies, in both pathways, we find both mindset factors are relevant, although cognition is not relevant per se, it becomes relevant when considering a combination of factors that lead to our outcome of interest (HPC adaption). This has implications for how firms to grow and create value through technology adoption.

This paper proceeds as follows. In Sect. 2 we first deliberate on the limits of TOE- and social psychology-based models, continue by introducing the mindset perspective, and introduce the end action, i.e., the adoption of HPC. Section 3 brings our method description and Sect. 4 the findings. We discuss and conclude in Sect. 5.

2 The factors of digital technologies' adoption: from technological, organisational to entrepreneurial mindset

2.1 MSME value creation and technology adoption

MSMEs are important contributors to economic development and growth in national economies (Lin et al., 2022) and are more open to responding to new market and technology opportunities (see OECD, 2017). While there is an ongoing debate about the definition of an MSME (see Nagari and Vaibhav, 2020), there is a growing body of MSME research that has focused on themes such as sustainability (see Cuerva et al., 2014), innovation (Scuotto et al., 2017), and R&D growth (Love & Roper, 2015; Baumann and Kriltikos, 2016). One of the core challenges that MSMEs face centres around finances. In developing economies this is even more acute (Atkinson, 2017; Saxena & Jagota, 2015; Zamberi, 2012; Khurana et al., 2019; Mittal & Raman, 2021).

This in turn can place some limitations and constraints on how MSMEs scale and growth their businesses. When it comes to value creation, some of the limited empirical evidence suggests that MSMEs achieve a return on investment from investing in digital technologies (Pfister & Lehmann, 2021, 2022) In undertaking value creation based on technology adoption there is some evidence to suggest this enhances their market position (see Share et al., 2023) and that they can gain a competitive advantage (Loforte and Love, 2003).

While technology adoption within the context of MSMEs demands a higher degree of awareness due to MSME's uniqueness and different characteristic compared to large organisations (Sugandini et al. 2018a; 2018b), it is also argued that these characteristics, their flexibility in particular can enable them to adjust to market changes by quickly transforming their business models (Shaikh et al., 2021), especially when adopting with the help of digital technology. For entrepreneurs to efficiently recognise such market opportunities and create their responses with the aim to contribute to value creation, their process of cognition is paramount. For this reason, the paper explores the prior research of technology adoption models (such as TOE) and entrepreneurial mindset as technology adoption factors.

2.2 The limits of TOE-based models and social psychology-based intention models

Prior research has pointed out several theoretical models that aim to predict the adoption of technologies (see Venkatesh et al., 2003, 2012; Cunningham et al., 2022; Holzmann et al., 2020). According to Lynn et al. (2020), the first is so-called innovation or organization centred, such as the model of technological, organisational and environmental (TOE) factors, or the Human-Organization-Technology Fit (HOT-fit) model (Tornatzky and Fleischer, 1990; Yosuf et al., 2008); and the second the adopter-centred theories, encompassing models based on insights from social psychology.

Concerning HPC, the usefulness of the TOE framework has already been elucidated recently (Cunningham et al., 2022). The TOE framework identifies three contexts of technology adoption by explaining the process of adopting and using technological innovations from the technological, organisational and environmental perspectives (Tornatzky and Fleischer, 1990). The technological perspective deals with incorporating owned technologies as well as those available on the market (Zhu et al., 2003), the organisational with elements such as company size and scope, managerial structure, human resources, and available slack resources, while the environmental perspective deals with the way the company communicates with external environments. The technological perspective addresses concepts related to IT infrastructure as well as technology skills including necessary technology competencies as well as employee-specific IT knowledge (Kuan & Chau, 2001; Nam et al., 2019; Nguyen, 2009; Thong, 1999). The environmental perspective focuses on concepts related to competitive intensity and pressure, overall cooperation, and systems openness (Grover, 1993; Iacovou et al., 1995; Kuan & Chau, 2001; Nguyen, 2009; Ongori et al., 2010; Premkumar & Ramamurthy, 1995). Lastly, the organisational perspective looks into perceived barriers, particularly those related to financial costs, e-business know-how and organisational readiness (Gilbert et al., 2004; Kuan & Chau, 2001; Nguyen, 2009; Thong, 1999; Zhu et al., 2003).

Nonetheless, using the TOE framework has a significant drawback, since it does not consider the 'soft' elements such as those connected to social or psychological factors, or indeed a developmental perspective. A small step forward, at least acknowledging the human factor is the Hot-fit model (Yusof et al., 2008), which includes user satisfaction, in addition to the TOE's technology and organizational factors (but in contrast to TOE, not including the environmental factors). Due to focusing on users, this model is already close to the second stream of literature. However, building on this, we see the existence of research and department in most companies underpin the continuous development of technology, which we rather classified as a behavioural factor than a pure technological element in the TOE framework (see Fig. 1).

In contrast to the innovation and organisation-centred models, another stream of literature points out that information systems literature has suggested intention models from social psychology as potential theoretical foundation perspectives for research related to adoption (Davis et al., 1989; Swanson, 1982) fitting the notion of adopter-centred theories (Lynn et al., 2020). Several models have been developed, such as a more general model of reasoned action (Fishbein & Ajzen, 1975), a more specific technology acceptance model

(Davis, 1985), or a development of the so-called unified model (Venkatesh et al., 2003, 2012). The differences between the first two have been addressed by Davis et al. (1989), who also developed the technology acceptance model, which already points out the importance of beliefs and attitudes. Venkatesh et al. (2003) unified model adopted mostly to consumer context (Venkatesh et al., 2012) includes four key factors: performance expectancy, effort expectancy, social influence, and facilitating conditions. But the model as a whole has rarely been applied, mostly researchers employing only a subset of its factors (Al-Gahtani et al., 2007; Venkatesh et al., 2012). Furthermore, most of the related literature on intention models, based on social psychology, is aimed at the adoption of solutions by individuals, including factors such as the role of anxiety, and attitudes toward using 3D technology by educators (Holzmann et al., 2020).

