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Determining factors for the digitization of micro, small, and medium-sized enterprises (MSMEs) in Ibero-America☆

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ABSTRACT

Industry 4.0 and the rapid evolution of the technological landscape have significantly impacted company value creation of. This study analyzed the determining factors influencing the digitalization of micro-, small-, and medium-sized enterprises (MSMEs) in Ibero-America. Data were collected from 14,972 companies in Ibero-American region, and a structural equation model (SEM) was constructed using variance analysis techniques with partial least squares (PLS). The results showed the relevance of training in digitalization skills and digital leadership in achieving different levels of digitalization among the companies studied, with digital leadership further enhancing training efforts. While the adoption of analog technology governance centered on human factors does not impact digital skills training, it is crucial for attaining a basic level of digitalization. Barriers related to technology, finance, human resources, and business culture affect the achievement of a basic level of digitalization but are no longer relevant as companies advance to higher levels. These results provide guidance for the digitalization processes of MSMEs and inform public policies aimed at stimulating the digital transformation of companies.

Introduction

In recent years, awareness about the benefits of digital technologies has increased (Lukito et al., 2023), prompting new ventures to focus on providing customers with solutions supported by digital infrastructure. This shift has intensified competition, disrupting established business models (King, 2017; Lester, 2018) and forcing companies to transform their business models in response to changing customer habits (Lukito et al., 2023) in order to survive in the market.

In addition to new customer demands and competitive pressure, constant uncertainty, environmental changes, and globalization are forcing companies to innovate, with the digitalization processes playing an important role in stimulating these rapid responses. The technological revolution driven by digitalization has caused significant changes in organizations, including the adoption of remote work, use of digital platforms, and integration of social networks for product marketing, business relationships, and commercial transactions with suppliers. These changes require substantial investment in technology (Valdez-Juárez et al., 2023).

Digitalization enables companies to remain competitive in the market by achieving higher efficiency levels, optimizing production processes (Warner & Wäger, 2019), increasing operational flexibility to meet market demands, and constantly innovating (Feliciano et al., 2023). Furthermore, digitalization reduces the time required for product design and commercialization, thereby allowing companies to respond quickly to consumer demands (Dabrowska et al., 2022).

Despite the significant advantages of digitalization and digital transformation, micro-, small-, and medium-sized enterprises (MSMEs) in Ibero-America exhibit a low degree of maturity in utilizing basic digitalization technologies (websites, e-commerce portals, e-commerce

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marketplaces, social networks for commercial purposes, digital banking, and teleworking). Additionally, these companies have an even lower level of maturity when it comes to utilizing advanced digitalization technologies, such as enterprise resource planning (ERP), corporate intranet, cybersecurity services, big data and data analysis, robotization, sensorization, localization, and the Internet of Things (IoT; García et al., 2022). Understanding the factors influencing the adoption of these technologies is important.

Although some studies have conceptualized various levels of digital technologies (Obukhova et al., 2020; Benga & Elhamma, 2024), few have focused on the factors that affect the implementation of these technologies at each level of digitalization.

Understanding these factors is important, especially because only a small number of companies that have embarked on digitalization and digital transformation have achieved their initial objectives (De la Boutetière et al., 2023; Forth et al., 2023). Many projects by global corporations have failed to generate the expected returns, leading to a loss of shareholder support (Davenport & Westerman, 2018).

Recognizing that the challenges and issues surrounding the digital transformation of SMEs have not been thoroughly examined (del Do, 2023), this study aims to analyze the factors that determine the digitalization and digital transformation of Ibero-American MSMEs. To this end, the study examines the direct effects of centralized technology governance focused on human factors, human talent training in digitalization, digital leadership, and barriers to digitalization on the different levels of digitalization achieved by these companies. It also analyses the influence of centralized technology governance and digital leadership on human talent training in these areas.

