Impact of Digitalization and Technological Human Capital on The Performance of The Brazilian PYME: An Empirical Study

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Abstract

Digital transformation is an essential part of the fourth industrial revolution, also known as Industry 4.0. With the COVID-19 pandemic, the process of adopting digital transformation has accelerated and is booming among companies of different sizes, sectors and regions around the world. In Brazil, 90% of MSMEs are at the initial level of digital maturity, which contrasts with the reality in developed European countries such as Denmark, Finland, Belgium, Malta and the Netherlands, where digital maturity is higher and largely results in the development of employees' digital skills and competencies through specific training for the development of online products and services. The study is relevant because it expands the empirical understanding of the effects of digitalization and the managerial characteristics of the ICT area of companies in a developing country like Brazil. For the academic sector, the research contributes by providing empirical evidence on the impact of digitalization on MSMEs, offering new perspectives for future research. In the business context, managers can use this information to formulate more effective digitalization strategies, adapted to the specific needs of their organizations.

Keywords: Digital Transformation, Business Performance, ICT Management, MSME.

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1. Introduction

The digitization of Micro, Small and Medium Enterprises (MSMEs) is a socio- economic phenomenon that has attracted the interest of academics and public organizations (Teng at al., 2022; Liu et al., 2024). In recent years, the adoption of digital technologies has become an effective strategy in the search for competitiveness gains through process and product innovation, cost reduction and market share expansion through digital interaction with customers and suppliers (Molina-Castilho et al., 2024; Ulas, 2019). The COVID-19 pandemic has accelerated the adoption of digital transformation, with effects on the expansion of interdisciplinary academic approaches (economics, administration, marketing, technology management and people management), with an emphasis on training technological human capital, especially in developing countries (Verhoef et al., 2021; Zia et al., 2023). The pandemic has also promoted the expansion of technological adoption among MSMEs (Gao et al., 2023; Soto-Acosta, 2020) with positive effects on performance (Sudrajat et al., 2023; Ulas, 2019). The power of the effects of digitalization on MSMEs stems, to a large extent, from the availability of financial resources, infrastructure, technology and human resources for technology (HRT) - people who master information and communication technologies (ICT) and are capable of creating innovative systems and new production processes (Gao et al., 2023; Verhoef et al., 2021). RHT is forged in the business environment through training to develop the necessary digital skills among managers and employees who operate these technologies (Pelletier and Raymond, 2023).

Digital transformation processes are strongly linked to the renewal of old business models, with an emphasis on new forms of management and communication, the effects of which affect interactions between people, the dissemination of information and even entertainment and education, establishing a new paradigm in the way of conducting business operations and generating value (Bouwman et al., 2018; Lamperti, Cavallo and Sassanelli, 2023; Gao et al., 2023). In the context of MSMEs, adopting digital transformation is an agile strategy to take advantage of the opportunities arising from the changes in the business environment brought about by the advance of new ICTs. Digitalization is a vital enabler for innovation and competitiveness (Coletto et al., 2024) and companies need to focus on their own transformation capabilities (Leso, Cortimiglis and Ghezzi, 2023; Yu et al., 2022). Platform ecosystems, digitalization, e-health, servitization and internationalization are phenomena that involve the digitalization of a company's relationships and activities with its partners, customers and markets (Budde et al., 2024; Cenamor, 2019). More efficient and competitive companies contribute to a more robust economy, increasing the supply of quality products and services for consumers (Bouwman et al., 2018; Molina-Castilho et al., 2024). Digital inclusion reduces social inequalities by providing access to new job and education opportunities (Gottschalk and Weise, 2023; Ulas, 2019).

The literature on digitalization and its effects on performance has been growing, with a more frequent focus on marketing, investigating the effects of adopting social networks and media (Jung and Shegai, 2023). In the field of strategic management, the motivation

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for research lies in the aspects of design, operationalization and new digital business models (Foss and Saebi, 2017; Helfat et al., 2023), requiring greater attention to the factors underlying the digitalization process and which explain performance to some extent, with emphasis on the digital training of managers and employees (Leso, Cortimiglis and Ghezzi, 2023; Verhoef et al., 2021). Given the complexity of the digitization process in MSMEs, Kallmuenzer et al. (2024) draw attention to the need for further studies into the relationship between the factors that influence the adoption of digitization and company performance. Likewise, Tsou and Chen (2023) reinforce the need for a more in-depth look at how digital transformation strategies influence company performance.