The ideas that different theories complement each other and allow for a more comprehensive understanding of the key factors of digital technology adoption are not new, e.g., for cloud computing. Oliveira et al. (2014) developed a research model based on the innovation characteristics from the diffusion of innovation (DOI) theory and the technology-organization-environment (TOE), Lynn et al. (2020) on the other hand when exploring the adoption of cloud computing for HPC combined the TOE with HOT-fit model. Nonetheless, to our knowledge, none has considered the role of the entrepreneurial mindset in the adoption of digital technology.

2.3 The Entrepreneurial mindset as a factor in technology adoption

The concept of entrepreneurial mindset has been researched extensively over the past decades with a focus on what makes one entrepreneur in a particular set of conditions and environments react differently to another (Daspit et al., 2021; Haynie et al., 2010; Pfeifer et al., 2016). What remains to be explored in the literature is the research on the impact, if any, of entrepreneurial mindset on digital technology adoption in MSMEs. The existing literature suggests that the entrepreneurial mindset combines several elements such as opportunity recognition, cognition and behaviours or actions (Davis, 1985; Kuratko et al., 2021, Aly et al., 2021) and enables entrepreneurs to predict, act, behave and respond to disequilibrium on the market (George et al., 2016) caused by factors such as competition advances, R&D progressions, innovation and developments in digital technologies to name a few. The ability to recognise opportunities depends mainly on prior knowledge and cognitive frameworks, where prior knowledge is understood as the key cognitive resource (George et al., 2016) acting as a guide to spot opportunities (Hajizadeh & Zali, 2016) and hence positively impacting the opportunity recognition process (Ardichvili et al., 2003; Shane, 2000). Mitchell et al. (2002) defined entrepreneurial cognition as "the knowledge structures that people use to make assessments, judgements, or decisions involving opportunity evaluation, venture creation, and growth" and is seen as connecting the dots (information) in a previously yet unconnected way to obtain and process new information (Dimov, 2007a, 2007b; Gaglio & Katz, 2001). Prior knowledge, particularly the entrepreneurs' special interests and knowledge of the industry (experiences) (Hajizadeh & Zali, 2016), facilitates the collection of new knowledge (Tang et al., 2012) and hence creates a foundation for entrepreneurs to recognise opportunities.

Opportunity recognition is understood to be an entrepreneurial learning process in which "the constructs of prior knowledge, experience, perception and cognition have been solidly integrated" (Hajizadeh & Zali, 2016; Kolb, 1984). Being able to identify opportunities in rapidly changing, volatile markets depends on prior knowledge of those environments, ways to serve the market, and customer challenges and needs (Shane, 2000; Wang et al., 2013), but it equally so also depends on non-external cognitive processes, thus differentiating one entrepreneur's actions when recognising an opportunity to the other's unrecognition of that same opportunity or their inaction when the opportunity is recognised (Baron, 2008). This is even more so in the case of digital technologies where the ability to respond to and/or recognise opportunities they offer to MSMEs may not be the primary focus of companies (based on the products and services they provide on the market) but a crucial one, nonetheless; influencing the efficiency of their processes and the ability to (un)successfully face the competition. While the changes in market environments such as technological developments can create opportunities (Shane, 2003), it is the entrepreneurs' characteristics (such as self-efficacy, prior knowledge, and social networks) that are instrumental to recognising those opportunities (Wang et al., 2013).

For our study, we are investigating if or how the entrepreneurial mindset, i.e., cognition and opportunity recognition, elements specifically play a role when companies (micro, small and medium-sized) adopt new digital technologies; particularly HPC as one of the most significant ones to date (Kindratenko & Trancoso, 2011) due to its ability to support technology innovation (Cunningham et al., 2022) by focusing on solving national and global challenges (Wince-Smith, 2009).

2.4 Towards the 'action': the adoption of HPC

Taking action (i.e., implementation or adoption) should be the end result of entrepreneurial cognition (Bird & Schjoedt, 2009; Van Geldren et al., 2018) and opportunity recognition. In their recent paper on entrepreneurial mindset, Kuratko et al. (2021) emphasize the issue of how entrepreneurs engage, or act based on opportunities, or for opportunities. Thus, this is a focus of our study using the broad definition of HPC which includes infrastructure and applications that are used for complex computational problems. HPC also includes at its core the modelling and simulation, as well as the integration of artificial intelligence and machine learning with HPC and high-performance data analytics (IDC, 2021; Rutten, 2022).

Some view HPC as one of the key general-purpose technologies in the fourth industrial revolution (Coscodaru et al., 2019; Lee & Lee, 2021). In addition, the ability to use HPC to quickly process large amounts of data has become pivotal in a world where the estimated size of the datasphere in 2020 has been 64.1 zettabytes, with predictions of a threefold growth by 2025 (Woodie, 2022). Nonetheless, the adoption of technology among small businesses and entrepreneurs and associated adoption actions varies across different technologies (Lee, 1995, 2004; Wamuyu, 2015; Cunningham et al., 2022), hence there is a need to focus on HPC as one of the key general-purpose, complex, digital technologies.