To achieve this, the study began with a review of the relevant background information, which supported the development of the study constructs and hypotheses. Data were collected from 14,972 MSMEs in Ibero-America through the Ibero-American Observatory of MSMEs. Subsequently, a structural equation model (SEM) was constructed and analyzed. The analysis emphasized the relevance of human talent training and digital leadership at all levels of company digitalization. It also revealed that analog technology governance focused on human factors and barriers to digitalization related to technological, financial, human, and business culture issues is relevant only at the basic level of digitalization. These factors are not relevant at the advanced and frontier levels as companies transition into digital transformation processes and become fully digital.

The results of this study are expected to serve as a guide for MSMEs to leverage their digitalization processes. Additionally, the results can inform governments in the formulation of public policies aimed at stimulating the digital transformation of enterprises, thereby increasing regional competitiveness. This study also proposes new avenues for future research.

Literature review and hypothesis planning

Digitalization and digital transformation

Although digitalization and digital transformation are often used interchangeably (Reis et al., 2018), it is worth differentiating between them, considering that, for some authors, digital transformation represents an advanced stage of digitalization (Busulwa et al., 2022).

Digitalization involves designing and implementing IT-based solutions by individuals, organizations, and society to increase user experience, efficiency, and effectiveness (Alt, 2018). According to Plotnikov (2018), digitalization corresponds to the predominant use of digital technologies for generating, processing, transmitting, storing, and visualizing information based on the emergence and dissemination of new hardware and software solutions. Thus, digitalization is reflected in the flow of information through technology and tasks performed on computers.

Digital transformation extends further and is conceived as the process of organizational change influenced by information technologies (Feliciano et al., 2023; Gebauer et al., 2020; Ulas, 2019), leading to changes in business processes, production, marketing, sales, support activities, and human talent management (Chanias & Hess, 2016). It represents a shift in how digital technologies are used to develop a new digital business model that creates value for the organization (Verhoef et al., 2021).

In this way, digitalization enables companies to adopt digital technologies to optimize workflows or processes and improve efficiency without the need to re-examine and redesign the core business. In contrast, digital transformation entails rethinking customer value propositions and fundamentally transforming value chains through digital business model innovation (Busulwa et al., 2022).

Levels of digitalization

According to the Economic Commission for Latin America and the Caribbean (ECLAC), as cited by Dini et al. (2021), companies have three levels of digitalization, which depend on the types of technologies adopted and their use (Table 1).

Studies have found that companies with higher digital maturity focus on integrating SMACIT digital technologies to transform their operations, while less digitally mature companies focus on solving specific problems with individual digital technologies (Kane, Palmer, Phillips, Kiron, & Buckley, 2015). SMACIT technologies refer to robust, readily accessible digital technologies that are highly complementary, such as social networking, mobile devices, data analytics, cloud computing, and the IoT (Sebastian et al., 2020).

According to Obukhova et al. (2020), the digital transformation of enterprises requires classifying digital technologies into three groups according to their accessibility and convenience: Basic technologies encompassing cloud, wireless, and paperless technologies, without which the digital transformation of an enterprise would be impossible; Critical technologies including big data, cloud computing, and unmanned technologies provide enterprises with a complete digital transformation; and innovative technologies such as artificial intelligence, neural networks, distributed data logging, and machine learning enable an enterprise to transition from analog to digital.

These levels of technologies—basic, critical, and innovative—allow organizations to evolve from digitalization to digital transformation, ultimately becoming digital enterprises that support countries' transition to a digital economy (Obukhova et al., 2020). In this sense, digital transformation implies organizational change triggered and shaped by the widespread diffusion of digital technologies (Hanelt et al., 2021) and the adoption of frontier-level technology.

This study examines the three levels of digitization—basic, advanced, and frontier—proposed by ECLAC. Each level was analyzed independently to identify the specific factors influencing its adoption. This approach allows for a comparison of company behaviors across different digitization levels. This study contrasts companies with basic or advanced digitization against those that have embraced frontier technologies, indicating a commitment to digital transformation and the development of a fully digital business model.

Impact of digitalization and digital transformation on organizational performance

The adoption of digital management and operational technologies allows companies to reduce operating costs by simplifying workflows, improving production efficiency (Law et al., 2018), and facilitating the implementation of digital innovations in products, services, and business models—differentiating their offerings and creating a competitive advantage (Seyitoglu & Ivanov, 2020).

