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MSME Businesses Performance: Examining the Impact of Digital and Technological Capabilities using Partial Least Squares Structural Equation Modeling and Necessary Condition Analysis

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Abstract. *This research aims to research the effects of innovation, as well as digital and technological capabilities, on the performance of micro, small and medium enterprises (MSME) in Portugal post the initial wave of the COVID-19 pandemic. Leveraging longitudinal data from the 2019 World Bank business surveys and the subsequent 2020 World Bank Covid-19 follow-up business surveys, encompassing a sample of 605 MSME, we delve into the relationships between these variables. We examine the impact of innovation and digital and technological capabilities on performance from two distinct perspectives: one based on necessity and the other on sufficiency. Our analytical approach combines the utilization of partial least squares structural equation modeling (PLS-SEM) with necessary condition analysis (NCA). The findings of our study unequivocally indicate that both technological capabilities and digital capabilities exert a positive influence on MSME performance. Additionally, it is noteworthy that innovation indirectly enhances performance by way of its impact on digital capabilities.*

Keywords: Digital Capabilities, Innovation, NCA, MSME, Tehnological Capabilities, Performance, PLS-SEM,

Introduction

COVID-19 has driven digital transformation across all sectors, offering companies the opportunity to fundamentally change their practices and change their strategic vision based on value creation and long-term growth (M. Wu et al. , 2021). As the pandemic forced MSMEs to remove many of the obstacles that previously impeded digital adoption, they made important investments to protect their digital security and created the technology infrastructure that allows employees to work from their home offices (Rupeika-Apoga et al., 2022). For a successful digital transformation, leading to value creation, organizations need to invest in the development of digital and technological capabilities, implying a change of mindset and adoption of new working methods (Heredia et al., 2022; Kraus et al. al., 2022; J. Wu et al., 2019).

Although scarce, some literature makes the connection between digital capabilities and technological capabilities (Calle et al., 2020; Ciampi et al., 2022; Heredia et al., 2022; Wahyuningtyas et al., 2022; Wiesböck et al. al., 2020; Zhen et al., 2021). However, absent in the literature is the link between digital capabilities, technological capabilities, innovativeness and business performance. Therefore, our study seeks to fill this gap by analyzing the success of MSMEs in times of turmoil, such as in the context of COVID-19, increasing company performance and digital transformation, particularly how technological and digital capabilities affect company performance. Second, this study includes the combined use of structural partial least squares equation modeling (PLS-SEM) and necessary condition analysis (NCA) to determine what factors are required for MSME performance. Thus, this study deeply enriches the theoretical understanding of fundamental organizational capabilities for obtaining competitive advantages by MSMEs.

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In this context, this study aims to address the following research questions (RQ).

RQ1: What is the impact of innovation, digital capabilities and technological capabilities on MSME performance, particularly during any turbulent situation such as the COVID-19 pandemic?

To answer this question, the dynamic capabilities theory approach was used, followed by the estimation of PLS-SEM and NCA, based on a sample of 605 Portuguese MSMEs included in the World Bank Enterprise Surveys 2019 and 2020.

Our study presents several significant results and conclusions. First, based on the PLS-SEM results, we found that both digital capabilities and technological capabilities impact the performance of MSMEs. Second, digital capabilities mediate between innovation and firm performance. We used the NCA because the development of technological capabilities is a necessary condition for the good performance of MSMEs.

The structure of this study is as follows: We start with an introduction to the relevance of innovation, digital and technological capabilities and their relevance for MSMEs. Next, we describe the theoretical foundations and present the hypotheses. In the third section, all the methodology used is detailed. Subsequently, we applied PLS-SEM and NCA for data analysis, and we discuss the results at the end.

Literature review

The COVID-19 pandemic was considered the great accelerator of the existing global trend towards the adoption of modern emerging technologies that transform lifestyle, work patterns and business strategies (Amankwah-Amoah et al., 2021), revealing a change significant in the environment and in building new business capabilities (Heredia et al., 2022; Zhou et al., 2021).