Recently the expression 'industrialisation' of HPC has been coined (Rutten, 2022; Lee et al., 2021), which indicates HPC technologies becoming commonplace, or in other words democratized. This runs opposite to the traditional views, that the large upfront investment and technical expertise required limited the HPC adoption to large organizations and organizations such as public institutes. Lynn et al., (2020: 1) believe, that especially the recent advances in cloud computing and telecommunications "have the potential to overcome the historical issues associated with HPC through increased flexibility and efficiency, and reduced capital and operational expenditure". HPC adoption is thus "no longer limited to well-funded national laboratories, universities, and select industries such as oil & gas, genomics, finance, aerospace, chemical, or pharmaceutical" (Rutten, 2022). We are now starting to enter an emerging era in which wider scale adoption of HPC is taking place; not only in research institutions, and in-service providers in the area of cloud, digital and communications but more importantly in many enterprises, including SMEs (Cunningham et al., 2022).

The adoption of HPC by smaller companies can lead to several advantages—such as increased productivity, reaping benefits from lowering costs, improved systems connectivity and process innovation all leading also to enhanced competitiveness (Cunningham et al., 2022)—the smaller companies in general struggle with an additional problem related to low ease-of-use, insufficient financial capacity and financial security, lack of information quality and information security, lack of internal competences or the necessary infrastructure (Dixon et al., 2002; Duncombe & Heeks, 2001; Gilbert et al., 2004; Kannabiran & Dharmalingam, 2012; Seyal et al., 2007), when adopting new digital technologies. It is thus pivotal to explore the adoption of HPC also in this setting, especially having in mind that advanced technologies have typically been designed for large corporations and other types of organizations (Kannabiran & Dharmalingam, 2012).

Research on HPC and its adoption in terms of both the innovation and management literature as well as the information systems literature is limited. The extant research is mostly technical in nature, and to a large degree focused on various applications of HPC (Cunningham et al., 2022; Lynn et al., 2020), with works dedicated to understanding the factors leading to the adoption of HPC being scarce. Nonetheless, Cunningham et al. (2022) have recently applied the TOE framework to the adoption of HPC by small and medium-sized companies, exploring how and when HPC adoption takes place. Furthermore, Lynn et al. (2020) explore the factors influencing the decision to adopt cloud computing for HPC. Based on a survey of 121 HPC decision-makers they point out that the organisational and human factors significantly influence cloud computing adoption decisions for HPC—pointing out both the importance of factors encompassed within TOE, as well as 'softer' factors.

Thus, this study is able to make simplifying assumptions about counterfactual configurations using fsQCA, to evaluate how different simplifying assumptions affect the configurations that are determined to be consistently sufficient for the findings. So, one further recommended practise includes the open justification of simplifying assumptions that are supplied to differentiate between core and contributing conditions to give readers the ability to evaluate the validity of the outcome (Olan et al., 2016). When all simplifying assumptions are taken into the account, core conditions continue to be a component of the solution. This holds true for assumptions that are consistent with empirical data and theoretical understanding (i.e., easy counterfactuals), as well as those that are not consistent with the empirical facts but inconsistent with the theoretical knowledge (i.e., challenging counterfactuals) (Ragin, 2009).

2.5 Propositions: entrepreneurial mindset and technology adoption

The entrepreneurial mindset is influencing the way firms to act under uncertain conditions, which are typically present in technology adoption, due to typically unknown challenges related to technology adoption. In general, an entrepreneurial mindset is related (Daspit et al., 2023; Kuratko et al., 2021) not only to value creation but the ability also to recognize and act on opportunities. The entrepreneurial mindset comes even more to the forefront when considering MSMEs, with their constraints in terms of resources (Koller et al., 2015). In such contexts of limited resources (such as lacking funding, etc.), it is reasonable to expect that other factors will become increasingly important for technology adoption, such as those related to the ability to act, and mobilize under uncertain conditions (Haynie et al., 2010), i.e., the entrepreneurial mindset.

In continuation of what was discussed in Sects. 2.1–2.4, theoretical foundations for the entrepreneurial mindset point to two primary characteristics (entrepreneurial cognition and cognitive and affective response). Numerous studies, including those conducted by Kuratko et al. (2021), McGrath and MacMillan (2000), and Daspit et al. (2023), have shown that an entrepreneur's ability to spot opportunities and introduce novel products or services to the market is dependent on their level of prior cognitive knowledge. Understanding how entrepreneurs' mindset react to new possibilities has been a topic of intense research interest. So, the capacity to see an opportunity—or to miss it altogether—depends critically on entrepreneurial cognition.

Proposition 1 (P1) *Opportunities recognition is one of the cornerstones of the complementary technology adoption which can build a foundation for creative innovation by MSMEs.*

When it comes to sustaining a competitive edge over the long term, a few factors are as important as keeping up with the latest technological developments and incorporating them into your organization. This is especially important for the development of MSMEs' entrepreneurial mindset. However, the literature on technology adoption and use in the entrepreneurial mindset is sparse.

Proposition 2 (P2) *MSMEs are adopting HPC, it is because they are taking advantage of cognition as part of their entrepreneurial mindset.*

3 Method

3.1 Research setting, data source and method

Our study is set in the Danube region of Europe—a European macro-region, including some of the most developed (e.g., Austria) and least developed (e.g., Bulgaria) parts of Europe. Although there is a critical mass of SMEs in the region with the need to use HPC (Coscodaru et al., 2019), there are substantial disparities between its well-off central (and especially westernmost) parts and the rest of the region. These disparities are fuelled by the disparities in innovative capabilities, available resources, and entrepreneurial spirit, with eastern parts having limited access and competencies as well as most HPC centres being in the western parts. Our sample includes micro, small and medium-sized (MSMEs) companies mostly from the automotive, electronics and IT sectors (see also Table 1). Companies from these industries are characterised by the relatively rapid uptake of HPC technology (Ezell & Atkinson, 2016).