The scientific literature on digital transformation in Latin America emphasizes the impact of digital technologies on indicators such as process automation, customer satisfaction, positioning, improvement in

Table 1
Levels of Digitalization.

Level	Technology	Type of use
Basic Level	Email	Use of email services to communicate with customers or suppliers.
	Website	Availability of a customized virtual space.
	Interaction with the state	Use of public services for which the government establishes Internet access modalities.
	Online banking	Banking operations carried out via the Internet.
	Social Networks	Communication mechanisms for data transmission (documents, images, etc.) to third parties.
	E-commerce	Purchase or sale of goods and services via the Internet.
Advanced Level	VPN	A virtual private network that operates using the Internet as infrastructure.
	Intranet	A company's private internal communication network, based on internet protocols, but only accessible to authorized users.
	Extranet	Secure extension of an Intranet, allowing access to external parties.
	Business Management System	Systems for customer relationship management (Customer Relationship Management, CRM), internal management (Enterprise Resource Planning, ERP; or Business Process Management, BPM), or supply chain management (Supply Chain Management, SCM).
	Storage Servers	Refers to remotely linked computers.
	Cloud Computing	Delivery of computing services such as servers, storage, and others via the Internet. Services include Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) or storage, database, etc.
Frontier Level	Big Data Analytics	Data analysis is characterized by high volume, speed, and a variety of sources, including market data, transactions, data retrieved from sensors, and social media content.
	Additive manufacturing or 3D	Production techniques by material addition. 3D printing is a technology that allows printing physical objects in three dimensions, from digital models, in a fast but limited way.
	Artificial Intelligence (AI)	This is the ability of machines and systems to acquire and apply knowledge, including through a wide variety of cognitive tasks, such as detection, language processing, pattern recognition, decision-making, and prediction.
	Advance Robotics	It incorporates intelligent automation in production equipment, (e.g., robots with strong autonomy at the decision-making level, communication, and deployment with other equipment). It also incorporates collaborative robots designed to physically interact with humans (along with other flexible and lightweight robots).
	Blockchain	Algorithms that enable authentication and secure transactions for various asset types across a network of computers. The network regularly updates the database everywhere it exists so that all copies are identical.
	Internet of Things (IoT)	Extended communication between machines, people, and products, enabling decision-making and task execution concerning the information that technology stores. Based on sensors and a connected production environment, combined with data analysis, communication is established at the level of machinery (machine to machine or M2M) and intelligent systems that collect and process available information in real time.

Source: Cetic.br, 2020 and Ministerio de Economía, Fomento y Turismo de Chile, 2020, as cited in Dini et al., 2021, pages 9–10.

data management, innovation, quality, organizational culture, and changes in business models.

Impact of digitalization and digital transformation on organizational performance

The theory of dynamic capabilities has been useful in studying the phenomena of transformation and change from a knowledge-based perspective (Mele et al., 2024). Empirical studies provide sufficient evidence on the importance of digital technologies as strategic resources for value creation within organizations (Egala et al., 2024).

However, existing scientific literature lacks general concepts that explore the strategic resources of an organization in relation to its digital orientation and digital transformation initiatives (Egala et al., 2024), which are essential for identifying the resources and capabilities that facilitate or obstruct the incorporation of technologies supporting companies' digital transformation.

Although SMEs have limited resources and fewer specialized capabilities compared to large companies, they can make decisions more quickly (North & Varvakis, 2016), which can benefit technology adoption. Despite this, low intention to use digital technologies and limited current adoption have become key barriers to the digital transformation of SMEs, which face a wide range of barriers, such as a lack of available resources and a low perception of external pressures (del Do, 2023).

Some factors that positively impact technological adoption and digital transformation in MSMEs include managers' professional training, the degree of internationalization, and company growth (Clemente et al., 2024).

Some studies have found that managerial myopia negatively impacts companies' digital transformation efforts (Zhang et al., 2024). Thus, a company culture and leadership prepared to drive digital transformation are key to differentiating a digital company from others and achieving a higher level of digital maturity in SMEs (del Do, 2023).