The disruptive nature of digital technologies in business processes and the dynamic nature of online environments suggest that the adoption of activities in a digital environment may require a strategic orientation that encourages new ways of doing business (Sun et al., 2019; F. Wang, 2020). Organizations that create the capacity to implement the appropriate management practices, structure, procedures and policies that facilitate and promote learning facilitate the organizational learning process or allow an organization to learn (Ferreira et al., 2021). Learning can serve as a means of creating and developing a wide range of organizational capabilities, driving companies towards continuous improvement rather than focusing on specific types of knowledge (Ferreira et al., 2021; Sun et al., 2019). Thus, it can be argued that companies that experienced before the COVID-19 pandemic in innovation activities implement digital and technological capabilities differently and that transformative practices lead to more business value. Thus, the following hypotheses are proposed:

H1: Innovation influences the performance of MSMEs

H2: Innovation influences the digital capabilities of MSMEs

H3: Innovation influences the technological capabilities of MSMEs

As an extension of the Resource-Based View, Dynamic Capabilities emerged as an approach to understanding strategic change (Teece et al., 1997), which seeks to provide a framework for how companies develop and maintain a competitive advantage in turbulent environments, to identify the underlying determinants of long-term success (Dejardin et al., 2022). This study used the theory of dynamic capabilities, that is, how companies reconfigured and renewed their resources and capabilities over time in turbulent environments (Teece et al., 1997). According to (Loureiro et al., 2021) most studies relate dynamic capabilities and company

performance. (Ferreira & Fernandes, 2017; Teixeira et al., 2022) argue that a good combination of resources and capabilities allows companies to achieve a competitive advantage, and consequently high performance, and (Wilden & Gudergan, 2015) claim that dynamic capabilities, namely technological capabilities, have a positive impact on the company's performance. However, there are previous studies that found a relationship between digital capabilities and company performance (Usai et al., 2021). Thus, the following hypothesis is proposed:

H4: Digital capabilities influence the performance of MSMEs

All businesses have a set of specific technical resources that can be used to provide products or services with specific characteristics. Technological capability reflects a company's ability to use these valuable resources as a source of competitive advantage since they are difficult to imitate resources (Jin et al., 2022). Technological capabilities refer to the ability of a company to develop new products and services, aligning its business strategy with innovation processes (C. L. Wang & Ahmed, 2007). Such capabilities involve knowledge and skills in acquiring, using, absorbing, adapting, improving and generating new technologies (Malhotra et al., 2022). These capabilities allowed for the development of new products and technologies, improving manufacturing processes and quality control skills and predicting technological changes in the industry (DeSarbo et al., 2005). Digital tools have enabled companies to continuously capture significant volumes of information about consumers in recent years (Veiga & Diogo, 2022). In this sense, the development of digital capabilities acquires relevance in firms, enabling the use of information to reduce the cost structure and redesign their business processes (Rupeika-Apoga et al., 2022; Usai et al., 2021; M. Wu et al., 2021). Thus, technological capabilities are driven by digital ones, improving the quality of products and services provided and, therefore, improving company performance (Ciampi et al., 2022; Heredia et al., 2022; M. Wu et al., 2021 ; Zhen et al., 2021). In this sense, the development of digital capabilities acquires relevance in firms, enabling the use of information to reduce the cost structure and redesign their business processes (Rupeika-Apoga et al., 2022; Usai et al., 2021; M. Wu et al., 2021). Thus, technological capabilities are driven by digital ones, improving the quality of products and services provided and, therefore, improving company performance (Ciampi et al., 2022; Heredia et al., 2022; M. Wu et al., 2021 ; Zhen et al., 2021). This study considers that digital capabilities facilitate the identification of particularities of the environment and as a fundamental complement to other capabilities. capital is very important for economic performance. (Jonker et al., 2006; Lee et al., 2001). As technological capabilities are idiosyncratic and valuable resources, they should have positive impacts on company performance (Su et al., 2013; Wilden & Gudergan, 2015). Thus, the following hypothesis is proposed:

H5: Digital capabilities influence the technological capabilities of MSMEs

H6: Technological capabilities influence the performance of MSMEs

Based on the established hypotheses, we created a theoretical model to explore the effects of innovation on digital capabilities, the impacts of innovation and digital capabilities on technological capabilities, as well as their influence on performance (Figure 1).

