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ABSTRACT

Business digitalization plays a fundamental role in the success of micro, small and medium-sized enterprises (SMEs), being crucial for their competitiveness and sustainability. This study aims to identify the key factors that influence the digitalization process of Peruvian SMEs. The research was conducted using a quantitative approach, with a simple random sample of 271 SMEs located in Metropolitan Lima. A survey based on a five-point Likert scale was used, targeting heads, managers, administrators and/or owners of SMEs distributed across the five geographical regions of the city. The results, obtained using JAMOVI statistical software and a linear regression analysis, reveal that the education level of managers, the degree of internationalization and the size of the company are determining factors in the digitalization process. These findings highlight the importance of implementing strategies that promote adaptability to new technological trends to enhance business competitiveness. Finally, despite its limitations, this study provides a valuable starting point for future research in other sectors and contexts similar to the Peruvian business environment

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Introduction

Digitalization has evolved significantly over time in companies from an optional approach to a strategic necessity for business survival (Priyono et al., 2020), which has become crucial for companies as it enables them to improve efficiency, compete in the market and respond to rapid change. It also drives innovation, improves productivity and enhances customer interactions (Radicic & Petković, 2023) enabling companies to adopt business intelligence tools, thereby improving data-driven decision-making and management optimization in their daily operations (Quinde & Quinde, 2023).

On the other hand, the evolution of digitalization in micro, small and medium-sized enterprises (SMEs) have been marked by a process of adaptation over time, and adjustments have to be made to their strategies to incorporate these digital tools into their operations (Inga-ávila et al., 2023). Thus, the synchronization between digital technology, firms and external social capital enhances the beneficial impact of digitalization on the performance of SMEs, while reducing its potential adverse effects (Charfeddine et al., 2024; Chen et al., 2024). Thus, the new digital era requires firms to generate wealth by adopting new digital business models that proactively leverage cutting-edge tools (Garrido-Moreno et al., 2024).

For SMEs, digitization means improving agility in both organizations and operations. It also involves delivering an improved customer experience by creating innovative products and quickly adapting to market demands through the adoption of new technologies (Kilay et al., 2022; Ramírez-Asís et al., 2023). In addition, absorptive capacity moderates the relationship between digital diffusion and product innovation, so digital diffusion is a factor to be considered in SME innovation (Hassan et al., 2024), and the

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management of information in the context of digitalization has enabled these companies to improve their production processes, make more informed decisions and increase their competitiveness in the marketplace (Méndez, 2023). Likewise, digitalization has become a key element that influences the possibility of expanding into new international markets, as well as coordinating the internal management of their processes and the optimization of their resources more effectively (Qiao et al., 2024).

However, despite advances in digitization and its optimal performance in SMEs, there are gaps in its adoption, especially in technological resources, employee skills and implementation of digital strategies (Bhatt & Kumar, 2022; Eller et al., 2020). In this regard, SMEs face various obstacles, such as lack of readiness to scale digitally, lack of key internal resources and the need to invest in digital technologies and cybersecurity. These challenges impact the ability of SMEs to grow through digital internationalization (Westerlund, 2020). In addition, other aspects such as internationalization and lack of expertise can be a particular challenge for SMEs, as they may face barriers in the adoption and management of digital technologies, which affects their competitiveness in the global marketplace (Clemente-Almendros et al., 2024).

In the Peruvian context, the impact of digitization on micro, small and medium-sized enterprises can be very positive, improving their operational efficiency, their ability to meet customer needs and make more informed business decisions (Charfeddine et al., 2024; Quinde & Quinde, 2023). However, there are gaps in the adoption of digitalization in SMEs, especially in countries such as Peru, where financial constraints, lack of digital skills among users, and resistance to change can hinder the implementation of cutting-edge digital technologies (Kallmuenzer et al., 2024).

Finally, this study not only contributes to the academic debate on the digitalization of SMEs but also offers a novel perspective by focusing on the Peruvian context, where business characteristics such as managers' educational level, degree of internationalization, and company size have not yet been studied comprehensively. In this regard, from a bibliographic standpoint, the article enhances the existing literature by incorporating updated references that contextualize the evolution of SME digitalization within both global and local settings. Moreover, the analysis of critical factors specific to SMEs in Peru provides a practical perspective, aiding both scholars and policymakers in identifying the barriers and opportunities within the digitalization process in Latin American markets, with particular emphasis on Peru. This approach allows for the generation of evidence-based recommendations that could promote the wider adoption of digital technologies in key sectors of the Peruvian market, highlighting the originality of the work and its relevance to both academia and business practice, notwithstanding its methodological limitation.

Theoretical framework

Educational level of managers

The training and educational function constitute part of the personal characteristics of executives that significantly impact corporate strategy (Hambrick & Mason, 1984; Pinski et al., 2024). Since, the choice of executives should be consistent with their educational and professional experience, which consequently, will influence the decision making and functioning of the company (Du et al., 2024). Thus, organizational digital development requires that executives possess new and up-to-date digital competencies, regardless of the hierarchical level held by their leaders (Kovačević & Labrović, 2024). These arguments align with those put forward by Chin et al. (2023), who emphasize that managers with higher educational levels tend to have a positive impact on the implementation of digital strategies and organizational behavior toward the adoption of information technologies (IT).

On the other hand, in SMEs, the hierarchical level is simpler and shorter, as the manager or director is responsible for intervening in most essential decisions (Del Do et al., 2023); therefore, it is necessary to know the educational level of key people in the EMS. In addition, Gottesman and Morey (2006) managers with MBA education from top schools performed better than those without. This suggests that the education received by managers is a relevant factor for the management and performance of a company.

In the context of the digital era, managers with a high level of education are more able to apply their digital literacy skills in the use of digital technologies (Zahoor et al., 2023), and senior executives face a major challenge in ensuring the competitiveness of their organization through the creation and execution of strategies that take into account the opportunities brought about by digital transformation (Hess

et al., 2016, as cited in Wrede et al., 2020). Moreover, a senior leader who understands digital technologies and strategies well, with technological expertise and a track record of learning, can positively influence the digital transformation of a firm (Zhang & Bu, 2024), which represents a critical antecedent for innovation. Thus, the literature concurs in determining that IT capabilities and organizational bricolage behavior – understood as the ability to efficiently combine technological resources – play a crucial role in the adoption of digitalization by emerging companies (Chin et al., 2023; Trieu & Pavelková, 2022).

Managers' educational level, professional experience and political connections are positively related to a firm's innovation activities (Okrah & Irene, 2023). This relationship is amplified in the context of digital transformation. This is because, as pointed out by Appio et al. (2024), the implementation of digital technologies promotes innovation, facilitates data-driven decision-making and gives rise to new business models. In this way, the level of educational attainment of a top manager can open the door to sustained competitive advantage. Therefore, top managers' promotion of digital technologies is a positive antecedent for innovation (Garrido-Moreno et al., 2024). The role of leadership in digital transformation is another key factor that should not be overlooked. Hargitai and Bencsik (2023) analyze how leadership behavior and an organizational learning culture influence a company's digital readiness. This approach not only enhances a company's ability to adapt to digitalization but also increases employee confidence in using these technologies, which is crucial for long-term success.