The aim of this article is to analyse the effects of digitalization and technological human capital on the performance of MSMEs in the context of Brazilian companies. The study was made possible by applying a questionnaire to a sample of 713 Brazilian MSMEs. The research seeks to answer the following research problems, considering Brazil's socio-economic and political reality: To what extent does digitalization impact the performance of MSMEs? What impact does the qualification of ICT managers have on the performance of MSMEs? Does the presence of an ICT manager improve the performance of MSMEs? Brazil is a particularly interesting case. In Brazil, where Micro, Small and Medium-sized Enterprises (MSMEs) account for just over 99% of all formalized businesses, 66% of MSMEs are at the initial level of digital maturity and only 3% are digital leaders (SEBRAE, 2023), which contrasts with the reality in developed European countries such as Denmark, Finland, Belgium, Malta and the Netherlands, where digital maturity is higher and largely results in the development of employees' digital skills and competencies through specific training for the development of online products and services.

The study is relevant because it expands the empirical understanding of the effects of digitalization and the managerial characteristics of the ICT area of companies in a developing country like Brazil. At the business level, the results provide guidance for the implementation and adoption of digitalization strategies, promoting a broader and more effective digital technology strategy, which in turn can boost competitiveness and innovation in MSMEs. In political terms, the study shows the need to develop public policies for training in digital technologies, whether in high school technological training or in technological training courses at university level, as a way of creating qualified human capital to make the use of technologies more efficient and create competitive advantages.

The next section of this article presents the literature review and the definition of the theoretical research hypotheses. The third section describes the methodology with the design of the sample and the process of systematizing the data collected, the definition and measurement of the variables and the statistical methods used to obtain the information needed to evaluate the research hypotheses. The fourth section presents the analysis of the results. Finally, there is a discussion and main conclusions about the research findings and its theoretical and empirical contributions.

2. Literature review and hypothesizing

The positive association between the use of digital technologies and the performance of MSMEs can be explained, to a large extent, by digital strategies that collaborate in value creation, structural changes and the interface with customers (Bain, 1956; Porter, 1985; Mishra et al., 2023). It can also stem from the set of internal resources that the company has to create value from their combination (Penrose, 1959; Wernerfelt, 1984; Barney, 1991; Peteraf, 1993; Helfat et al, 2023). In both approaches, ICT is an important strategy for creating an innovation ecosystem that leads to gains in competitiveness (Coletto et al., 2024). However, in disruptive markets, the emphasis is on dynamic capabilities (Soluk, Decker-Lange and Hack, 2023; Teece, Pisano and Shuen, 1997), such as what happened during the COVID-19 pandemic, when the adoption of digitalization helped companies develop the organizational capabilities needed to respond to the changes and opportunities of the digital market and gain competitiveness. The biggest challenge to implementing the digitization process in MSMEs is the qualification of organizational capacity, in particular the development of digital capabilities that are important for learning and adapting to opportunities in the digital environment, and the success of digitization in companies depends to a large extent on the presence of a leader who effectively drives the digital transformation (Isensee et al., 2020; Turyadi et al., 2023).

Digital transformation involves more than simply adopting digital technologies; it requires a profound change in organizational structures, processes and cultures (Bozkus, 2023; Pelletier; Raymond, 2020). In the context of digital transformation, in addition to performance indicators, it is crucial to understand the underlying factors that influence these indicators (Leso, Cortimiglis and Ghezzi, 2023). Underlying factors are fundamental elements that, although not immediately visible, significantly affect organizational performance. In general, understanding the factors that influence digital transformation is essential to maximizing its benefits and improving organizational performance (Kallmuenzer et al., 2023; Eller et al., 2020). These factors help explain how and why certain performance indicators are affected by the digital transformation strategies adopted by companies (Bouwman et al. 2018; Turyadi et al., 2023). By addressing and optimizing these factors, companies tend to achieve a more effective and sustainable digital transformation, significantly improving their performance in several dimensions (Kallmuenzer et al., 2023). The literature on digitization and its effects on performance has been growing, with a more frequent focus on marketing follow-up investigating the effects of adopting social networks and media (Jung and Shegai, 2023). In the field of strategic management, research motivation sheds light on aspects of design, operationalization and new digital business models (Lamperti, Cavallo and Sassanelli, 2023; Foss and Saebi, 2017), requiring greater attention to the factors underlying the digitization process and which explain performance to some extent, with emphasis on the digital training of managers and employees (Kallmuenzer et al., 2023; Verhoef et al., 2021).