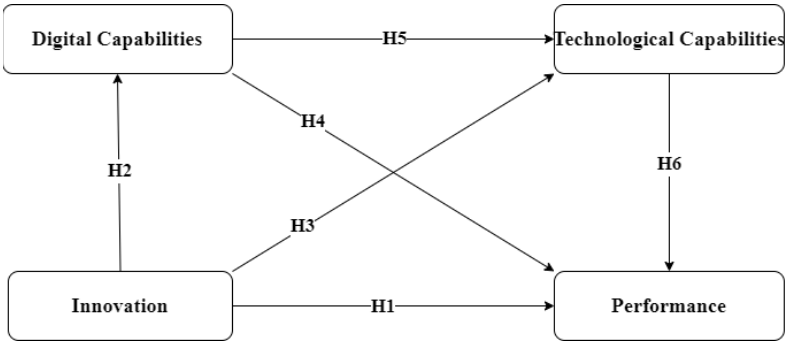

Figure 1. Conceptual model

Methodology

Data and sample

To validate the hypotheses, data obtained through the Enterprise Surveys conducted by the World Bank were used (https://www.enterprisesurveys.org/), in particular, the data collected for Portugal regarding the Enterprise Surveys 2019 (ES 2019) (1062 companies, data collected between November 2018 and January 2020) and the Enterprise Survey 2000 − Covid19: Impact on the firm (ES 2020) (monitoring of 820 companies, data collected between September 2020 and October 2020). The sample was selected by stratified random sampling. Of the 820 companies surveyed in 2020, 84 had closed resulting in 736 companies, with the final sample consisting of 605 MSMEs. Table 1 presents the characterization of the sample used for this research.

Table 1. Sample charateristics

		N	%
Industry	Food	83	13,7%
	Garments	61	10,1%
	Fabricated Metal Products	89	14,7%
	Machinery & Equipment	105	17,4%
	Other Manufacturing	122	20,2%
	Retail	73	12,1%
	Other Services	72	11,9%
Size	Micro	346	57,2%
	Small	230	38,0%
	Medium	29	4,8%
Location	North	118	19,5%
	Algarve	99	16,4%
	Center	102	16,9%
	Lisbon Metropolitan Area	80	13,2%
	Alentejo	105	17,4%
	Autonomous Regions of the Azores	47	7,8%
	Autonomous Region of Madeira	54	8,9%
Activity time (years), Mean ± SD (Amplitude)		26,4 ± 18,5 (3 - 203)	

Note: SD – Standard Deviation

Measures

The present study considered three variables (resources and capabilities) that are relevant to the company's performance in this "new normal". The independent variables of the model were innovation, digital capacity and technological capacity, with digital capacities and variable

technological capacities also being mediating variables. The dependent variable was the company's performance. We emphasize that all variables are constructs consisting of a series of indicators Table 2 describes the variables used in this investigation.

Table 2. Variables included in research

Constructs	Indicators	Question	Scale	Source
Digital capability	Online activity	Started or increased business activity online?	0 - No; 1 - Yes	ES 2020
	Delivery	Started or increased delivery or carry-out of goods or services?	0 - No; 1 - Yes	ES 2020
	Remote work	Started or increased remote work arrangements for its workforce?	0 - No; 1 - Yes	ES 2020
Technological capability	Supply Variation	Comparing the supply of inputs, raw materials, or finished goods and materials purchased for resale from this establishment to the same month in 2019	1 - Decrease; 2 - Remain the same; 3 - Increase	ES 2020
	Variation hours of operating	Comparing the total hours of operation of this facility per week to the same month in 2019	1 - Decrease; 2 - Remain the same; 3 - Increase	ES 2020
Innovation	Product	Introduced New Products/Services Over the Last 3 Yrs	0 - No; 1 - Yes	ES 2019
	Process	Introduced New/Significantly Improved Process Over Last 3 Yrs	0 - No; 1 - Yes	ES 2019
Firm Performance	Demand variation	The demand for this establishment's products and services in the same month in 2019	1 - Decrease; 2 - Remain the same; 3 - Increase	ES 2020
	Change in sales	Change in sales for the last month compared with the same month in 2019	1 - Decrease; 2 - Remain the same; 3 - Increase	ES 2020
Control variables	Type of industry	To which industry does the company belong	Manufacturing; Retail; Services	ES 2019
	Firm Size	Permanent, full-time workers end of December 2019	Number	ES 2019