Seventy percent of companies that undertake digital transformation processes fail to maintain their benefits in the medium or long term, mainly due to challenges in implementing deep organizational changes, establishing adequate learning systems, or implementing changes in the culture and mentality of employees. For digital transformation to generate an impact on innovation and the competitive advantage of companies, cultural, strategic, technological, and operational changes are required (del Do, 2023). All of the above underscores the importance of studying the role of digital leadership, human talent training, and technology governance in digitalization processes.

Digital leadership and level of digitalization in MSMEs

A dynamic environment characterized by volatility, uncertainty, complexity, and ambiguity (VUCA factors) demands a visionary global leader to guide digital business transformation. Such leaders must possess broad knowledge, a continuous learning mindset, and a deep understanding of learning and change management (Mihardjo et al., 2019). Likewise, digital competence requires new management capabilities that were not relevant in the past (Vial, 2019).

Leadership is essential in the digitalization of organizations (Bozkurt & Sharma, 2020) since digital leaders inspire their employees to adopt innovative behaviors by leveraging data and digital resources (Patiar & Wang, 2022). Furthermore, digital leadership plays a crucial role in

shaping a culture that fosters digitalization by encouraging employees to be curious and think differently (Petrucci & Rivera, 2018).

In the digital era, digital leaders must support a culture of innovation in companies by envisioning new ways of conducting business. They must possess deep knowledge to take risks and make decisions that drive organizations to become more innovative, modular, and decentralized (Rudito & Sinaga, 2017).

Digital leadership combines digital culture and competence to drive change and seize opportunities through digital technology (Mihardjo et al., 2019; Rudito & Sinaga, 2017).

These arguments lead to the following hypotheses:

H1. Digital leadership impacts the basic digitalization level of Ibero-American MSMEs.

H2. Digital leadership impacts the advanced digitalization level of Ibero-American MSMEs.

H3. Digital leadership impacts the frontier digitalization level of Ibero-American MSMEs.

Digitalization training of human talent and digitalization level in MSMEs

Knowledge is essential in developing digital business models (Goethals et al., 2004), with digital literacy positively influencing the performance of digital transformation processes (Marsh, 2018).

Companies must enhance and develop their digital skills to succeed in digital transformation in the current digital era. However, due to the diversity of these skills, it is nearly impossible to acquire all of them, making it challenging for organizations to identify which are genuinely strategic (Lukito et al., 2023), especially considering that the skills in the work team may become barriers that hinder digitalization processes (Adomako et al., 2021).

The rapid pace of technological change requires companies to constantly adjust workforce capabilities (El Sawy et al., 2016). Therefore, training and development efforts in human talent are critical to supporting the digitalization processes.

This leads us to propose the following hypotheses:

H4. Digitalization training for human talent impacts the basic digitalization level of Ibero-American MSMEs.

H5. Digitalization training for human talent impacts the advanced digitalization level of Ibero-American MSMEs.

H6. Digitalization training for human talent impacts the frontier digitalization level of Ibero-American MSMEs.

Centralized technology governance and digitalization level in MSMEs

Organizational structures play a significant role in the digitalization process of companies by establishing technology governance (Eberl & Drews, 2021), whereby individuals are earmarked who can be given responsibility to evaluate activities and investments based on their contribution to the strategic vision of organizations (Westerman et al., 2014). This ensures high-quality information (Outvorst et al., 2018) and safeguarding data privacy (Sahyaja & Sekhara, 2018).

A wide range of roles can be created within companies to manage the digital transformation process. Notable positions include E-Leader, Chief Digital Officer (CDO), Social and Remote CEO, Influencer, Agile Evangelist, Content Manager, Online Moderator, Product Owner and Scrum Master, Chief Information Officer (CIO), IT Manager, Programmer, and Big Data and Artificial Intelligence Manager (Zeichhardt, 2018).

According to a study by Deloitte Digital GmbH (2023), 70% of companies that have been highly successful in digital transformation processes have a CDO responsible for this process. This highlights the importance of assigning clear responsibilities to ensure the success of digitalization processes within organizations. Based on the above, the following hypotheses are proposed:

H7. Centralized technology governance impacts the basic digitalization level of Ibero-American MSMEs.