2.1 Digitization and performance

The positive relationship between the adoption of digitalization strategies and the performance of MSMEs is frequently reported in the literature (Cenamor et al., 2019; Sudrajat et al., 2023). The arguments to justify this positive relationship are diverse, whether it's because the adoption of digital technologies allows companies to restructure their processes and improve their capabilities in a way that facilitates innovation and operational efficiency, resulting in superior performance (Li et al., 2017; Zia et al., 2023). Digital maturity is strongly correlated with improvements in companies' operational and strategic performance, highlighting the importance of digitalization for long-term competitiveness and sustainability (Insani, Nugroho and Winarno, 2023; Mittal et al., 2018). Digitalization improves companies' ability to adapt quickly to market changes and to continuously innovate through digital platforms, highlighting that network capacity and ambidexterity are critical factors that drive performance (Budde et al., 2024; Cenamor, Parida and Wincent, 2019). Another way that digitalization works to increase performance is that investment in digital technologies can improve management and produce information effectively to implement successful strategies (Kusa, Suder and Duda, 2024). These strategies to increase company performance via digital transformation have been used during the COVID-19 pandemic, where digitalization is crucial for resilience and business continuity in times of crisis, reinforcing the importance of technological adaptation for survival and success (Perera et al., 2024; Priyono, Moin and Putri, 2020). In this sense, the explanatory factors for the positive relationship are generally linked to the presence of infrastructure, financial and technological resources considered to be valuable, rare, inimitable and with no substitute available in the companies' market, as discussed by the Resource-Based Theory (RBT) (Barney et al., 2021; Hsiao, 2024), and with dynamic capabilities that enable the adoption of new flexible business models with a strong disruptive appeal that require MSMEs to be able to perceive market changes, identify internal capabilities and reconfigure processes (Ancillai et al., 2023; Teece, 2018).

H1: digitalization is positively related to the performance of MSMEs.

2.2 Digital human capital and performance

The production paradigms defined by Industry 4.0 have had a major impact on work routines and employee habits, reshaping the way employees learn, managers recruit and interact with each other (Schäfer et al., 2023). These changes have been accelerated by the challenge for companies to overcome the negative effects of the COVID-19 pandemic (Chatterjee et al., 2022), in particular the adoption of technology and the need for qualified human capital to operate digitalization, defined here as Digital Human Capital (DHC), which is the person who operates technological resources to develop new products, collect information about customers, create production and marketing management systems and plays a mediating role between technological capacity and company performance (Al-Omush et al., 2023).

The literature review on the effects of CHD on performance shows that there is no consensus on this relationship (Heredia et al., 2022). Some studies argue that employees' digital capabilities, resulting from digital experiences of using technologies, alone are not enough to positively affect company performance (Usai et al., 2021). This shows the importance of the company's people management to transform resources into human capabilities that know how to use information technologies to improve performance (Proksch et al., 2021). This demonstrates the need for more studies on human capital and human resource management in order to understand the relationship between this intangible asset and company performance (Faccio et al., 2023; Ammirato et al., 2023).

Heredia et al. (2022) shows that digital capabilities positively affect company performance, and that this relationship is largely explained by the company's management capabilities, suggesting that dynamic capabilities are necessary but not sufficient to act as a mechanism for forming these capabilities. However, Usai et al (2021) show that previous studies have found a negative relationship between digital capabilities and company performance, justifying that this is because companies have invested in research and development of products and services, which has led to expertise and not just the effect of digital capabilities. Kádárová, Lachvajderová and Sukopová (2023) identified that the combination of IT implementation and improved employee skills drives digitalization with positive effects on performance. The formation of a digital culture in the company increases the impact of digital technologies on company performance (Al-Omush, 2023).