Thus, the literature gap centers on the limited understanding of how the educational background and professional experience of senior managers in SMEs specifically influence their ability to lead digital transformation and drive innovation within the constraints typical of smaller firms. Although the relationship between education, managerial performance, and innovation has been explored (Gottesman & Morey, 2006; Okrah & Irene, 2023), much of the research has focused on larger companies or general corporate environments, neglecting the specific dynamics of SMEs. Given that decision-making in these firms is often concentrated in a few key individuals (Del Do et al., 2023), it is crucial to investigate how managers' educational qualifications, particularly in relation to digital literacy and strategic decision-making, impact the adoption and successful integration of digital technologies. While some studies suggest that more highly educated managers are better equipped to leverage these tools (Zahoor et al., 2023; Zhang & Bu, 2024), further empirical evidence is needed in the context of SMEs, especially in emerging markets where digital transformation is still in its early stages. This would allow for a more nuanced understanding of the role of managers' educational backgrounds in driving competitive advantage through digital innovation.

Thus, for the reasons, the following hypothesis is proposed (H1): There is a significant relationship between the educational level of managers and the digitization of Peruvian SMEs.

Level of internationalization

In an increasingly complex and global environment reflected in international trade, SMEs face several obstacles that make it difficult for them to enter and discover the potential opportunities that foreign markets can offer (Pacheco, 2023). SMEs that internationalize tend to be more competitive, generate more employment and contribute significantly to economic development. These companies face challenges and limitations in their internationalization process, which has led to an increase in research on how to optimize this process, identifying patterns, key actors and emerging areas of study (Casado-Belmonte et al., 2020).

One of the most prominent challenges in the literature is related to how SMEs achieve better and more effective internationalization through digitalization as a driver of structural and strategic transformations within organizations. Ciasullo et al. (2022), for instance, assert that the adoption of digital technologies enables these companies to undertake structural and strategic transformations, providing them with new opportunities to expand and succeed in foreign markets. This assertion is echoed by Herrera et al. (2023), who state that manufacturing SMEs in Latin America have identified digitalization as a key tool for internationalization, as it allows them to adapt to the new demands of the global market.

On the other hand, the size of organizations is another factor that affects the level of internationalization. For instance, keeping up with the pace of an organization is already a challenge for SMEs due to high operational costs and limited funding (Adan Gallo et al., 2022). This means that internationalization is a challenge for SMEs, especially in emerging countries such as South America, where there is little international experience for these organizations (Qiao et al., 2024). However, thanks to digital

transformation, SMEs could benefit from international growth, gain new markets and maintain greater competitiveness (Denicolai et al., 2021). That is to say, integrating digitalization into their business model can make them more competitive and enable SMEs to face the challenges of internationalization more effectively (Herrera et al., 2023).

International SMEs and start-ups run the risk of digitalization, negatively impacting their organization if they do not carefully manage problems related to lack of knowledge, experience and resources (Feliciano-Cestero et al., 2023). However, the generation of optimal digitization in SMEs improves their performance, in which they become a useful and recognized organization compared to their competitors (Vasquez-Moreno et al., 2023).

In this sense, domestic markets can be limiting for companies, so internationalization is an option that constitutes a potential source of financial returns (Pacheco, 2023), organizations' ability to expand internationally is indispensable for the survival and development of SMEs, and the degree of internationalization is also relevant to the impact of performance and the implementation of digital technology tools (Costa Melo et al., 2023).

The literature gap in this context, focused on the Peruvian case, revolves around the limited understanding of how SMEs in Peru can effectively leverage digital transformation to overcome the challenges of internationalization. While it is acknowledged that digitalization can facilitate international growth and enhance competitiveness (Denicolai et al., 2021), there is a scarcity of empirical research that examines the specific factors influencing the successful international expansion of Peruvian SMEs, which often face constraints in terms of resources, knowledge and experience. Moreover, much of the existing literature has focused on the internationalization processes of larger firms, overlooking the dynamics faced by Latin American SMEs, especially those in Peru, where many businesses have little to no experience in international markets.

Although digitalization is seen as a key tool for SMEs to access new markets and improve their performance (Vasquez-Moreno et al., 2023), there has been insufficient exploration of how the degree of internationalization interacts with the adoption of digital technologies and how this impacts their long-term competitiveness and performance. This gap is particularly significant in the Peruvian context, where domestic markets are often limited, and internationalization presents itself as a critical option for the growth and survival of SMEs.

Thus, based on the reasons outlined above, the following hypothesis is formulated (H2): There is a direct relationship between internationalization and the digitization of Peruvian SMEs.

Company size

In Peru, micro, small and medium-sized enterprises are classified into one of these three categories according to their annual sales. In ascending order, a micro enterprise must have an amount of up to 150 Tax Units (UIT); a small enterprise must have annual sales of more than 150 UIT, up to a maximum amount of 1700 UIT; and a medium enterprise must have annual sales of more than 1700 UIT, up to a maximum amount of 2300 UIT (Congreso de la República del Perú, 2013). For the fiscal year 2024, one UIT is equivalent to 5150 soles. This is approximately $1353 dollars at the Peruvian exchange rate.

On the other hand, Cotler (2015) talks about the size of a company being reflected in the number of employees, sales, the amount of money spent on raw materials or goods for resale and influences the interest in its reputation and the possibility of receiving trade credit. Furthermore, Holl and Rama (2023) company size, measured in terms of the number of employees, is significantly related to the adoption of digital transformation. This is because their study shows that larger SME size increases the likelihood of implementing digitalization processes by 4.3%. Therefore, the size of the company influences the adoption of digital tools, given that the smaller the organization, the more limited resources it will have and the less capacity for international expansion (Massa et al., 2023); consequently, the integration of digital transformation in organizations is limited in SME innovation, and the degree of impact of digitalization will not happen immediately, but will be a long-term process (Radicic & Petković, 2023; Zhang & Bu, 2024).

Clemente-Almendros et al. (2024) talks about smaller companies are mostly limited in terms of human and monetary resources. Therefore, it is necessary to stress the importance that SMEs find it difficult to get the dream of digitalization on track, which leads to a series of steps to realize this transformation process (Kolagar et al., 2022). Smaller companies may face specific financial challenges compared to

larger companies due to differences in their available resources, budgets and financial strategies. This means that SMEs possess a lower degree of financial resources to invest in innovation activities (Bradač Hojnik & Huđek, 2023), while large companies can make use of their own resources to easily establish cooperation agreements with other companies and commercial actors without requiring the involvement of an intermediary (Martínez-Torres & Vega-Jurado, 2022).