Taken together, this makes it an especially salient environment to study the technology adoption of HPC, since our sample spans companies from the more developed central parts as well as two peripheral parts (the east and the south, see also Table 1), however, they are all embedded in the Danube macro-region, within which the digital transformation and the adoption of HPC are seen as the path toward re-industrialising the region and closing the

Table 1 Basic sample descriptive

	Usage			
	∑Use yes		∑Use no	∑Total
Size				
Micro	8		14	22
Small	9		12	21
Medium	12		11	23
∑	29		37	66
Geolocation				
Danube central	11		10	21
Danube east	14		9	23
Danube south	4		18	22
Industry				
Automotive	11		14	25
Electronics and IT	13		14	27
Other	5		9	14
Average time since HPC adoption	≤ 3 year **13**	> 3 years **16**	n/a	n/a

Bold values are the number of companies within the sample that have been using HPC: 13 companies have been using HPC for 3 years or less, while 16 companies for over 3 years

Danube East are Moldova, Romania and Bulgaria, Danube South are Serbia, Montenegro and Bosnia and Herzegovina, the rest are part of Danube Central. Under "other" we classified for example companies that declare being within two sectors (e.g., automotive and IT) or are operating in related industries (e.g., engineering consulting company that works for the automotive sector)

gap between dispersed parts of this region (Besednjak Valič, 2019). Furthermore, we focus on companies from industries within which the spread of HPC is especially relevant.

Our analysis relied on data collected as part of the High-performance Computing for Effective Innovation in the Danube Region (InnoHPC) project. This multinational project included several data collections during 2017 and 2018 (InnoHPC, 2020). This includes the InnoHPC (ANON) survey we primarily rely on. The sample includes 66 micro, small and medium companies, 44% of which use HPC, and 56% of which do not (see Table 1).

When identifying the relevant respondents and collecting this data, two strategies were used. Firstly, the networks of outreach partners and other relevant support organisations were used to compile and engage potentially relevant organizations. Secondly, web searches and screening questions were used to understand whether the companies use HPC [or (potentially) plan to use HPC] and who would be the most appropriate respondents, which would correspond to the notion of elite informants in qualitative research (Hage, 1980; Kincaid & Bright, 1957).

We use the fuzzy set qualitative comparative analysis method, which is well-suited also for the analysis of a small-N sample, but for which carefully selected cases including those of general importance concerning the research problem can still allow for a reasonable generalization (Modic and Roncevic, 2018). fsQCA follows the principles of complexity theories in a configurational approach which allows for the examination of interplays that develop between elements of a messy and non-linear nature (Fiss, 2011; Mikalef et al., 2019). The distinctive feature of the fsQCA in comparison to other (statistical) methods is that it supports equifinality (Fiss, 2011). This enables us to understand how a particular outcome (e.g., adoption of a particular technology) may be caused by a different combination of factors and is as such especially relevant for a fine-grained understanding of the factors influencing the adoption (or non-adoption) of complex digital technologies such as HPC. Moreover, the advantages of the fsQCA have recently been demonstrated in a variety of applications, including the analysis of configurational paths to technology transfer and innovation (Ganter & Hecker, 2014; Stejskal & Hajek, 2019).

3.2 Measure operationalization

Our study considers factors from the technology, organisational and environmental framework, technology adoption of behaviour perspective and entrepreneurial mindset theories for the entrepreneurial adaptation of HPC. To measure HPC adaptation for MSMEs, the following theoretical fundaments were developed from the literature review section; technology adaptation factors were adapted from the previous studies of Cunningham et al. (2022); Doganova and Eyquem-Renault (2009), organisational and environmental factors from the TOE framework were adapted from the studies of Awa and Ojiabo (2016); Chatterjee et al. (2021); Gangwar et al. (2014) and cognition and opportunities recognition from entrepreneurial mindset studies of Daspit et al. (2021); Kuratko et al. (2021); Pidduck et al. (2021). We used the combination of data from data sources to categorise measurable items such as behaviour (technology adoption), TOE framework (organisational and environmental), and lastly entrepreneurial mindset (cognition and opportunities recognition) (see Fig. 1).

HPC adoption in this study theorises that factors such as entrepreneurial mindset are significant for MSMEs to successfully implement new technologies when distinct operational factors and strategic capabilities are orchestrated with the MSMEs structure (Kuratko et al., 2021). Thus, the theoretical support allowed this study to propose configuration associations whereby entrepreneurial mindset, behaviour and TOE framework are three formative constructs comprising of individual dimensions that link uniquely three interrelated phenomena. These formative associations further demonstrate the interrelationship of the three constructs with multiple dimensions (Olan et al., 2019). The individual connectivity of entrepreneurial mindset, behaviour and TOE framework constructs follow the fsQCA conjunctural, equifinal and asymmetrical analysis which allow for the testing of complementarity of the three dimensions. According to Gilbert and Campbell (2015) and Mikalef

Table 2 Variables association

Variables Theory	Cognition (COG)	Opportunity recognition (OPPrec)	Technology adoption (TECHadp)	Organisation (ORG)	Environment (ENV)
Entrepreneurial mindset	✓	✓			
Behaviour			✓		
TOE framework				✓	✓

et al. (2019), the use of formative constructs is more accurate for complementarity analysis in fsQCA. Furthermore, the stream of literature covered in this study covered the theoretical considerations and expert validation through the construct validity and reliability for equifinal and asymmetrical in fsQCA analysis.