The academic literature on the adoption of digitalization considers the digital capability of company employees as a central factor in achieving the best performance, assuming that in the process of digitalization all company employees are committed to continuous digital innovation (Kallmuenzer et al., 2024). However, company management is faced with barriers to being more effective and efficient, such as a lack of competencies and skills, a lack of recruitment standards, and resistance to change (Brodny and Tutak, 2021). In this context, the existence of digital leadership with skills and competencies motivates employees to contribute to the success of the organization through the appropriate use of the company's digital resources (Öngel et al., 2024). A study by Mollah et al. (2023) shows that there is a positive relationship between digital leadership and organizational performance in South Korea.

The digital leadership of a company's managers makes it possible to define strategies that raise the digital capabilities of employees and take advantage of existing ones to develop new skills, which leads to improved organizational performance (Shin, Mollah and Choi, 2023). The ability of managers to operate digitalization is one of the issues that defines companies' strategies in the era of Industry 4.0, since CHD management skills are central to identifying threats and opportunities, and guiding training and taking advantage of the inherent capabilities of each employee (Elghayesh and Abdeen, 2023). Indeed, the presence of qualified managers does not automatically guarantee that their skills are being applied strategically and in line with the company's objectives (Casagrande, 2023). Likewise, the presence of ICT managers or managers with diplomas can encounter cultural resistance among employees, which reduces the effectiveness of the new digitalized processes with repercussions on organizational

performance (Carter et al., 2024). The complexity of implementing new technologies and organizational changes, coupled with resource limitations and cultural resistance, contributes to this negative relationship, reflecting the need for a more holistic approachadapted to the specific realities of Brazilian companies (Cordeiro; Reis; Fernandes, 2024).

Another factor to consider is the initial negative impact of technological change, as during the implementation of new technologies and digitalization strategies, there may be a period of adaptation, where performance may initially drop while employees adjust to the new processes (Qin; Shen, 2024), in which case the initial costs of training, technology acquisition and restructuring may outweigh the immediate benefits, resulting in an apparent drop in performance.

H2: the presence of managers with higher education has a positive effect on the performance of MSMEs.

H3: the presence of an ICT manager positively affects the performance of MSMEs.

Research Methods

3.1 Sample design and information collection

The survey's target population was 713 MSMEs that have effectively adopted digitalization, according to a survey carried out by FAEDPYME in 2022 entitled "*Digitalization and Sustainable MSME Development in Iberoamerica*". The sampling was non-probabilistic, which makes it impossible to expand the sample results to the population of Brazilian MSMEs. However, this type of sampling has the advantages of greater control over the composition of the sample, efficiency due to direct choice and greater flexibility, so that the sample can be adapted to the specifics of the research (Richardson et al., 1985). 83.0% of the companies are located in the cities of Belo Horizonte (27.9%), São Paulo (22.9%), Rio Grande do Sul (20.6%) and Santa Catarina (11.6%), which concentrate around 51% of MSMEs in Brazil. The largest proportion of companies in the survey were micro and small, accounting for 87.4%. The results show that 56.0% of the managers were from micro companies, 30.0% from small companies and 14% from medium-sized companies. Men account for 68.0% of managers, while women account for 32.0% (MEMEPP, 2024).

A quantitative survey questionnaire was applied to managers or owners of MSMEs in order to obtain data on resource allocation, obstacles to innovation, adoption of digital transformation strategies, performance indicators, innovative processes and sustainable practices in MSMEs. The questionnaire consists of structured questions based on five-point Likert scales. Data was collected online using a link provided by FAEDPYME from February to May 2022.

3.2 Measurement of variables

Performance: a multidimensional scale based on the Quinn and Rohrbaugh (1983) model, also used in previous studies such as those by Castillo-Vergara & Garcia-Pérez- de-Lema (2021), was used to measure the performance of mipymes. In this construct, the entrepreneur was asked to indicate the position of his company, in comparison with its direct competitors, in relation to the following performance indicators: 1) Quality of its products (Mehralian et al., 2018); 2. Efficiency of production processes (Salimi and Rezaei, 2018); 3. Customer satisfaction (Mehralian et al., 2018); 4. speed of adaptation to changes in the market (Farris et al., 2021); 5. speed of sales growth (Farris et al., 2021); 6. profitability (Helmold and Samara, 2019); 7. employee satisfaction (Salimi and Rezaei, 2018); 8. degree of absenteeism from work (Salimi and Rezaei, 2018).