The literature gap, in the Peruvian context, focuses on the limited understanding of how the size of micro, small and medium-sized enterprises (MSMEs) affects their ability to adopt and implement digital transformation. While previous research (Holl & Rama, 2023; Massa et al., 2023) has established that larger SMEs are more likely to integrate digital tools due to their greater financial and human resources, there is a lack of empirical evidence on how the specific characteristics of Peruvian MSMEs, defined by annual sales and number of employees, influence their capacity for digitalization.

In Peru, MSMEs face significant resource constraints, particularly micro and small enterprises, which are further restricted by the country's economic environment (Luu et al., 2024). The current classification of these businesses based on annual sales (Congreso de la República del Perú, 2013) provides a general framework, but little research addresses how these resource limitations – financial, human and technological – affect their preparedness for digital transformation. While larger companies can leverage greater resources to adopt innovations (Bradač Hojnik & Huđek, 2023), smaller businesses in Peru often struggle with limited budgets and lack of access to the necessary tools for digitalization.

Moreover, studies have not explored the specific obstacles faced by Peruvian MSMEs in attempting to engage in digital transformation, nor how these challenges vary according to company size. Research often overlooks the gradual and long-term nature of digital transformation for smaller enterprises, and the financial and structural challenges faced by smaller Peruvian businesses are underrepresented in the literature. Future research should focus on how the size of MSMEs in Peru directly impacts their digitalization process, including the unique financial, human and technological constraints of these enterprises, to provide a more comprehensive understanding of their innovation potential and capacity for international expansion.

Therefore, based on the reasons outlined above, the following hypothesis is formulated (H3): There is a significant relationship between firm size and the digitization of Peruvian SMEs.

Methodology

Procedure, objectives and hypotheses

Three main research objectives were established in this study. First, Objective 1 (O1) focuses on analyzing how the educational level of managers influences the digitization of Peruvian SMEs, supported by Hypothesis 1 (H1), which seeks to demonstrate a significant relationship between the educational level of managers and digitization. Second, objective 2 (O2) seeks to investigate the influence of internationalization on the digitization of Peruvian SMEs, supported by Hypothesis 2 (H2), which posits a direct relationship between internationalization and digitization. Finally, objective 3 (O3) seeks to determine how firm size affects the digitization of Peruvian SMEs, supported by Hypothesis 3 (H3), which posits a significant relationship between firm size and digitization in the context of Peruvian SMEs.

Accordingly, we examine the correlation between management education, internationalization and firm size and the digitization of SMEs in Lima (Peru). To achieve this, we identified these key factors in relation to the digitization of Peruvian SMEs. Therefore, to test the hypotheses, set out in this section, we use a quantitative approach under the scheme of structured surveys. Furthermore, due to the prevailing digitalization of the current situation, the questionnaire application will be conducted through digital media.

Application of the instrument

A meticulously designed questionnaire was used to measure the key variables for each aspect investigated. Through this instrument, we sought to collect accurate and detailed information on the digitalization of Peruvian SMEs, the educational level of managers, the degree of internationalization and the size of the participating companies.

The participants selected for our study were invited to answer questions designed to explore and analyze the different aspects linked to the problem. These questions address relevant aspects related to the adoption of digital technologies in Peruvian SMEs, the impact of managers' educational level in this process, the influence of internationalization on digitalization and the relationship between business size and the implementation of digital strategies.

In this sense, through the collection of answers to these questions, a comprehensive and detailed view of the current situation regarding the digitization of SMEs in the Peruvian context was obtained, as well as the key factors that can influence this process.

Lastly, the survey conducted in this study was designed and implemented in accordance with the principles established in the Declaration of Helsinki and APA policies, ensuring confidentiality, data protection, respect for human rights and the dignity of participants. Informed consent and anonymity clauses were incorporated to ensure that all participants fully understood the study's objectives and their rights before participating. The survey was conducted with verbal informed consent and the data was collected using a Google Form. The survey protocol was reviewed and approved by the Ethics Committee of the Research Group on Administration and International Business at the Peruvian University of Applied Sciences, ensuring that all procedures adhered to the required ethical standards.

The sections of the instrument were designed to measure key variables related to the digitalization of Peruvian SMEs, the educational level of managers, the degree of internationalization and the size of the participating companies. In the present research, to understand the impact of the factors influencing the digitalization process in Peruvian SMEs, the questionnaire by Clemente-Almendros et al. (2024) was used to determine the impact of the factors influencing the digitalization process in Peruvian SMEs.

Lastly, the questions in this survey, which have been validated both theoretically within the conceptual framework and empirically by Professors Carlos Azabache and Juan Eduardo Acosta, specialists in International Business at the Peruvian University of Applied Sciences, were constructed based on a comprehensive review of relevant literature, ensuring that each one is theoretically grounded in established academic research.

To address Objective 1, which examines the influence of managers' educational level on digitization, the questions were developed based on studies by Clemente-Almendros et al. (2024), Türkeş et al. (2019) and Gallegos and Lazo (2021), focusing on educational attainment, digitization training and the perceived impact of academic background on digital processes. For Objective 2, which explores the influence of internationalization on digitization, the questions were informed by the works of Clemente-Almendros et al. (2024), Velásquez Cuervo et al. (2024) and Virglerová et al. (2022), investigating the company's participation in international markets, international sales and the role of internationalization in the adoption of digital technologies. Finally, Objective 3, which seeks to determine the impact of company size on digitization, incorporates questions derived from Clemente-Almendros et al. (2024), Virglerová et al. (2022) and Vardari et al. (2022), focusing on the number of employees, the influence of company size on digitization and the strategies implemented to overcome size-related challenges in adopting digital technologies. For further details, please refer to Appendix.

Population and sample

The population selected for the surveys were entrepreneurs (heads, managers, or owners) of SMEs in Metropolitan Lima from 2022 to 2023 with more than six months of work experience. According to Ministerio de la Producción (2024), there are more than two million formal SMEs in Peru; however, for the purposes of this research, we considered those located in Metropolitan Lima, which are 1,017,780 SMEs. Likewise, SMEs from different economic sectors are considered to obtain a complete and transparent analysis of the Peruvian business reality. The sample consisted of 271 SME entrepreneurs from various economic sectors in Metropolitan Lima, randomly selected. Both microenterprises and small and medium-sized enterprises were included, with a range of employees from 1 to 100. Additionally, the age of the business was considered, grouping SMEs according to their operational time: from six months to two years, from two to five years and more than five years.

Table 1. Sample calculation formula.

Finite population	Calculation
$n = \frac{Z^2\sigma^2 N}{\varepsilon^2(N-1)+Z^2\sigma^2}$	$n = \frac{1.645^2 0.5^2 1{,}017{,}780}{0.05^2(1{,}017{,}780-1)+1.645^2 0.5^2} = 271$

Note: The table shows the sample calculated according to the finite population formula, obtaining 271 EMS workers in Metropolitan Lima to be selected.