Table 2 describes all variables linked with theories in the variable's association matrix. There are three distinct measurement scales that were employed for the data collected for this investigation. The direct approach of calibration is the one that is utilised for the ordinal scale data calibration the vast majority of the time (Olan et al., 2019). There are three anchors in order to determine the cut-off points for a case's full non-membership, full membership, and a crossover point at which the case is neither a member nor a non-member while using this method (Olan et al., 2016). Within the context of this investigation, we adhered to the ordinal data calibration rule proposed by Ragin (2013). This rule identified the 5th percentile as the non-membership anchor, the median score of each variable as the crossover point, and the 95th percentile as the full set membership score. We employed the calibration method provided by Malik et al., (2020) for the ratio scale of ROA. This rule used the 25th, 50th, and 75th percentile scores as the three anchors for full non-membership, crossover, and full membership anchors, respectively.

3.3 Data calibration

According to Ragin (2009), the ordinal scale data in fsQCA are used as a direct method for calibration, as this study implements the three ordinal different measurement scales for calibrating the data in this research. As shown in Table 1, three anchors for identifying cut-off points for membership classification of full non-membership, the crossover point and full membership where the association is either a full member or non-member (Ragin, 2013). Thus, this study complies with the ordinal data calibration rule by Russo et al. (2018) where the 5th percentile is the non-membership anchor, the median score of each variable is the crossover point and the 95th percentile is the full set membership score. Using the fsQCA 3.0 software to carry out a routine that systematises how a direct method of calibration supports uncalibrated data as input and further classifies the three-set membership

Table 3 Descriptive statistics and calibrated scores

Variable	Descriptive statistics values				Calibration		
	Mean	SD	Min	Max	Full non-membership	Crossover point	Full membership
Entrepreneurial mindset							
COG	0.610	0.262	0.05	0.98	0	0.2	0.4
OPPrec	0.620	0.300	0.11	0.99	0	0.4	1
Behaviour							
TECHadp	0.710	0.190	0.19	1	0	0.5	1
TOE framework							
ORG	0.656	0.303	0.05	1	0	0.2	0.4
ENV	0.443	0.353	0.01	1	0	0.5	1

COG Cognition, *OPPrec* Opportunity recognition, *TECHadp* Technology adoption, *ORG* Organisation, *ENV* Environment anchors (Ragin, 2013). We implemented the nominal scale data as developed by Ragin (2009) to calibrate the full membership represented 'Yes', the crossover points as 'Partial' and finally the full–non- membership as 'No' (see Table 3).

3.4 Truth table

The truth table enables data to be presented in the format that allows for fsQCA to carry out a specific relationship analysis between the causal conditions and the result (Ragin, 2013). The fsQCA 3.0 software has the characteristic to produce 128 feasible configurations that support the seven causal conditions, the algorithm maps perform logical statistics possibilities and empirical configurations of fuzzy set data. An empirically supported configuration implies that a membership score of > 0.5 represents a scenario in which the value is 'more in than out, meaning, verifying the membership of the case configuration (Pappas & Woodside, 2021). Grouping of cases that demonstrate a similar configuration of the causal conditions assessed whether the configuration criteria agree with the outcome. The measurement of consistency scores is conditioned to the degree to which the data demonstrate consistent relationships between the causal conditions and the outcome (Ragin, 2013). Thus, the ranges are measured between 0 and 1, and all cases sharing a configuration score of 1 show the same outcome. The measurement for both the individual configuration level and multiple configurations shares the same consistency scores (Olan et al., 2022a, 2022b). According to Woodside (2013), to determine the frequency and consistency cut-offs for subsequent analysis, frequency cut-offs measured to the configuration of membership of minimum cases are included for further analysis.

We also provide the information on core and peripheral conditions. The core conditions are "decisive causal components" (Olan et al., 2022a, 2022b) since they continue to be a part of the solution even when assuming a state of the world in which challenging counterfactuals that are not supported by the existing theory take place. When easy counterfactuals are considered, contributing factors continue to be a component of the solution; but, when difficult counterfactuals are considered, these conditions are "stripped away" from the answer. In order to meaningfully differentiate and evaluate core and contributing circumstances (i.e., region), it is a good practise to disclose the assumptions that were included in the analysis in a clear manner, together with the theoretical rationales for their inclusion and plausibility (Fiss, 2011).

4 Findings

The analysis carried out demonstrates fsQCA outcomes of three possible solutions: complex, parsimonious, and intermediate. A complex solution depends independently on the empirical indication, while both the parsimonious and intermediate solutions are supported by counterfactual analysis, hence, to conform with the practical interpretability of findings, the configurations were classified as not empirically observed in the fsQCA analysis (Olan et al., 2022a, 2022b, 2022c; Woodside, 2013). A core condition occurs in both intermediate and parsimonious solutions if there exists a causal condition. As discussed by Fiss (2011), a peripheral condition can only be observed in an intermediate solution, therefore, a stronger causal effect occurs on the results rather than the peripheral condition. Table 4 demonstrates the number of observed cases with membership showing at least 0.5 that

Table 4 Sufficient configurations for HPC adoption

	HPC Adoption		
Variable	P1	P2	P3
Entrepreneurial Mindset			
COG	•	•	⊗
OPPrec	⬤	⬤	⨂
Behaviour			
TECHadp	⬤	⬤	⨂
TOE Framework			
ORG	⬤		⨂
ENV		⬤	⨂
Raw Coverage	0.76	0.55	0.18
Unique Coverage	0.19	0.02	0.03
Consistency	0.95	0.93	0.72
Solution Coverage	0.82		
Solution Consistency	0.88		
Frequency cut-off	1		
Consistency cut-off	0.81		

⬤ = presence of a core condition; ⨂ = absence of a core condition; • = presence of a peripheral condition; ⊗ = absence of a peripheral condition; empty cell shows a 'do not care' condition.

support each configuration. Consequently, this study draws on Fiss (2011)'s suggestions to support the uniqueness of the configurations.