H8. Centralized technology governance impacts the advanced digitalization level of Ibero-American MSMEs.

H9. Centralized technology governance impacts the frontier digitalization level of Ibero-American MSMEs.

Barriers to digitalization and digitalization level in MSMEs

Various studies have identified multiple obstacles or barriers affecting digitalization and digital transformation in companies. These include the need for skills and resources, adoption of changes in innovation management and technological systems (Lerch & Gotsch, 2015), ability to handle large volumes of data, and need for technological competencies (Kim et al., 2018).

Other barriers to digitalization include the lack of trained personnel, insufficient time to undertake innovations, high technological costs, reluctance to invest in digital technologies (Hosan et al., 2022; Ullah et al., 2021), uncertainty regarding financial investments, technical problems (Coreynen et al., 2017), risk of piracy, and data privacy issues (Rymaszewska et al., 2017). Accordingly, the following hypotheses are proposed:

H10. Barriers to digitalization impact the basic digitalization level of Ibero-American MSMEs.

H11. Barriers to digitalization impact the advanced digitalization level of Ibero-American MSMEs.

H12. Barriers to digitalization impact the frontier digitalization level of Ibero-American MSMEs.

Digital leadership and digitalization training of human talent in MSMEs

The resource-based view of an organization positions knowledge as a critical resource that influences its ability to compete in the marketplace (Grant, 1996). In the digital era, digital leaders must facilitate the integration of digital capabilities into the development of organizational culture and the competencies of companies' human talent (Rudito & Sinaga, 2017).

Digital leadership plays a key role in companies, as digital leaders encourage employees to continuously expand their knowledge (Petrucci & Rivera, 2018). They also serve as mentors for human talent in organizations (Eggers & Hollmann, 2018) to promote digitalization processes.

Based on the above, the following hypothesis is proposed:

H13. Digital leadership impacts the digitalization training of human talent in Ibero-American MSMEs.

Centralized technology governance and digitalization training of human talent in MSMEs

Some authors question the role of corporate technology governance, arguing that it delays centralized decision-making and hinders innovation (April & Dalwai, 2019; Tiekam, 2019). However, this study argues that these authors overlook the importance of training each employee to become a digital leader within their areas of expertise.

In this regard, the need for companies to act with agility (Wade & Obwegeser, 2019) has led some studies to emphasize the importance of empowering each employee to act as a digital leader (Borowska, 2019) and delegating decision-making authority to cross-functional teams

(Klein, 2020). Thus, the following hypothesis is proposed:

H14. Centralized technology governance impacts the digitalization training of human talent in Ibero-American MSMEs.

The model shown in Fig. 1was formulated based on the proposed hypotheses.

Methodology

Design

This research employed a quantitative, empirical, non-experimental, contemporary, structural, and transactional descriptive method. The proposed model was analyzed using SEM with variance analysis techniques through partial least squares (PLS).

It is important to highlight that causal methodologies have become essential, as they allow for the understanding and analysis of complex networks. Through multivariate analysis, multiple variables can be analyzed simultaneously. According to Hair et al. (2017), multivariate methods are suitable for identifying patterns and relationships in data involving multiple variables. For this reason, this method was used to test the hypotheses of the proposed framework.

Sample

The study population consisted of 14,972 MSMEs in Ibero-America from various regions and sectors of the economy. Data were collected by researchers from several universities that are part of the Ibero-American Observatory of MSMEs, coordinated by the Foundation for the Analysis and Strategic Development of SMEs (FAEDPYME in Spanish), Network of University Entrepreneurship – Colombian Association of Universities (REUNE-ASCUN) in Spanish), Network for Motivation and Talent in Value (MOTIVA in Spanish), and the Latin American Council of Management Schools (CLADEA in Spanish). The study population was selected through non-probabilistic convenience sampling.

The countries that participated in this study were Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Spain, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, the Dominican Republic, and Uruguay.

According to the economic sector, the companies surveyed belonged to the following sectors: Primary Sector, Extractive Industries, Manufacturing Industries, Energy, Water and Recycling, Construction, Commerce and Services.