The study population was finite; therefore, the sample size was 271 SME entrepreneurs. Based on the calculation of the sample, a confidence level of 90% and a margin of error of 5% were used; therefore, the following formula was used in Table 1:

Where:

Z: Confidence level = 1.645

σ: Standard deviation = 0.5

N: Size of the population = 1,017,780

ε : Maximum error = 0.05

To address the potential common method bias, Harman's Single Factor Test was applied, and it was determined that no dominant variable explained more than 50% of the variance, suggesting that common method bias is not a significant concern in this study.

For the sampling process, it is necessary to establish that a simple random sampling method was used, as this is the most common probabilistic sampling technique for applying this sample size formula in populations of SMEs that share similar characteristics, such as those operating in the Peruvian market. This method ensures that all elements of the population have an equal probability of being selected. To ensure a more precise analysis, economic sector and business size were included as control variables. These variables were incorporated into the statistical analysis, allowing for the observation of possible differences in the results based on these business characteristics.

The standard deviation of $\sigma = 0.5$ is assumed in sample size calculations when no prior information is available regarding the proportion of the population that meets a specific characteristic. This value maximizes variability, ensuring a larger and more conservative sample size, which allows for more accurate results in situations of uncertainty.

Linking the instrument to literature

In this research, the linkage of the instrument designed for data collection with the existing literature is based on the interrelationship between the key factors influencing the digitization process of Peruvian SMEs and the findings of previous research. An approach that integrates concepts and results from relevant studies has been followed to support the selection of variables and the formulation of questions in the survey instrument, which can be seen in more detail in Appendix 1.

For the section dealing with the educational level of managers, support is based on the findings of authors such as Clemente-Almendros et al. (2024), Türkeş et al. (2019), Gallegos and Lazo (2021) and have highlighted the importance of professional training and experience in the implementation of digital processes in organizations. Thus, questions related to educational level in the questionnaire sought to capture the influence of education on the adoption of digital technologies in Peruvian SMEs.

Likewise, in addressing the section on the level of internationalization of firms, research by authors such as Clemente-Almendros et al. (2024), Velásquez Cuervo et al. (2024) and Virglerová et al. (2022) have pointed out the relationship between internationalization and the adoption of digital technologies. Thus, questions related to participation in international markets in the questionnaire sought to assess the impact of internationalization on the digitization process of Peruvian SMEs.

Finally, in exploring firm size and its relationship with digitization, the findings of Clemente-Almendros et al. (2024) and Vardari et al. (2022), who have highlighted the influence of firm size to validate the hypotheses proposed in this research, have been considered.

Results

After validating the data obtained from our research tool in JAMOVI program, and as can be seen in Table 2, a Cronbach's alpha coefficient of 0.813 was obtained all variables in this study, which indicates that our tool or scale has a considerably solid internal consistency, as it is close to 1. This indicates, at a quantitative level, that being greater than 0.7, is acceptable for the purposes of our research and is a reliable tool for measuring the variables in question. Moreover, when analyzing the specific dimensions of the study, the reliability of each subset of variables was also assessed. The dimension of training of managers, for example, yielded a Cronbach's alpha of 0.843, indicating a high level of internal consistency for this category. In contrast, the dimension of company size presented a significantly lower reliability score, with a Cronbach's alpha of 0.333, which may be due to multiple neutral responses from respondents, suggesting that this dimension may require further refinement or reassessment in future studies. The dimension of internationalization of companies achieved a satisfactory score of 0.788, reinforcing the validity of the measurement in this area. Finally, the digitization of SMEs dimension displayed a Cronbach's alpha of 0.692, slightly below the optimal threshold of 0.7 but still within an acceptable range for exploratory research. These results provide valuable insights into the robustness of each dimension, highlighting areas of strength while identifying aspects that may benefit from further development.

On the other hand, to validate the correlation between the dimensions and variables, we started by validating the correlation between the variable factors (management education or training, firm size and internationalization) and the variable digitalization in SMEs. We find that the asymptotic significance is less than 0.001 between the correlation of variable 1 (management education or training, firm size and internationalization) and variable 2 (digitalization of SMEs). If the *p* value was less than the chosen significance level, the results were considered statistically significant. In our study, the *p* value is associated with the correlation between the factors of internationalization, firm size and management education with SME digitalization, which is less than .001.

Table 3 shows that a comprehensive analysis was carried out to assess the relationship between the variables studied using various statistical tests, including the Pearson Chi-Square test, the likelihood ratio and the linear-by-linear association, with a total of 270 valid cases.

The Pearson's chi-square test yielded a value of 180.870 with nine degrees of freedom and an asymptotic significance (*p* value) of .01. This *p* value, which is less than the significance level of .05, indicates that the observed relationship between the variables is not due to chance, allowing the null hypothesis of independence to be rejected and concluding that there is a statistically significant association between the variables under study.

Complementarily, the likelihood ratio was applied, which resulted in a value of 119.327 with 9 degrees of freedom and an asymptotic significance of .001. This even smaller *p* value reinforces the evidence that the observed relationship between variables is not random. The significant difference between the *p* values obtained and the standard significance level support the robustness of the association between the variables, suggesting a strong and significant relationship.

In addition, the linear-by-linear association test was used to detect a possible linear trend between variables. The results showed a value of 88.786 with one degree of freedom and asymptotic significance of 0.001. This result also indicated a significant linear relationship between the variables, strengthening the evidence of a non-random association.

Table 2. Reliability statistics.

Cronbach's alpha	Description
0.813	All variables
0.843	Training of managers
0.333	Company size
0.788	Internationalization of companies
0.692	Digitization of SMEs

Table 3. Chi-square tests.

Probabilistic concept	Value	df	Asymptotic significance (two-sided)
Pearson's chi square	180.870α	9	<.001
Probability index	119.327	9	<.001
Linear by linear association	88.786	1	<.001
N of valid cases	270		

For further analysis, we separately assessed each dimension (management education, internationalization and firm size) and its correlation with the SME digitalization dimension to validate the specific hypotheses of our research.

To descriptively corroborate the statistically significant association between the results obtained in the Pearson's chi-square test, we highlight three key questions used in our sample.

Education level and digitalization of SMEs

An asymptotic significance of less than 0.001 is observed, suggesting that the correlation between the dimensions is statistically significant and that management education is significantly related to the digitization of EMSs (see Table 4).

Thus, the surveyed sample indicates that 78.9% (5.9% agree and 28% strongly agree) consider that academic training influences the implementation of digital processes in their workplace, thus validating our first premise, which indicates that it significantly influences digitalization in Peruvian SMEs.