In keeping with Fiss (2011), Pappas and Woodside (2021) and Woodside (2013), our study highlights the distinctive characteristics of the three HPC adoption configurations with appropriate labels to illustrate the organising themes of the independent configurations. By associating the three HPC adoption configurations, cognition and opportunity recognition are two entrepreneurial mindset subsets characterised by transparency patterns that are strategic for MSMEs to promote the entrepreneurial readiness for a strategic decision on the HPC adoption process while providing entrepreneurial assurance mechanisms to support the implementation of innovative technology that seamlessly continue backing entrepreneurial processes. Additionally, MSMEs implementing new technology rather than cognition did not reveal the presence of any direct membership; therefore, the association is dependent on other associations with opportunity recognition. The proposition P1 demonstrates that the empirical indication that a combination of an entrepreneurial mindset (cognition and opportunity recognition) with the provision of behaviour specifically technology adoption and organization from the TOE framework supports MSMEs HPC adoption as shown by strong raw coverage of 0.76. For the proposition P2, the empirical evidence ranges of cognition and opportunity recognition of the entrepreneurial mindset, technology adoption of the behaviour and environment of the TOE framework support MSMEs HPC adoption with a raw coverage score of 0.56.

The configuration associations influence MSMEs' perceptions of HPC adoption enabling firms to project-specific strategic objectives tailored to acquiring reputational improvement across entrepreneurial processes. The entrepreneurial mindset's two dimensions—cognition and—opportunity recognition combined both behaviours one dimension—technology adoption and one of the TOE framework two dimensions—organisation or—environment notwithstanding two differences: (a) there was stronger support for the proposition P1 configuration represented full condition disclosures whereas proposition P2 also provided similar condition disclosures which the associations support the HPC adoption, and (b) there was support for the proposition P2 on the presence of peripheral and core conditions disclosure whereby the proposition P1 present some absence of both conditions. Collectively, these two distinctive characteristics have enabled this study to describe the proposition P1 as stronger support in necessary associations for HPC adoption and the proposition P2 also shows support in necessary associations for MSMEs HPC adoption. Both propositions P1 and P2 further provide configuration propositions regarding the complementarity effect for HPC adoption. Adjoint the proposition P3, showcases a weak support for the entrepreneurial mindset's two dimensions—cognition and—opportunity recognition combined both behaviours one dimension—technology adoption and one of the TOE framework two dimensions—organisation or—environment.

In addition, the propositions P1 and P2 also provide support for the conjunctural causation effect proposed for functional equivalence, suggesting that considering some of the entrepreneurial mindset dimensions such as opportunity recognition is a priority for HPC adoption. The outcomes of the necessary condition empirical testing show that cognition the first dimension of the entrepreneurial mindset demonstrates a significantly low consistency score of 0.85 compared to opportunity recognition with a consistency score of 0.94, which is above the required consistency score of 0.90 for the necessary condition. However, when cognition is combined with other conditions such as technology adoption, organisation or environment, the consistency score is above 0.90.

The remaining dimension, P3, combined the variables of an entrepreneurial mindset (cognition and opportunity recognition), entrepreneurial behaviour (technology adoption), and the TOE framework (environment) with negative (−) values, except for the variable organisation from the TOE framework. The P3 transparency dimensions consist of two key distinctions: (1) the P3 configuration represented limited disclosures, whereas the P1 and P2 also provided assurance mechanisms to verify information that was disclosed; and (2) there was a greater emphasis placed on behaviour and an entrepreneurial mindset in P1, as opposed to the P3. The combination of these two distinguishing characteristics has made it possible for us to demonstrate that the P1 result supports the adoption of technology as a focused limited negated () values of the P3 as an insufficient support strategy for the adoption of technology. Both the propositions P1 and P2 provide support for the third proposition, which is about the compensatory effect of variable organisation based on the TOE framework. In addition, the conjunctural causation effect that was proposed receives support from both P1 and P2.

According to Kraus et al. (2018) suggested crafting an overarching narrative that is being revealed across configurations to 'capture the whole.' The comprehensiveness of the entrepreneurial mindset as the common orchestrating attribute across all three association configurations represents an effect that this study proposed in the conceptual framework (Fig. 1). This inference is based on our data which showed that nearly two-thirds of MSMEs are already implementing some form of innovative technology. Moreover, some MSMEs with advanced innovative know-how score high on technology adoption. The pattern of a positive relationship between the comprehensiveness of the entrepreneurial mindset and technology adoption was examined for some MSMEs, while other MSMEs had a high entrepreneurial mindset but a low technology adoption.

The joint presence of entrepreneurial mindset and behaviour dimension for proposition P1 and proposition P2 and the presence of TOE framework dimensions for confirmation of the ability of MSMEs to leverage HPC adoption for innovative performance.