Instrument

Data were electronically collected through a closed questionnaire distributed via email between February and June 2022. Responses were obtained from the managers or directors of the companies under study.

The questionnaire was divided into two sections. The first section inquired about the general characteristics of the companies (sector, activity, location, and number of employees). The second section gathered information on the degree of digitalization development within MSMEs, barriers to digitalization, digitalization training of human talent, centralized technology governance, and role of digital leaders. Various Likert-type scales were used to assess entrepreneurs' opinions across different criteria (degree of importance, agreement, or favorability). Table 2 presents the constructs of the model based on the

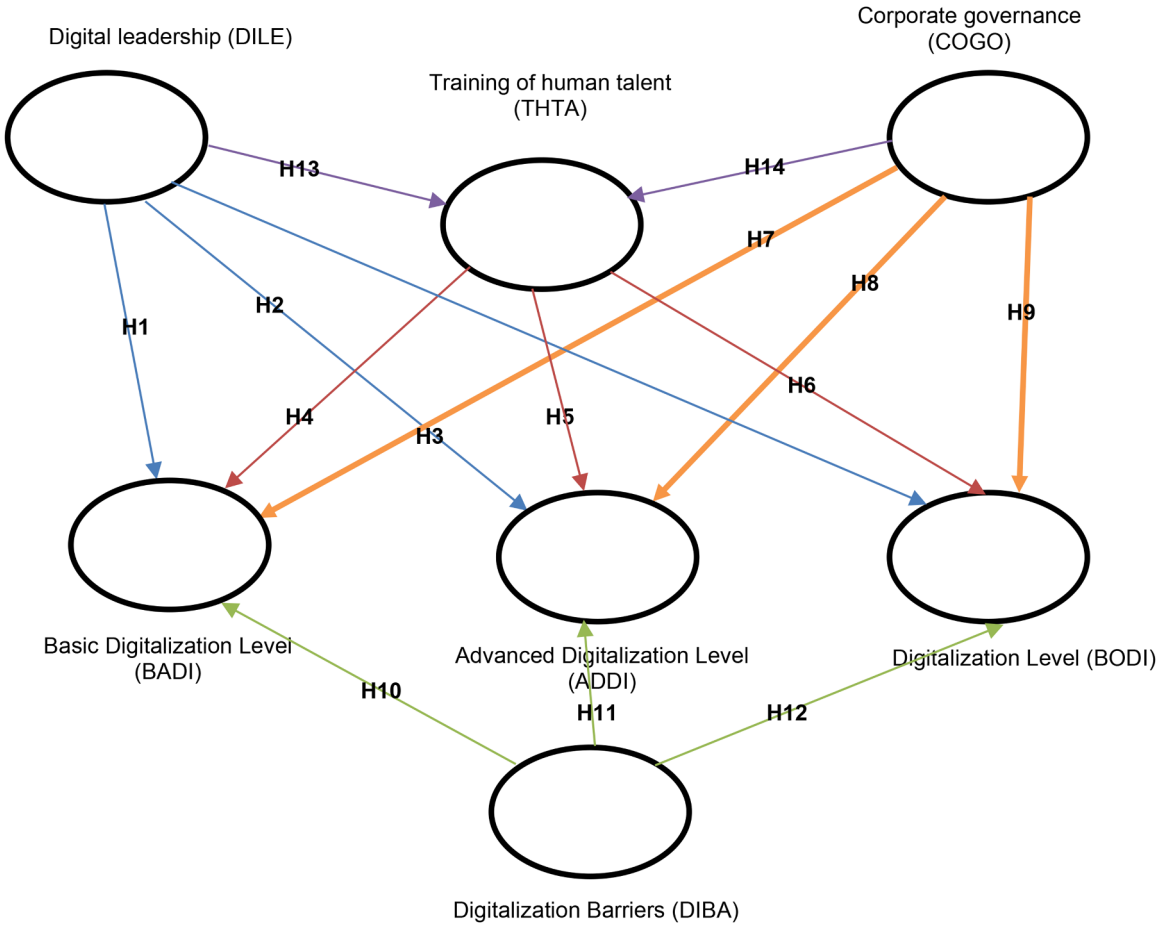

Fig. 1. Nomogram of The Proposed Model.
Source: Author.