Company size and digitization of SMEs

For the firm dimension, an asymptotic significance of less than 0.001 is observed, suggesting that the correlation between the dimensions is statistically significant and that firm size is related to the digitization of SMEs.

Likewise, 65.6% (54.2% agree and 11.4% strongly agree) of the surveyed sample affirmed that the size of the company influences digitalization compared to companies of other sizes, thus ratifying our third premise, which states that it significantly influences the digitalization process in Peruvian SMEs (see Table 5).

Level of internationalization and digitalization of SMEs

For the internationalization dimension, an asymptotic significance of less than 0.001 is observed, suggesting that the correlation between the dimensions is statistically significant and that internationalization is significantly related to the digitization of SMEs (see Table 6).

Finally, 69% (57.2% agree and 11.8% strongly agree) of the sample surveyed consider that they have experienced some significant influence of internationalization on the process of adopting digital technologies in their company, so the premise that internationalization significantly influences the digitalization process in Peruvian SMEs is valid.

Table 4. Chi-square tests.

Probabilistic concept	Value	df	Asymptotic Significance (two-sided)
Pearson's chi square	111.855	12	<.001
Probability index	80.678	12	<.001
Linear by linear association	61.825	1	<.001
No. of valid cases	270		

Table 5. Chi-square tests.

Probabilistic concept	Value	df	Asymptotic Significance (two-sided)
Pearson's chi square	66.977	12	<.001
Probability index	51.816	12	<.001
Linear by linear association	6.526	1	.011
N of valid cases	270		

Table 6. Chi-square tests.

Probabilistic concept	Value	df	Asymptotic significance (two-sided)
Pearson's chi square	170.825	12	<.001
Probability index	133.139	12	<.001
Linear by linear association	97.101	1	<.001
N of valid cases	270		

Table 7. Linear regression analysis.

Predictor	Estimator	EE	t	*p*
Constant	1.5319	0.218	7.03	<.001
Training of managers	0.236	0.0457	5.17	<.001
Company size	0.0576	0.0469	1.23	.221
Internationalization of companies	0.3705	0.04	9.27	<.001

It is concluded that general level factors influence SME digitization. Specifically, management education is significantly related to SME digitization, internationalization is significantly related to SME digitization, and firm size is significantly related to SME digitization.

Linear regression analysis

The general linear regression model presented in this study (see Table 7) analyses the relationship between the dependent variable 'SME Digitalisation' and three independent variables: 'Manager Training', 'Company Size' and 'Internationalisation of Companies'. The results indicate that the correlation coefficient (R) is 0.652, suggesting a moderately positive relationship between the independent variables and SME digitalization, and that the dependent variable is 65.2% influenced by the independent variable, which is very significant for this study. This implies that, as the independent variables increase, digitalization also tends to increase, although the relationship is not exceedingly strong. Furthermore, the coefficient of determination (R^2) of 0.425 reveals that approximately 42.5% of the variability in digitalization can be explained by these three independent variables, while the remaining 57.5% is influenced by factors not considered in this model.

The results of the multiple regression analysis allow for the identification of the individual impact of each independent variable on SME digitalization. Firstly, Manager Training shows an estimated coefficient of 0.236 with a *p* value <.001, indicating that there is a significant relationship between this variable and digitalization. In practical terms, for each additional unit of improvement in manager training, SME digitalization increases by 0.236 units, keeping other variables constant. This result validates the importance of training in the digital transformation of small and medium-sized enterprises.

On the other hand, Company Size shows a coefficient of 0.0576 but with a *p* value of .221, indicating that this effect is not statistically significant. Although the coefficient suggests that an increase in company size could slightly influence digitalization, there is not enough evidence to assert that size has a direct impact on this dependent variable. This finding suggests that other factors may play a more important role in SME digitalization than company size.

Finally, the level of internationalization of companies stands out as a variable with a significant and positive impact on digitalization, with an estimated coefficient of 0.3705 and a *p* value <.001. These results suggest that for each additional unit of internationalization, SME digitalization increases by 0.3705 units, highlighting the fundamental role of internationalization in the adoption of digital technologies by companies.

In conclusion, the analysis shows that both manager training and internationalization of companies are key factors in driving SME digitalization, while company size does not appear to play a significant role in this context. Although the model explains a considerable proportion of the variability in digitalization (42.5%), it also suggests that other factors not included in the model influence this process. These findings provide relevant evidence for designing policies and strategies aimed at promoting digital transformation in SMEs, with a particular focus on managerial training and internationalization as drivers of change.

Discussion

Hypothesis 1

Hypothesis 1 of the present research suggests a significant relationship between the educational level of managers and digitalization. Based on the results of this study, it was found that educational level is related to and reflects a positive impact on digitization. Previous research has also supported this theory (Clemente-Almendros et al., 2024) by noting that managers with a higher educational background are more likely to understand both the advantages and obstacles of implementing digital technologies.

Management education plays an important role in the adoption of digital technologies within firms, as noted by Zahoor et al. (2023).

According to the results of our instrument, we found that 10.7% of respondents strongly agreed that the organization has properly trained its staff on digitization issues, highlighting also the need for specific training (51.3%) and that it is up to date to be able to handle digital tools. Furthermore, 53.5% of respondents agreed that they had received training on the digital tools that their organization was using, supporting the importance of continuous training in this area.

On the other hand, 50.9% of our respondents agreed and 28% strongly agreed that educational background does influence the implementation of digital processes in their company. The data obtained supports our hypothesis, and the literature confirms that the educational background of business leaders has a significant impact on corporate strategy and the implementation of digital technologies in the business environment (Gallegos & Lazo, 2021).

Thus, these survey data reflect the relevance of having business leaders trained in new technologies to improve the competitiveness and sustainability of companies as well as the importance of management education in the successful implementation of digital technologies (Clemente-Almendros et al., 2024).

The main limitation of the research on the effect of management education level on digitalization in SMEs is the size of the sample and its representativeness. It presents results based on 270 respondents, so it may not be sufficiently representative of the generalized context of SMEs in Metropolitan Lima.

Additionally, the limitation of respondents' self-assessment bias, that is, the respondents' own underestimation or overestimation of their educational attainment or generalized studies with the social expectations of stakeholders, is considered relevant. Finally, the constant variability of the level of digitization also acts as a considerable constraint because, even if managers are skilled in present or past technologies, the constant induction and variability of disruptive technologies might make comparisons between companies difficult.

In relation to the external variables not considered in the study, the level of digital education of the sample plays an important role, as it can facilitate or hinder the adoption of digital tools, regardless of the educational level of SME managers in Peru. Likewise, another variable that may influence is organizational culture, which may or may not encourage continuous learning to update knowledge and skills in digitization.