5 Discussion

In this paper we bridge the literature focused on technology adoption (Tornatzky and Fleischer, 1990; Yosuf et al., 2008; Cunningham et al., 2022) and entrepreneurial mindset (Daspit et al., 2023; Kuratko et., 2021) by engaging in a configurational study addressing how technological, organisational, and environmental factors and the entrepreneurial mindset factors can be interwoven to achieve the desired result, the technology adoption for value creation purposes. Our framework connects this relatively disparate literature and builds upon their (overall and specific) contributions. In terms of technology adoption framework in particular extending and connecting the notions from the innovation or organization-centred (Tornatzky and Fleischer, 1990; Yosuf et al., 2008) and adopter-centred frameworks (Fishbein & Ajzen, 1975; Davis, 1985).

This study offers two main contributions. Firstly, we address the lack of specific contextual elements related to technology adoption, with a particular focus on the lacking conceptualisation of entrepreneurial mindset (Daspit et al., 2021; Cunningham et al., 2022). In this line, we focus especially on the technology adoption of MSMEs, HPC adoption in particular, and within that context show both cognition and opportunity recognition need to be considered as elements of the entrepreneurial mindset bridging diverse literatures. The ability for companies to grow and expand based on the digital technology adoption is impacted by a combination of several factors, including the two mindset factors the paper focuses on. Hence, both cognition and opportunity recognition can lead to the entrepreneurial action for value creation purposes.

Our second contribution centres on extending the limited understanding of how MSMEs undertake technology adoption to value creation purposes. We illustrate in this study that there is complementarity when MSMEs combine more established elements of technology adoption frameworks with an aspect of an entrepreneurial mindset. To capture value from technology adoption MSMEs need to be complementary so that they ensure that they fully realise the disruptive and competitive benefits of technology adoption. The extant literature has acknowledged that in order to understand the role of different types of factors relevant more holistically to the adoption of (digital) technologies, it is necessary to combine these a range of factors based on different models—e.g., TOE and HOT (Lynn et al., 2020; Oliveira et al., 2014). Such of these models contribute to value creation but do not address some of the contextual and organisational constraints that instigating MSME firms experience. Hence our study addresses these contextual criticisms levelled at technology adoption frameworks and we integrate entrepreneurial mindset factors that contribute to MSMEs creating and realise value through value capture.

The focus of our study is on entrepreneurial mindset factors, which have so far been mostly overlooked in the analyses of technology adoption focusing on MSMEs. Although not at the centre of our interest, we however also demonstrate again how integrating entrepreneurial concepts and theories can uniquely bridge the individual–organizational divide (i.e., the micro–macro divide). In terms of the entrepreneurial mindset, we use the concept on a collective level, since as McMullen and Shepherd (2006) so adequately put “there is no market independent of the actors who create it. Therefore, ultimately, someone somewhere must undergo a decision process in which action is chosen if any market "process" is to occur.” In a similar vein, there is no technology adoption, without the forces of entrepreneurial mindsets within an organization, which is even more visible within small entities, such as the MSMEs we explore.

Furthermore, scholars have mostly paid attention to either the role of an entrepreneurial mindset and their individual components, or innovation, organisation or adopter-centred factors, separately, and to a large degree focused on single cause-effect relationships. We argued that we also need to understand the underlying configurations, whereby also including softer factors (that is the mindset) for value creation purposes. In line with the conceptual framework on the interplay of technology and mindset for innovation (Ringberg et al., 2019), we engage in the analysis of configurational effects to better understand how diverse antecedents work together and combine into configurations that indicate an outcome consistently. Hence, we can demonstrate that albeit a certain factor is not necessary per se to lead to the outcome of interest, yet when taken together with other factors, it can support the adoption of HPC—technology adoption for value creation purposes.

To this end, our study employs a fuzzy set qualitative comparative analysis (fsQCA) as an empirical testing technique to address the possibility of equifinality (Fiss, 2007), i.e., a situation where several diverse configurations lead to the outcome of interest. fsQCA has also been used to gain a more fine-grained understanding of the outcomes of the adoption of new emerging technologies (Mikalef et al., 2019) as well as the diverse paths leading to their adoption (Gilbert & Campbell, 2015), where we use this configurational approach to address the interplay of innovation and organization centred factors with the entrepreneurial mindset for technology adoption.

For the purposes of this study, we examined the cognition and opportunity recognition dimensions of an entrepreneurial mindset. Concerning cognition is not a necessary condition for technology adoption, but opportunity recognition is as the consistency score met the required of $>=0.90$. Our finding further confirms MSMEs Wang et al. (2013) research claiming opportunity recognition depends on variables such as self-efficacy, prior knowledge, and social networks but not necessarily cognition. Interestingly, the solution table includes two unique configurations of factors that lead to our outcome of interest, i.e., the adoption of HPC (P1 and P2, with P3 having insufficient coverage). Both pathways include the two dimensions of our mindset factors, cognition, and opportunity recognition—either in combination with organizational factors (higher support) or environmental factors (lower support). We confirm and extend the prior work of Hajizadeh and Zali (2016) and Kolb (1984) who claimed that among other dimensions, cognition and opportunity recognition are strongly interconnected among MSMEs when it comes to technology adoption for value creation purposes We have thereby addressed the recent call by Cutolo and Kenney (2019) to increase our understanding of how cognition and opportunity recognition change entrepreneurial behaviour, i.e., lead to entrepreneurial action, including that of adopting or not adopting new digital technologies, such as HPC.

Concerning the environmental factor, interestingly we find that this factor is not a necessary condition for HPC technology adoption for value creation purposes. Our study builds on previous research on factors for the adoption of digital technologies. For example, Ifinedo (2011), Borgman et al. (2013) and Oliveira et al. (2014), all show that different elements of the environment do not affect the adoption of digital technologies. Moreover, this would suggest for value creation purposes that different elements of the environment are not as influential for MSMEs technology adoption. Our study is thus a step in the direction of a more comprehensive understanding of factors, their configurations and complementarity that lead to the adoption of digital technologies, and in particular of HPC by MSMEs.