Data Analysis

To validate the study hypotheses, we made recourse to a structural equation model (SEM), with the estimation method applying Partial Least Squares (PLS). We used the PLS-SEM as an alternative to covariance-based SEMs (CB-SEM) because the research model is complex (direct, mediation, and moderation effects), not imposing distributional assumptions for the indicators, and the constructs included are composite (Hair, Ringle, and Sarstedt 2011). This model is also widely used to test theories using the dynamic capabilities approach (Hair et al. 2014). The estimation of the model based on PLS-SEM involved several steps defined by (Hair et al. 2014) e (Hair et al. 2019).

NCA is a relatively recent approach to data analysis that allows the identification of necessary conditions in a dataset (Dul, 2016a). Rather than analyzing mean relationships between dependent and independent variables, NCA aims to reveal areas on scatterplots of dependent and independent variables that might indicate the presence of a necessary condition. Techniques based on regression of squares (OLS) such as PLS-SEM establish a linear function, ie a dashed line through the center of the relevant data points, NCA determines a ceiling line over the data. Thus,

we used NCA to determine the levels of need for innovation, digital capabilities and technological capabilities for company performance, this study used NCA (Dul, 2016a). This is a method of analysis that assists researchers in identifying the degree of a necessary (but not sufficient) condition for an outcome.

We used the procedures defined for the combined use of PLS-SEM and NCA by (Richter et al., 2020), which allow us to explore and validate hypotheses following a sufficiency logic, as well as hypotheses based on a necessity logic. All calculations were performed using the SmartPLS software version 4.0.8.3 (Ringle et al., 2015) and the NCA package developed for R (Dul, 2016b).

Results and discussions

PLS-SEM

Although some indicators do not show factor loadings greater than 0.707, we maintained these indicators considering that a value above 0.5 may be sufficient and to improve the explanation of the construct. The composite reliability (CR) of the constructs was greater than 0.7 and the Average Variance Extracted (AVE) was greater than 0.5 (Table 3). We assessed discriminant validity using the Heterotrait–Monotrait correlation ratio (HTMT) criterion. The values, including the upper limit of the confidence intervals, are all below the more conservative cut-off value of 0.9 (Table 4), indicating that the measurement instrument is capable of distinguishing the constructs.

Table 3. Reliability and validity of constructs and indicators

Name	Mean	SD	Factor loadings	CR	AVE	VIF
Innovation				0,718	0,571	1,027
Innov1	0,21	0,56	0,895			
Innov2	0,07	0,46	0,584			
Digital Capabilities				0,702	0,536	1,028
Dig1	2,12	0,33	0,491			
Dig2	2,19	0,40	0,699			
Dig3	2,21	0,40	0,937			
Technological Capabilities				0,814	0,690	1,209
Tech1	0,79	0,45	0,710			
Tech2	0,57	0,61	0,935			
Performance				0,937	0,881	2,384
Perf1	1,45	0,60	0,931			
Perf2	1,55	0,64	0,946			

Table 4. HTMT values and discriminant validity

	HTMT
Innovation <-> Digital Capabilities	0,603
Innovation <-> Technological Capabilities	0,144
Innovation <-> Performance	0,034
Digital Capabilities <-> Performance	0,091
Digital Capabilities <-> Technological Capabilities	0,056
Technological Capabilities <-> Performance	0,582

Finally, we follow the proposed measures to assess the goodness of fit of the estimated model. The standardized root mean square residual (SRMR) of the model was less than 0.10 (0.087) and the discrepancy measures were significant because the bootstrap 95% quantiles of the value of the three measures (SRMR, the unweighted least squares discrepancy dULS and the geodetic discrepancy dG) were higher than the original values.