The confirmation of the first hypothesis postulating a direct relationship between the level of management education and digitalization in SMEs represents a significant advance in the theory linked to digital transformation in emerging business contexts. In this sense, it reinforces the idea that adequate education and training of business leaders are key elements in fostering the adoption of digital technologies. From a practical point of view, it highlights the need to invest in educational programs to develop the skills of leaders and managers, which serves as a basis for strategic decision-making in terms of digitization and the improvement of organizational culture. Furthermore, they open new perspectives on how different educational approaches could influence Peruvian business digitalization. These findings suggest direct applications in business decisions and public policy design aimed at promoting the development of digital skills among business leaders and strengthening the adaptation of Peruvian SMEs in a globalized market. The role of regulatory bodies such as the Ministry of Production and the Ministry of Trade and Foreign Trade of Peru is necessary for the improvement of the export culture, a mechanism that needs full attention for a significant increase in the internationalization of Peruvian SMEs.

The linear regression analysis supports Hypothesis 1 of this research, which posits a significant relationship between managerial education and digitalization. The results show that managerial training has a positive and statistically significant effect on the digitalization of SMEs, with a coefficient of 0.236 and a p value <.001. This confirms that higher levels of training are associated with greater digitalization, where each unit increase in training leads to a 0.236 unit rise in digitalization, holding other factors constant.

These findings align with existing literature (Zahoor et al., 2023), highlighting the critical role of managerial education in driving digital transformation in SMEs. The strong impact observed suggests that well-trained managers are not only better equipped to understand digital technologies but also more adept at overcoming the operational challenges of implementation.

From a practical perspective, this evidence underscores the importance of investing in managerial education to promote digitalization in SMEs. Such training equips leaders with the skills needed to

spearhead digital initiatives effectively, reaffirming Hypothesis 1 and emphasizing the strategic value of education in advancing digitalization efforts.

Future research should examine how resistance to change among owners and management affects the adoption of new practices and innovations. This would help clarify the influence of resistance on company decision-making and overall efficiency improvements.

Hypothesis 2

Hypothesis 2 suggests that internationalization is directly related to the digitalization process. According to the data obtained, 69% of the respondents (57.2% agree and 11.8% strongly agree) indicate that they have experienced some significant influence of internationalization on the adoption of digital technologies in their workplace, so this information adequately supports the hypothesis and the literature that digital transformation brings with it an exponential opportunity for widespread growth and, above all, the achievement of entering new international markets and becoming more competitive (Denicolai et al., 2021). In addition, 69% of respondents (53.9% agree and 15.1% strongly agree) believe that internationalization has enhanced the digitization of the company where they work, thus fulfilling the theory that for the maximization of survival and development that occurs in a national framework for companies, the internationalization of these is key to the impact on performance and the application of digital technology tools (Costa Melo et al., 2023).

Although the results of this study support the second hypothesis, it is crucial to consider some limitations that could affect the interpretation of the findings. First, the possible lack of equal representation of the economic sectors in which the selected sample operates could bias the relationship found between the level of internationalization and digitization. Sectors less oriented to imports or exports, and with less perceived need for digitization, might have been under-represented. Another relevant limitation is the choice of a Likert scale to measure the level of internationalization in this study. This methodology might not capture the facets and variables of the internationalization process in SMEs because it focuses on understanding the perceptions and attitudes of the surveyed managers or bosses regarding the dimension under study.

However, this may be due to a failure to consider certain variables, for example, the influence of external stakeholders, such as the intervention of the state with programs that contribute to training or provide an economic boost to the organization. Even the inclusion of strategic alliances with distributors represents one of the variables that can be relevant from the perspective of a company oriented toward planning its entry into international markets.

According to the second hypothesis, which states a significant influential relationship between internationalization and digitalization in SMEs in Metropolitan Lima, the theoretical approach can reinforce the understanding in previous literature that internationalization broadly influences the digitalization process for SMEs considering the perception of the surveyed actors. The practical implications prove that the process of intervening in international markets considerably benefits operations and productivity and even reinforces the handling of digital tools in these companies. Thus, contrasting induction training and advice on strategies for international markets would be an important step for companies seeking a start or better handling of digital technologies. Therefore, this research suggests more training for start-ups in Metropolitan Lima in the process of induction to international markets.

Although company size shows a positive coefficient (0.0576), its p value of .221 indicates it is not statistically significant for the digitalization of SMEs in this study. This suggests that, while larger companies may have more resources to invest in digital technologies, there is insufficient evidence to conclude that size directly influences their adoption. Other factors, such as access to finance, organizational culture, or local technological infrastructure, may play a more crucial role in digitalization than company size alone.

This finding aligns with existing literature, which recognizes that SMEs, regardless of size, often face similar challenges in adopting digital technologies, particularly in emerging markets like Peru.

Based on the limitations presented, it is considered necessary to conduct future specific studies for the most representative economic sectors in Peru on the relationship between the level of internalization and digitalization, for a more precise analysis. In addition, qualitative studies, including in-depth interviews or ethnographic studies, analysis of foreign trade data and more detailed surveys on the international activities of SMEs are needed to expand the methodology for measuring the level of internationalization.

Consequently, with the aim of determining how the size of the company affects the digitization of Peruvian SMEs, according to the results, it was found that there is a relationship between the size of the company and digitization in Peruvian SMEs, which is reflected to a similar extent to what Holl and Rama (2023) is mentioned at a theoretical level, which positively relates the degree that a company reaches in size with the adoption of digitization. By way of comparison, the percentage of respondents of 65.6% (54.2% agree and 11.45% strongly agree) affirms the influence of firm size on the digitization process, which alludes to what is mentioned by Massa et al. (2023) about the higher probability that a larger company will implement a digitization process because this process is limited in the development of innovation and is generated in the long term in SMEs (Radicic & Petković, 2023). The latter coincides with the neutrality of difficulties in exercising the adoption of digital technologies.

Hypothesis 3

Although the research results support the third hypothesis, there are limitations to considering the premise that firm size significantly influences the digitization process. First, within each type of enterprise Micro (2–9 employees), small (10–49 employees) and medium enterprise (50–199 employees), there is variability in the size categories that must be considered, as the resources between these three segments can be significantly different based on their purchasing power. In addition, the geographical context of these segments within Metropolitan Lima may be limited given the technological infrastructure of each specific district or area; therefore, companies located in areas with poorer technological infrastructure may present problems in their digitization process despite their segment size.

Access to finance is one of the external variables that was not considered in the research and may have influenced the results, as this factor can affect firms' digitization, and SMEs with financial constraints may face difficulties in investing in technologies. Future research could include this variable in the analysis to more precisely determine how firm size presents challenges in implementing the use of digital tools, as access to finance can vary significantly between firms of different sizes, even more so in financial realities such as Peru, where confidence varies depending on the interest rate of the Central Reserve Bank of Peru and the country's political situation.

On the other hand, organizational culture is another external factor that was not considered in the research, as an innovative organizational culture can facilitate the assertive adoption of digitalization. On the contrary, if it is more resistant to change, depending on its size, it could present a negative predisposition of employees to adaptability.