5.1 Limitations and further research

We recognise the following limitations related to the study carried out in this paper. Firstly, the variations in cultural, economic, and regulatory factors across contexts (both geographical and sectorial) may introduce unique constraints and could potentially require further investigation to validate the transferability of our findings. The data set only included MSMEs from the European Danube region. Albeit our chosen context has several advantages (such as the diversity of local contexts the firms come from as well as that the introduction of the HPC enjoys considerable policy support in the region), it is limited to a European context, which is also influenced by its macro-regional specialities (general development of HPC within the region both in terms of Danube as well as EU; specific policy mechanisms, which might defer in other parts of the world (such as US, China, Japan). The selected companies were representatives from three industries (automotive, electronics and IT). Arguably, these are industries prone to HPC adoption, yet they might not be representative of the entire economies, nor can we derive insights for industries that are less HPC-savvy or in which fewer opportunities related to HPC can conceivably be precepted. However, the fuzzy set analysis can also provide a flexible framework that can be adapted and applied to different industries and regions, allowing for customisation, and fine-tuning to specific contexts. Next, the utilisation of self-reported measures of reverse causality constrains the capacity to establish definitive inferences from the findings of this research. The acknowledgement of potential recall bias in the reporting of reverse causality, particularly if the occurrence occurred further in the past, is widely recognised in academic literature. Notwithstanding our dependence on retrospective reporting, self-awareness, and willingness to disclose, the credibility of these indicators of previous reverse causality is corroborated by research.

Furthermore, our study focused on two of the entrepreneurial mindset variables (cognition and opportunity recognition). Further research efforts are required to examine the adoption of the conceptual model that has been developed. It would be beneficial to carry out longitudinal studies that focus on different technology adoption frameworks, as specified by the technology and/or the user group. The longitudinal evidence that may be gathered via this method has the potential to improve our comprehension of the causation or interrelationships between or among choice factors that are significant to the acceptance of technology by entrepreneurs for value creation purposes. Furthermore, since in this study, we do not differentiate different modalities of HPC (e.g. own infrastructure for HPC versus applications via distant access), further research could focus on these specific modalities, providing there is an argument their adoption might play out differently considering different stages of adoption as e.g., considering the three stages proposed by Grover (1993): (i) initiation, which includes the initial steps, which culminate in the adoption, then (ii) adoption (in the narrower sense) as the decision to commit (further) resources; and finally, the (iii) implementation, i.e., the development and further activities that ensure the realisation of benefits. Therefore, more research is needed to better understand the value creation dynamics within MSMEs through these different stages of adoption. Also further research on sources of value friction and destruction for MSMEs entrepreneurs is also warranted.

Our limitations thus imply future research opportunities to explore; namely to recreate the approach used in different regional settings (either within other European regions or wider), to expand the data set by involving companies from multiple industries and finally, to investigate the implications of other entrepreneurial mindset variables for instance prior knowledge, entrepreneurial alertness and learning, self-efficacy and social networks on companies' behaviour when adopting digital technologies such as high-performance computing.

5.2 Implications for management, innovators and policymakers

Acknowledging our study limitations our study also raises some relevant issues for entrepreneurs, innovators and policymakers particularly as new technologies become more industrialised and democratized at a more rapid rate.

Firstly, our findings have some implications for managerial and innovation practice. For MSME entrepreneurs and innovators in order to realise value through new technology adoption, the opportunity recognition is a critical element of their entrepreneurial mindset. Therefore, such MSME entrepreneurs and innovators need to be continually building and enhancing their knowledge base within and beyond their industry and competitive settings if they are to accrue value from new technology adoption. Moreover, for individual MSME entrepreneurs and innovators there is a need to consider building and leveraging firm team-wide cognitive frames to enhance their opportunity recognition (George et al., 2016). Moreover, possessing a capability concerning opportunity recognition beyond technology adoption could become a dynamic capability for MSMEs (Caiazza et al., 2015, 2020) and provide the basis for wider value-creation efforts within a firm.

Secondly, for policymakers, our study raises a challenging policy question of how to effectively support MSME entrepreneurs and innovators to exploit new technologies once the initial infrastructure is in place and avail for exploitation with public investment support. Our study would suggest that supporting MSME entrepreneurs and innovators to develop the opportunity recognition dimension of their entrepreneurial mindset through targeted policy interventions is necessary to realise the wider benefits of public investment in new technologies and to support individual entrepreneurs, innovators, and firms to create value for growth purposes. Addressing this aspect of the entrepreneurial mindset could further the diffusion of innovation through the adoption of new technologies (Oliveira et al., 2014) and potentially develop new dynamic capabilities within MSMEs centred on opportunity recognition that can pervade all aspects of a firm's operations and processes.

Our study also highlights the need for policymakers to understand the softer dimensions of new technology adoption. Simply investing in large public entrepreneurship and innovation programmes that have the potential to create value is not sufficient. Such programmes need to consider the entrepreneurial mindset of entrepreneurs and innovators who will create their own value. The policy danger is that if such softer factors are not accommodated these programmes and policies that are aimed at creating value this may lead to unintended value destruction (Cunningham et al., 2018) and suboptimal impacts for entrepreneurial ecosystems (Audretsch et al., 2019, Audretsch et al., 2022). We believe our study helps to underpin this important issue.

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