Degree of digitalization: companies were asked about the use of different technologies and their degree of importance on a scale from 1 to 5, where 1 is not very important to 5 is very important. This construct is made up of 12 technologies. These characteristics were chosen based on a review of the literature on digitization. 1. own website (Edelman, 2015; Alves e Silva, 2021); 2. we sell on our own e-commerce portal(McGrath and McManus, 2020; Costa et al., 2021; Pratama et al., 2021): 3. e-commerce in Marketplace (Amazon or equivalent) (Costa et al., 2021); 4. social networks with commercial purposes (Costa et al., 2021; Horváth, 2021). 5. digital banking (Sánchez and Zuntini, 2018). 6. teleworking (Edelman, 2015); 7. ERPs (integrated management systems) (Edelman, 2015); 8. corporate intranet (Castellar et al., 2021); 9. Services to cover cybersecurity (Edelman, 2015); 10. Big data and data analysis software (Pinochet et al., 2021); 11. Robotization, sensorization (Andrade and Gonçalo, 2021); 12. Localization, Internet of Things (Subramaniam, 2021).

Digitization strategies: The degree of agreement or disagreement on a scale of 1 to 5 on the aspects identified in the literature was asked. (1) We are well aware of the possibilities and advantages of digitalization (Castellar et al., 2021); (2) We have allocated significant resources to digitalizing the business (Subramaniam, 2021); (3) We are committed to digitalizing the business. (Subramaniam, 2021); 3. the business model is evaluated and updated in terms of digitalization (Sánchez and Zuntini, 2018; Pinochet et al., 2021); 4. our employees are prepared for the digital development of the company (Fountaine et al., 2019); 5. Our managers have good training in digitalization (Furr and Shipilov, 2019); 6. The degree of process automation is high in my company (Castellar et al., 2021; Subramaniam, 2021); 7. We use digitalization in the organizational management of the company (Horváth and Szabó, 2019; Verhoef et al., 2021); 8. Training for digital transformation is usually organized in our company (Castellar et al., 2021); Salume et al., 2021)

Technologica human capital: The implementation of digitalization requires skilled human resources (Gudanowska, 2017). According to Grant (2021), higher education can provide business leaders with the analytical and strategic skills needed to navigate an increasingly complex and digitized business environment. Also, formal education can play a crucial role in business leaders' ability to adopt and implement digital technologies. Jobber and Ellis-Chadwick (2019) point out that academic knowledge can facilitate the understanding and application of new technologies and data analysis, which are essential for digital transformation. In addition, Harris et al. (2021) emphasize that

academic training can prepare leaders to face the challenges of digitalization by providing a solid foundation in process management and information technologies. The variables used were the manager's level of education, taking a value of 1 = general manager of the company with higher education and 0 otherwise; and whether the company has an internal manager, taking a value of 1, and 0 otherwise.

To determine the validity of the dimensions used in our study, Cronbach's alpha was analyzed and a factorial analysis was performed. The values obtained demonstrated the validity of these dimensions. The variables used to construct the digitalization adoption and performance indicators were those with a linear correlation greater than 0.400 (Hair, 2009). Among the 28 items that make up the questionnaire block related to What technologies are used in your company and how important are they, Indicate the degree of agreement or disagreement on a scale of 1 to 5 on the following aspects related to the digitalization strategy, Indicate the degree of importance of the following obstacles or barriers to the development of digitalization in your company. Eleven variables were chosen whose linear correlation value was 0.450, with a cronbach's alpha of 0.862, indicating a strong moderate internal correlation between the variables (Fávero et al, 2017). The variables in Table 2 were used in the EFA to construct the Standardized Digitization Index (SDI) and, which represent the three blocks of questions, two items on the Importance of ICT adopted by the company, six on the companies' digitization strategy, and three items on obstacles and barriers to implementing digitization (Likert 1 to 5), as shown in Table 1.

Table 1: Variables used to construct the IPDIG

Items used in the EFA	Cronbach's alpha
Own website	
We sell on our own e-commerce portal (via the internet)	
We allocate important resources to digitize the business	
The business model is evaluated and updated in terms of digitalization	
Our managers are well trained in digitalization	
The degree of process automation is high in my company	0,862
Our employees are prepared for the company's digital development	
In our company, digital transformation training is carried out on a regular basis	
Digitalization may be poorly received by workers	
Lack of well-qualified staff who are difficult to find and keep	
Lack of knowledge about technology providers	

Source: Developed by authors

The variables in Table 2 refer to the block of items that make up the question on performance, "in comparison with your direct competitors, indicate where your company stands with the following performance indicators", whose linear correlation was greater than 0.400. These items were used in the EFA to construct the Standardized Performance Index (SPI) (Likert 1 to 5).