On the other hand, the linear regression analysis indicates Hypothesis 3, Internationalization emerges as a crucial variable in the digitalization process of SMEs, with an estimated coefficient of 0.3705 and a p value <.001, indicating a positive and statistically significant relationship. This result reflects that, as companies internationalize, their digitalization increases significantly, underscoring the importance of global operations as a driver for digital transformation. Internationalization facilitates access to new technologies and encourages the adoption of digital tools to enhance the competitiveness and efficiency of companies in international markets (Denicolai et al., 2021). This finding suggests that public policies aimed at supporting SME internationalization, such as export programs or international strategic alliances, can significantly contribute to the digitalization process.

The demonstration of the third hypothesis reinforces the idea that SMEs with greater resources tend to adopt digital technologies more effectively and on a larger scale than smaller ones do. This finding not only supports theories on the importance of resources and investments in digitization but also extends the theoretical framework by highlighting the specific relevance of firm size in this context. From a practical perspective, SMEs can use these results to adapt their digitization strategies according to available resources by implementing digital solutions that fit their operational scale. Consequently, the findings guide the strategic allocation of financial, human and technological resources toward the initiative that will foster digitization and maximize the efficiency of their operations. They also suggest the need for government agencies to adjust funding and subsidy policies for small businesses to facilitate their adaptation to the digital era.

Future research should focus on the influence of company size on sustainability practices, as trends are more relevant today for Sustainable Development Goals.

Conclusions and recommendations

In line with the first specific objective, our findings support the idea that managers' educational level is directly related to the adoption of digital technologies in SMEs, which in turn positively affects the efficiency, competitiveness and adaptability of these firms in a dynamic business environment. Therefore, we conclude that management education determines the digitization process of Peruvian SMEs, as our survey results highlight that the academic training of business leaders and managers influences the implementation of digital processes. In addition, training in technologies and understanding current technological trends can be crucial elements for improving competitiveness in the development of their activities. Moreover, the linear regression model suggests that training of managers and internationalization of companies are the main drivers of SME digitalization, whereas company size does not show a significant impact. With a coefficient of determination (R^2) of 0.425, the model explains approximately 42.5% of the variability in digitalization, indicating that other factors not included in the analysis also play an important role in this process.

In alignment with the studies of Hambrick and Mason (1984) and Du et al. (2024), the educational and professional backgrounds of managers are pivotal in shaping business strategy and decision-making processes, a finding corroborated by the results of this research. Moreover, advanced training, such as an MBA, has been associated with enhanced managerial performance, as emphasized by Gottesman and Morey (2006). These insights underscore the critical role of formal education in the effective management of small and medium-sized enterprises (SMEs).

Based on the conclusion of Objective 2, the internationalization variable's approach in association with the digitalization of SMEs represents the expansion of the frontiers of an SME with the use of digital tools, a necessary resource to make its entry into international markets effective. It is worth noting that the influence of digitalization is greater in an SME oriented toward directing its processes on an international scale because of the pace attributed to international markets that require efficient performance that provides the possibility of competing at a high level. Conversely, the adoption of digital technology is not a determining factor for SMEs that do not opt for internationalization.

Second, regarding the second specific objective, we can conclude that the internationalization of firms is significantly related to the digitization process of Peruvian small and medium-sized enterprises (SMEs). The positive influence of internationalization on the adoption of digital technologies by SMEs is evidenced by the perception of the respondents, who consider that internationalization has significantly boosted digitalization in their companies. This positive relationship between internationalization and digitalization highlights the importance of international expansion as a key factor for improving the efficiency and competitiveness of Peruvian SMEs in an increasingly globalized business environment.

Furthermore, the results indicate that SMEs that actively participate in international markets and derive a significant share of their sales tend to be more driven toward the adoption of digital technologies. This correlation between internationalization and digitization suggests that companies seeking to grow internationally are better positioned to take advantage of the opportunities offered by digital transformation, allowing them to remain competitive and effectively respond to the demands of the evolving global marketplace. From a practical perspective, the results suggest that SMEs should prioritize managerial training and internationalization as key strategies to accelerate their digital transformation. Likewise, public policies should focus on providing resources and support for managerial training and facilitating access to international markets, thereby promoting a more conducive environment for digitalization within the business sector.

In line with Consistent with the findings of Kovačević and Labrović (2024) and Chin et al. (2023), managers possessing advanced digital skills are observed to significantly influence the adoption of digital technologies within SMEs. This underscores the importance of managers receiving up-to-date training in digital technologies to lead effectively in a digitalized environment. Zahoor et al. (2023) assert that digital literacy is indispensable in the modern era, further reinforcing the conclusion that leadership grounded in technological competencies is essential for the successful digital transformation of SMEs.

Regarding the third specific objective, it is necessary to indicate that the size of the company plays a significant role in the digitalization process of Peruvian SMEs. There is a clear relationship between company size and the implementation of digital technologies in these organizations. Larger SMEs tend to

adopt digital technologies more effectively, suggesting that firm size directly influences the digitization of firms. This relationship between firm size and digitization highlights the importance of considering the operational and structural dimensions when implementing digitization strategies. However, as indicated by the linear regression model, company size did not show a significant impact in this study. On a practical level, the results indicate that organizations can adapt their technological approaches and resources according to their size to improve efficiency and competitiveness in an increasingly digitized business environment. Consequently, considering company size as a key factor in the digitization process can guide Peruvian SMEs toward more effective and strategic implementation of digital technologies.

It is important to highlight, as noted by Del Do et al. (2023), that in SMEs, the educational level of managers plays a crucial role due to the simplicity of the organizational hierarchy and the centralization of decision-making in a small group of individuals. This contrasts with larger firms, where the hierarchical structure is more complex and decisions are typically more decentralized.

On the other hand, the methodology used in this study was instrumental in obtaining reliable and revealing results that allowed us to test the hypotheses and accurately answer the research questions. Through a structured survey of a representative sample of 271 SMEs in the capital city of Lima, detailed data were collected on the level of managers' education, degree of internationalization and size of the company and its relationship with the market. Regarding the internal validity of the methodology, strong internal consistency was demonstrated in the measurement scales used, with a Cronbach's alpha coefficient of 0.813. This indicates that the questions designed in the applied instrument were consistent and reliable in measuring the key variables related to the digitalization of Peruvian SMEs. Correlation and significance tests were performed to validate the relationships between the variables studied.

In terms of statistical significance, the results obtained through Pearson's chi-square, likelihood ratio and linear-by-linear association analysis show that the variables studied (educational level, internationalization and company size) have a statistically significant correlation with the digitalization of SMEs in Metropolitan Lima. These results strongly support the hypotheses and confirm the importance of considering these critical factors when analyzing the digitization process in the Peruvian business context. However, the coefficient of determination (R^2) of 0.425 indicates that other factors, such as organizational culture, access to finance and government policies, could also influence the adoption of digital technologies. Thus, the results of the applied methodology have allowed us to affirm that the educational level of managers, internationalization of companies and company size have a significant influence on the digitalization of Peruvian SMEs.