To assess the statistical significance of the path coefficients, we used bootstrapping (10,000 resamples) to generate t-statistics along with confidence intervals. The R2 values for digital capabilities (2.2%) and PME performance (71.0%) were significant, with no statistical significance being observed in the R2 of technological capabilities. Table 5 presents the results of the estimated model. It is observed that innovation has a statistically significant positive impact on digital capabilities (H1: $\beta = 0.17$; $p < 0.001$). Digital capabilities (H5: $\beta = 0.15$; $p < 0.01$) and technological capabilities (H6: $\beta = 0.84$; $p < 0.001$) have a positive impact on performance with statistical significance. It was not possible to observe any statistically significant eMSMEect of innovation on technological capabilities (H2) and performance (H3), as well as of digital capabilities on technological capabilities (H4). The results also reveal the existence of a statistically significant indirect eMSMEect between innovation and performance, an eMSMEect that is mediated by digital capabilities ($\beta = 0.03$; $p < 0.05$).

Table 5. Standardized coefficients of the conceptual model

	β	SE	p
Direct Effects			
Innovation -> Digital Capabilities (H1)	**0,17**	**0,05**	**0,000****
Innovation -> Technological Capabilities (H2)	0,14	0,12	0,115
Innovation -> Performance (H3)	0,05	0,06	0,221
Digital Capabilities -> Technological Capabilities (H4)	-0,01	0,10	0,464
Digital Capabilities -> Performance (H5)	**0,15**	**0,05**	**0,003****
Technological Capabilities -> Performance (H6)	**0,84**	**0,01**	**0,000****
Indirect Effects			
Innovation -> Digital Capabilities -> Performance	**0,03**	**0,01**	**0,018***
Innovation -> Digital Capabilities -> Technological Capabilities	0,00	0,02	0,466
Innovation -> Digital Capabilities -> Technological Capabilities -> Performance	0,00	0,02	0,466
Digital Capabilities -> Technological Capabilities -> Performance	-0,01	0,09	0,464
Innovation -> Technological Capabilities -> Performance	-0,12	0,10	0,115

Nota: * $p < 0,05$; ** $p < 0,01$; SE – Standard Error

Based on the conceptual model estimated through PLS-SEM, it was possible to validate hypotheses H1 (Innovation has an impact on digital capabilities), H5 (Digital capabilities have an impact on performance) and H6 (Technological capabilities have an impact on performance), and not being possible to validate hypotheses H2 (Innovation has an impact on technological capabilities), H3 (Innovation has an impact on performance) and H4 (Digital capabilities have an impact on performance).

NCA

As there are three endogenous constructs in the model, namely digital capabilities, technological capabilities and business performance, we perform three NCAs. As the CE-FDH ceiling line accuracy is by definition 100%, we have not added a separate column for ceiling line accuracy.

The NCA results (Table 6) indicate that technological capabilities are a relevant ($d \geq 0.1$) and significant ($p < 0.05$) necessary condition for the performance of MSMEs. Digital capabilities and innovation are not significant preconditions for MSME performance and technological capabilities. Likewise, innovation is not a significant precondition for digital capabilities.

Table 6. NCA effect size

	Performance		Technological Capabilities		Digital Capabilities	
	CE-FDH	**p**	**CE-FDH**	**p**	**CE-FDH**	**p**
Innovation	0,000	1,000	0,000	1,000	0,000	1,000
Digital Capabilities	0,000	1,000	0,000	1,000		
Technological Capabilities	**0,273**	**0,002****				

Note: * p < 0,05; ** p < 0,01

Necessary conditions can be evaluated in detail with bottleneck tables. As only technological capabilities are a necessary condition for MSME performance, we only present this bottleneck table. Table 7 highlights that, to reach a level of 50% performance, it is a necessary condition that the technological capabilities cannot be less than 17.2%. Figure 2 presents the scatterplot for technology capabilities and performance.