Table 2: Variables used to construct the IPD

Variables	Cronbach's alpha
Quality of your products	
Efficiency of production processes	
Customer satisfaction	0,852
Speed of adaptation to market changes	
Rapid sales growth	
Profitability	

Source: Developed by authors

4. Analysis of results

4.1 Standard Digitization Index (SDI)

This indicator was developed by applying Exploratory Factor Analysis (EFA) to the 11 variables selected after analyzing the linear correlation between the 28 variables that make up this indicator. The Kaiser-Meyer-Olkin (KMO) test of sampling adequacy was 0.834, higher than the minimum value of 0.700 considered adequate for the application of the technique (Hair, 2009). The statistical significance of Bartlett's test of sphericity close to zero allows the null hypothesis that the variance matrix is an identity matrix to be rejected, with the value of the Chi-Square statistic equal to 786.46. The measure of the sample's suitability for the technique was greater than 0.700, indicating that the data was suitable for the application of EFA (Favero et al., 2017). By applying the EFA technique to the selected variables, three latent variables were extracted, representing 66.57% of the total variance. With the results of the factor scores for each of the companies in the research sample, resulting from the application of EFA, the Standardized Digitization Index (SDI_i) was calculated, according to the econometric model to be adjusted $IPDIG_i = 0{,}5296F_1 + 0{,}2822F_2 + 0{,}1882F_3$, where F_1 *represents* strategic ICT management, F_2, the Barriers to ICT adoption and F_3 the Importance of ICT adoption.

Standard Digitization Index (SDI)

The results of the application of EFA show that the set of variables used is suitable for the application of EFA, as the Kaiser-Meyer-Olkin (KMO) test of sampling adequacy was 0.821, higher than the minimum value of 0.700 required for the application of the technique (Hair, 2009). The result of the statistical significance of Bartlett's test of sphericity, which is close to zero, serves to reject the null hypothesis that the variance matrix is an identity matrix, whose Chi-Square statistic value was 1532.43. In effect, this indicates that the data is consistent with the application of the technique. The EFA technique was used to generate the latent factors. A single factor was generated which explains 55.92% of the total variance of the variables used in the technique.

4.3 Multiple Linear Regression Model

The estimated model specified to assess the relationship between the explanatory variables, the Digitization Standard Index (IPDIG) and the variables representing technological human capital (DG and G_TIC) are as follows:

$$SPI_i = 0{,}406 + 0{,}676IPDIG_i - 0{,}057DG_i - 0{,}040G\_TIC_i \quad (1)$$

Where

SPI_i = Standardized Performance Index of company i $IPDIG_i$ = Standardized Digitization Index of company i

DG_i = Dummy where 1= general manager of the company with higher education and 0

G_TIC_i = Dummy where 1= company has internal ICT manager and 0 otherwise

The Coefficient of Explanation was 0.218, indicating that the variability in the independent variables causes an average of 21.8% in the dispersion of the explained variable IDPi. The standard error was 0.5157. Based on the regression results, it can be concluded that there is a significant and positive relationship between the Digitization Standard Index (IPDIGi) and the Performance Index (IPDi) in companies. This means that the central hypothesis of this dissertation cannot be rejected: the digitization process in MSMEs positively affects performance.

Table 3 analyzes how different factors (IDIG, Diploma Manager and ICT Manager) affect company performance (IDP). The coefficient of IDIG (Digitization Index) is 0.676, indicating that the higher the digitization index, the better the company's performance, this result being highly significant ($p < 0.001$). The coefficient of Manager Diploma (DG) is -0.057, suggesting that the presence of a manager with a diploma is associated with slightly worse performance, also with statistical significance ($p < 0.001$). Similarly, the coefficient for ICT Manager (G_TIC) is -0.04, showing that the presence of an ICT manager is associated with slightly worse performance, with statistical significance ($p < 0.01$). The adjusted R^2 of the model is 0.218, which means that 21.8% of the variation in company performance is explained by these variables. The Durbin-Watson statistic of 1.936 indicates that there are no significant autocorrelation problems in the residuals.