Table 2
Relationship between the Constructs and Questions of the Questionnaire.

Nomenclature	Construct	Questions (Scale)
INDEPENDENT VARIABLES		
DILE	Digital leadership	Our managers are well-trained in digitalization (Likert scale)
		We know the possibilities and advantages of digitalization (Likert scale).
		The business model is evaluated and updated in terms of digitalization (Likert scale).
		We allocate significant resources to digitizing the business (Likert scale).
THTA	Training in digitalization of Human Talent	Our company regularly organizes training for digital transformation (Likert scale)
		Our employees are prepared for the digital development of the company (Likert scale)
		Percentage of employees using ICT in their position (%)
COGO	Centralized technology governance	Assignment of an internal person responsible for digitalization in the company (YES/NO)
		Outsourcing of external companies for digitalization/ICT support (YES/NO)
DIBA	Barriers to Digitalization	Lack of business culture to drive digital transformation (Likert Scale)
		Insufficient broadband connection
		Demanding information technology security requirements (cybersecurity) (Likert scale)
		Lack of technology suppliers (Likert scale)
		Lack of financial resources in the company (Likert scale)
		High investment costs (Likert scale)
		Digitalization may be poorly received by employees (Likert scale)
		Lack of well-qualified personnel as well as difficulty in find and retaining well-qualified personnel (Likert scale)
DEPENDENT VARIABLES		
BADI	Basic Digitalization Level	Own website (Likert scale)
		Own e-commerce portal (Likert scale)
		E-commerce in the marketplace (Likert scale)
		Social networks for commercial purposes (Likert scale)
		Digital banking (Likert scale)
		Telework (Likert scale)
ADDI	Advanced Digitalization Level	ERPs (Integrated Management Systems) (Likert scale)
		Corporate intranet (Likert scale)
		Services to cover cybersecurity (Likert scale)
BODI	Border Digitalization Level	Big data and data analytics software (Likert scale)
		Degree of process automation (Likert scale)
		Robotization, sensorization (Likert scale)
		Localization, Internet of Things (Likert scale)

Source: Author.

questionnaire items.

Finally, the data were processed and analyzed on an Excel spreadsheet, which was then exported to the SmartPLS v3.0 statistical software.

Results

Table 3 presents the goodness-of-fit statistics for the reflexive and structural model, showing that it meets the criteria for convergent validity, internal consistency reliability, discriminant validity, and collinearity.

Table 3
Loadings and Collinearity of Indicators.

Construct/Indicator	Load Factor ≥ 0.60	VIF	*P*-Value
DILE			
P014_SQ001	0.742	1.618	0.000*
P014_SQ002	0.890	2.762	0.000*
P014_SQ003	0.879	2.613	0.000*
P014_SQ005	0.826	1.861	0.000*
THTA			
P014_SQ004	0.895	1.678	0.000*
P014_SQ008	0.913	1.678	0.000*
COGO			
P00902_SQ001	1.000	1.000	0.000*
DIBA			
P015_SQ001	0.674	1.468	0.000*
P015_SQ002	0.694	2.205	0.000*
P015_SQ003	0.689	2.086	0.000*
P015_SQ004	0.700	1.567	0.000*
P015_SQ005	0.746	1.942	0.000*
P015_SQ006	0.780	2.295	0.000*
P015_SQ007	0.804	2.059	0.000*
P015_SQ008	0.744	1.964	0.000*
Construct/Indicator	**Load Factor ≥ 0.60**	**VIF**	***P*Value**
DIGITALIZATION			
BADI			
P013_SQ001	0.746	1.505	0.000*
P013_SQ002	0.806	1.913	0.000*
P013_SQ003	0.688	1.550	0.000*
P013_SQ004	0.687	1.339	0.000*
P013_SQ006	0.621	1.193	0.000*
ADDI			
P013_SQ007	0.850	1.830	0.000*
P013_SQ008	0.868	1.958	0.000*
P013_SQ009	0.866	1.852	0.000*
BODI			
P013_SQ010	0.776	2.112	0.000*
P013_SQ011	0.713	1.932	0.000*
P013_SQ012	0.695	1.693	0.000*
P014_SQ006	0.838	2.285	0.000*
P014_SQ007	0.830	2.238	0.000*

* $p < 0.001$.
Source: Author.