In addition, a significant percentage of respondents expressed their perceptions and experiences regarding digitalization in their companies. Furthermore, our study fills an important gap by analyzing in detail and in a comprehensive manner the interaction of education, internationalization and firm size of Peruvian market leaders with the digitization of SMEs. The results provide useful information for firms, researchers and policymakers interested in promoting the digitization of the Peruvian business sector, emphasizing the importance of adapting to technological trends to increase competitiveness and sustainability in a dynamic business environment.

As is common in empirical studies, our research has inherent limitations. One of these was the sample size used. Although an adequate sample size was calculated for a finite population by selecting 271 EMS workers in Metropolitan Lima, this number may not be sufficient to accurately represent the diversity and complexity of the EMS universe in the region. In this sense, this aspect could compromise the generalizability of the results on a broader scale.

Furthermore, within the framework of the adopted quantitative research design, based on structured surveys, we faced challenges during face-to-face data collection. For example, the lack of time for EMS employees makes it difficult to obtain complete and detailed responses. In addition, concerns were raised about the reliability of the personal data of the surveyed entrepreneurs owing to the privacy policies of the companies where the participants worked. These concerns, related to the fear of unauthorized disclosure of information or possible data breaches despite having signed informed consent, may have affected respondents' willingness to provide truthful and complete information.

This study provides a solid basis for future research to delve deeper into the specific aspects of digitization in Peruvian SMEs. In this sense, it could motivate comparative studies between different sectors and regions of the country. This will allow the identification of variations in digitization practices to

adapt to specific strategies. It will also provide guidance for new authors to explore mixed methodologies (including) that consider not only surveys but also case studies or qualitative interviews to collect a greater diversity of information to complement the statistical results.

From a practical point of view, the findings of this study provide a comprehensive framework for strategic decision making in the digitization of Peruvian SMEs. First, the significant correlation between management education and digitalization suggests the importance of investing in training and professional development programs for business leaders. This approach will not only contribute to an improvement in managerial skills but would also allow for the effective implementation of technological solutions adapted to current market needs. With respect to internationalization, the results underline the need to promote policies that support the expansion of operations internationally as a digital growth strategy. The influence of company size highlights the significance of offering specific support programs for SMEs to help them overcome financial and technical barriers in the digitization process.

Limitations and future research

One of the principal limitations of this study is the representativeness of the sample used. Although an appropriate statistical formula was applied to calculate the sample size, the 271 selected participants may not accurately reflect the diversity of SMEs in Metropolitan Lima, particularly considering the differences across economic sectors. This lack of representativeness could affect the generalizability of the findings at a national level. Moreover, the self-assessment approach employed in the surveys introduces the risk of response bias, as participants may have overestimated or underestimated their capacities, thereby influencing the results regarding the relationship between education, internationalization and digitalization.

Another significant limitation lies in the dynamic nature of digital technologies. The rapid pace of technological advancements means that the knowledge and strategies that are useful today may become obsolete in a short period. This directly affects the long-term relevance of the results, as the study does not account for the continuous adaptation of SMEs in response to technological changes. In this regard, it would be beneficial for future research to adopt a longitudinal approach, allowing for the observation of the evolution of digitalization in relation to technological advancements and its sustained impact on SMEs.

Additionally, this study does not delve deeply into certain external factors that may influence the digitalization process, such as access to financing or government support. These aspects are crucial for understanding the limitations many SMEs face in their efforts to implement digital technologies. Access to financing, for instance, can determine a company's ability to invest in innovative technologies, while government policies may offer incentives or pose barriers that influence technology adoption. Including these factors in future research could provide a more comprehensive view of the digitalization process.

Furthermore, although this study focused on a quantitative approach through structured surveys, future research could benefit from mixed-method approaches. The inclusion of in-depth interviews, case studies, or qualitative methodologies would allow for the collection of more detailed and nuanced information about SMEs' experiences in adopting digital technologies. These qualitative approaches could complement the statistical data obtained and provide a richer understanding of the barriers and facilitators that SMEs in Peru face.

Finally, it would be advisable to conduct comparative studies across different regions or economic sectors to identify variations in digitalization practices. This would allow for the adaptation of specific strategies to meet the needs and challenges of each industry or geographical area. Additionally, future studies could explore how factors such as organizational culture or resistance to change within SMEs affect the implementation of digital technologies, providing a more holistic and practical perspective to support digitalization in these enterprises.

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Data availability statement

The data that support the findings of this study are available from the corresponding author [J.R.M.C] upon reasonable request.

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Appendix

Table A1. Format of the survey used for data collection.

Target	Question	Theoretical basis
O1: Determine the influence of managers' educational level	1. What is your highest level of education attained (select one: high school, technical education, university education, postgraduate, master's or doctoral degree)?	(Clemente-Almendros et al., 2024)
	2. Do you consider that the organization has adequately trained its staff on digitization issues?	(Türkeş et al., 2019)
	3. Do you consider that you have received sufficient specific training in digitization-related issues?	(Gallegos & Lazo, 2021)
	4. Do you consider that academic background influences the implementation of digital processes in your organization?	(Gallegos & Lazo, 2021)
O2: Determining the influence of the level of internationalization	5. From your perspective, do you consider your company to be an active participant in international markets?	(Clemente-Almendros et al., 2024)
	6. Do you consider that your company's sales come from international markets?	(Clemente-Almendros et al., 2024)
	7. Do you consider that you have experienced any significant influence of internationalization on the adoption of digital technologies in your company?	(Velásquez Cuervo et al., 2024)
	8. Do you think that internationalization has boosted the digitalization of your company?	(Virglerová et al., 2022)
	9. According to the technological tools that you use in your company, please indicate the degree of acceptance on a scale from 1 to 5, where 1 is totally disagree and 5 is totally agree: ERP Corporate Intranet Cybersecurity services Cloud or CRM (Customer Management Software) Trello, slack, asana, Google Workspace Power BI, Tableau, Google Data Studio	(Clemente-Almendros et al., 2024)
O3: Determine the influence of company size on the digitization process.	10. How many employees does the company where you work have (micro, small, medium)?	(Clemente-Almendros et al., 2024)
	11. Do you consider that the size of your company influences the digitization process compared to companies of other sizes?	(Virglerová et al., 2022)
	12. Do you consider that your company has difficulties related to the size of your company in the adoption of digital technologies?	(Vardari et al., 2022)
	13. From your perspective, do you consider that the organization has implemented strategies to overcome possible obstacles due to size in digitization?	(Vardari et al., 2022)