Table 3: Multiple linear regression results.

Variables	Non- standardized coefficients	Standard Error	t-statistics	Sig.	Collinearity statistics	
					Tolerance	VIF
(Constant)	0,406	0,030	13,312	0,000		
IDIG	0,676	0,050	13,463	0,000	0,948	1,055
DGi	-0,057	0,015	-3,757	0,000	0,995	1,005
G_TIC	-0,040	0,014	-2,853	0,004	0,953	1,05

Source: FAEDPYME Observatory database (2022).

Dependent variable: IDP

Weighted Least Squares Regression - Weighted by the number of employees using ICT at their workplace in your company

Adjusted $R^2 = 0.218$ Durbin-Watson statistic = 1.936

The tests for the main violations in the estimated regression model show that: the residuals have a distribution close to normal, according to the results of the Kolmogorov-Smirnov test, for a statistical significance of 1.0%; There are no multicollinearity problems, according to the results of the VIF statistic, with all values less than 10 units; Autocorrelation between the residuals was ruled out based on the result of the Durbin-Watson statistic with a value close to 2 (DW=1.936).

Based on the data in Table 3, it was possible to detect that there is a negative relationship between the presence of ICT managers, managers with degrees and company performance. Considering the Brazilian reality, this reveals important insights. This data indicates that, although the presence of qualified managers is expected to improve performance, most companies do not. This phenomenon can be explained by several factors, as Brazilian MSMEs often face financial and infrastructure limitations that make it difficult to fully implement effective digitalization strategies, even when they have qualified managers (Oxford Analytica, 2023).

5. Discussion and Conclusions

The coefficient of the DEdu_Manager dummy is negative (-0.057), suggesting that the presence of a manager with a degree is associated with worse performance, with statistical significance ($p < 0.001$), which leads to the rejection of hypothesis H2, that the presence of managers with higher education has a positive effect on the

performance of MSMEs. The result indicates that, although the presence of qualified managers is expected to improve company performance, in the Brazilian case, Brazilian MSMEs often face financial, infrastructural and technological capacity-building limitations from these professionals, which makes it difficult to fully implement effective digitalization strategies, even when they have managers with higher education (Oxford Analytica, 2023).

The coefficient of the G_TIC dummy is negative (-0.040), showing that the presence of an ICT manager is associated with worse performance, with statistical significance ($p < 0.01$), which leads to the rejection of hypothesis H3: the presence of an ICT manager positively affects the performance of MSMEs. According to Carter et al. (2024), resistance to organizational change is a significant challenge because when introduced by ICT managers or managers with higher education degrees, they may encounter cultural resistance, which decreases the effectiveness of the new processes. Strategic misalignment is also a concern, as the presence of qualified managers does not automatically guarantee that their skills are being applied strategically and in line with the company's objectives (Casagrande, 2023). Technological changes to adopt digitalization in the company require a period of adaptation, in which performance may initially drop while employees adjust to the new processes. The initial costs of training, technology acquisition and restructuring can outweigh the immediate benefits, resulting in an apparent drop in performance (Qin, Shen, 2024).

Discussion

The results of the research show that there is a positive and significant relationship between digitalization and business performance and is in line with the communications made by other articles, such as the results of Li et al. (2017) , who analyzed digital transformation, seen from the perspective of MSMEs' capabilities, which facilitates innovation and operational efficiency, resulting in superior company performance. They argue that the adoption of digital technologies allows companies to restructure their processes and improve their competitive capabilities. Mittal et al. (2018), assume that digital maturity models are strongly related to improvements in companies' operational and strategic performance, highlighting the importance of digitalization for competitiveness and long-term sustainability.

According to Cenamor, Parida and Wincent (2019), entrepreneurial companies that compete through digital platforms implement network capability strategies and ambidexterity that boost performance. The presence of adaptive and dynamic capabilities enables companies to reconfigure themselves quickly and compete in the market as a way of taking advantage of opportunities to gain market share.