Table 6. Bottleneck table (percentages)

Performance	Digital Capabilities	Innovatio	Technological Capabilities
0%	NN	NN	NN
10%	NN	NN	NN
20%	NN	NN	NN
30%	NN	NN	1.1
40%	NN	NN	9.2
50%	NN	NN	17.2
60%	NN	NN	25.3
70%	NN	NN	33.4
80%	NN	NN	41.5
90%	NN	NN	49.6
100%	NN	NN	57.7

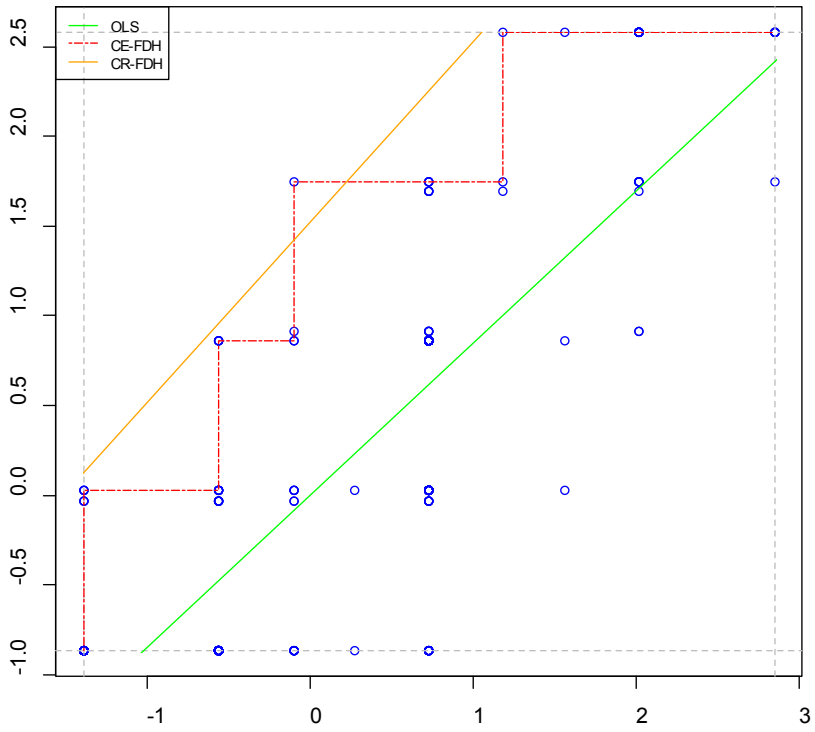

Figure 2. Scatter plot (X: Technological Capabilities vs Y: Performance)

Conclusion

Although we know that digital capabilities and technological capabilities are related to firm performance, we know very little about the mechanisms of this relationship and the role of innovation capability in explaining this phenomenon. To that end, we estimated a structural model, based on PLS-SEM, complemented by the NCA to assess the performance of a company in this "new normal" resulting from the COVID-19 pandemic. Regarding the data, we used 605 MSMEs surveyed in Portugal, in 2019 and 2020, with the World Bank's Entreprise Survey. This study shows that digital capabilities and technological capabilities directly aMSMEect firm performance. In addition, digital capabilities act as a mediator between innovation and MSME performance. In this sense, the development of technological and digital capabilities is essential to generate value and improve the performance of the MSME.

Implications

In this study, we have three levels of implications, particularly methodological, theoretical and practical implications.

Methodologically, the contributions are related to the application combined of the PLS-SEM and NCA in strategic management research, identifying the necessary and sufficient effects of technological and digital capabilities and innovation on MSME performance. Thus, both approaches, PLS-SEM and NCA, are essential for a comprehensive understanding of MSME performance.

The results show the necessary and sufficient contributions of business performance: it is not only a sufficient factor but also a mandatory factor for positive results of MSMEs. Technological capabilities are a necessary condition for performance. These results, together with

the bottleneck analysis, enrich the understanding of admiration in strategic management research. These results show that the NCA can complement the PLS-SEM analysis, emphasizing that significant determinants can constitute necessary conditions.

The analysis carried out in our research was based on longitudinal information in two moments, a moment before the pandemic and after the first pandemic wave in Portugal. In the future, we can analyze the dynamics of MSMEs with the follow-ups that were done by the World Bank. Furthermore, we propose to analyze the interaction of digital and technological capabilities with other types of capabilities and resources in MSMEs, as well as with entrepreneurial orientation and market orientation. Likewise, another line of future research is in the dynamic perspective of the model, which would allow us to contrast our results and bring significant contributions in light of the emergence of new variants of the COVID-19 virus. Finally, future research should replicate this study including other subgroups of companies, such as family businesses, services, or even companies from several developed countries, as well as studies with several developing countries or several underdeveloped countries.

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