The digital transformation is an organizational strategy that contributes to increasing the value created by the company's products, but there is a need to create dynamic capabilities (Matarazzo et al., 2021). The formation of these capabilities leads to the creation of new products and services that generate sustainable competitive advantages for companies and partly explain the improvement in performance. The presence of human resources with mastery of ICT processes and uses is a necessary, but not sufficient, condition for creating dynamic capabilities that can generate disruptive processes that lead to value creation. This was evidenced in the study by Priyono, Moin and Putri (2020), which showed the importance of digitalization for resilience and business continuity in times of crisis, reinforcing the importance of technological adaptation for survival and success during the COVID-19 pandemic.

The negative relationship observed between the presence of ICT managers, managers with degrees and performance for Brazilian companies contradicts the results shown by Denicolai et al. (2021), Bouwman et al. (2018) and Eller et al. (2020). However, several factors may explain this contradiction, including the fact that the country is a developing economy in which 66% of MSMEs are at the initial level of digital maturity and only 3% are digital leaders (SEBRAE, 2023). The reality of digital transformation in Brazilian MSMEs is complex. Many entrepreneurs still don't understand the benefits of digital technologies or face significant barriers to their adoption. Among the main adoption strategies are cybersecurity, efficiency, productivity, connection and customer prospecting, according to, the results of a survey carried out by Microsoft (Microsoft, 2023). In the case of smaller companies in particular, they struggle to acquire and integrate new technologies due to a lack of financial and human resources.

The Brazilian reality contrasts with that of developed European countries such as Denmark, Finland, Belgium, Malta and the Netherlands, where digital maturity is higher and largely results in the development of employees' digital skills and competencies through specific training for the development of online products and services (Brodny, Tutak, 2022).

The reality of Brazilian MSMEs is similar to countries with a low level of digitalization, such as Bulgaria, Hungary, Romania and Greece, known as developing countries (Brodny, Tutak, 2022) and the undeveloped countries of the African continent, as observed in the study by Ng'ora et al. (2022) for African countries, which highlights the fact that managers and owners lack the necessary managerial skills to leverage the business, which to a large extent explains the low absorption capacity, which reduces the effects on company performance.

The divergence of these results can be attributed to the low maturity of industry 4.0 in Brazil, according to studies carried out by the Institute for Applied Economic Research (IPEA) on the impacts of digitization and information and communication technologies: opportunities and challenges for Brazil. In the case of MSMEs, there are restrictions on ICT adoption, such as the lack of qualified workers and high implementation costs, which largely explains the low number of technologies adopted, with repercussions on company performance (Kubota and Rosa, 2024).

The findings confirm that companies that invest in digital technology tend to show better results, in line with previous studies that highlight the benefits of digitalization for companies' competitiveness. The adoption of digital technologies has proved crucial for improving operational efficiency, reducing costs and increasing innovation in MSMEs.

The refutation of hypotheses H2 and H3 can be attributed to a combination of practical and contextual challenges faced by Brazilian MSMEs (Dionisio, 2022). The presence of ICT managers and managers with degrees may be associated with high expectations and costs of implementing digitization that, in the short term, result in performance perceived as negative (Szalavetz, 2022). The adaptability of companies and the effectiveness of implementing digital strategies are crucial factors that need to be considered in order to fully understand this observed negative relationship (Dionisio, 2022; Cordeiro; Reis; Fernandes, 2024).

The availability of adequate financial resources is essential for investing in new technologies and in training to develop the necessary skills (Denicolai; Zucchella; Magnani, 2021). The lack of financial resources is often cited as one of the main barriers to digital transformation, especially among MSMEs (ABDI, 2021). Pelletier and Raymond (2020) argue that limited resources can significantly hinder the implementation of advanced digital processes.

In practical terms, the results suggest the need for continued investment in digital technologies and employee training to maximize the benefits of digital transformation. For the academic sector, this research contributes by providing empirical evidence on the impact of digitalization on MSMEs, offering new perspectives for future research. In the business context, managers can use this information to formulate more effective digitalization strategies, tailored to the specific needs of their organizations.

In general, the limitations of the research are associated with complex interactions between variables that may not be fully captured by the specified econometric model, and internal and external factors not included in the model, such as general economic conditions, government policies, the lack of practical experience or the inadequacy of managerial skills to the specific needs of MSMEs, which may influence the results.

Future studies using questionnaires designed specifically for this purpose could provide deeper insights into the factors that actually influence business performance as a result of adopting the digital transformation. The use of structural equation models will also make it possible to understand the effects of each of these variables related to manager training and the structuring of MSMEs.

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