Table 3 shows that the loadings exceeded the value of 0.60, suggesting sufficient levels of indicator reliability (Bagozzi & Baumgartner, 1994; Bagozzi & Yi, 1988). Regarding collinearity, all VIF values in the structural model exceeded 1, complying with this criterion (Hair et al., 2017), and were below 3.3 (Diamantopoulos & Siguaw, 2006).

Table 4 presents the analysis of internal consistency, reliability, and convergent validity for each latent variable.

Concerning convergent validity, Table 4 shows that the average variance extracted (AVE) exceeded 0.60, suggesting sufficient levels of indicator reliability (Bagozzi & Baumgartner, 1994; Bagozzi & Yi, 1988). Furthermore, regarding internal consistency reliability, both Cronbach's Alpha and Composite Reliability for each latent variable exceeded the minimum acceptable value of 0.60, based on the criteria established by Bagozzi and Yi (1988) and Nunnally and Bernstein (1994).

Fornell and Larcker's criterion was used to determine discriminant validity, which indicates that the square root of the AVE for a construct must exceed its correlation with any other construct (Fornell & Larcker, 1981; Henseler et al., 2015). Table 5 shows compliance with this criterion.

Table 6 shows the results obtained for the R-squared (R^2) value of the endogenous latent variables, providing statistically significant evidence that barriers to digitalization, centralized technology governance, and digital leadership explain the levels of digitalization and human talent training in Ibero-American MSMEs.

Table 4
Reliability and Validity of Constructs.

Internal Consistency Reliability Latent Variable	Convergent Validity		Average Variance Extracted (AVE) ≥ 0.50
	Cronbach's Alpha ≥ 0.60	Composite Reliability ≥ 0.60	
Barriers to Digitalization (DIBA in Spanish)	0.876	0.901	0.533
Advanced_Digitalization Level (ADDI in Spanish)	0.826	0.896	0.742
Basic_Digitalization Level (BADI in Spanish)	0.754	0.836	0.507
Frontier_Digitalization Level (BODI in Spanish)	0.837	0.880	0.597
Digitalization Training of Talent (THTA in Spanish)	0.777	0.900	0.817
Centralized Technology Governance (COGO in Spanish)	1.000	1.000	1.000
Digital Leadership (DILE in Spanish)	0.856	0.903	0.700

Source: Author.

To analyze the structural model and verify the proposed hypotheses, the significance level of the relationships was evaluated using the bootstrapping technique with 5,000 samples. This was conducted to evaluate the standard error and determine whether formative indicators significantly contribute to the corresponding factor (see Table 7).

The results in Table 7 empirically support our hypotheses. However, H8, H9, H11, H12, and H14 exhibit weak relationships and effects. According to Hair et al. (2017), path coefficients above 0.10 are typically considered significant, while those below 0.10 are regarded as insignificant.

The results show that digital leadership had a strong effect on the digitalization training of human talent. This highlights the important role of digital leaders as key actors in promoting conditions for selecting competent personnel for the use of information and communications technology (ICT), supporting digital development, and driving investments in continuous training of personnel in digital transformation issues.

Furthermore, the results showed a strong effect of training on the digitalization of human talent at the three levels of digitalization. This reflects that organizing regular training for digital transformation and preparing human talent for the use of ICT in their roles and digital development are key factors for adopting digital technologies at the basic, advanced, and frontier levels.

The results demonstrated a strong effect between digital leadership and the various levels of digitalization achieved by companies. This highlights the crucial role of digitally proficient leaders who understand the potential benefits of digitalization and prioritize resource allocation for digital transformation initiatives. Such leaders are more likely to invest in employee training, update business models to reflect digital advancements, and adopt technologies across all levels—basic, advanced, and frontier—to drive their company's digital transformation.

Finally, the results showed that centralized technology governance had a weak effect on the levels of advanced and frontier digitalization and on the training of digital talent, being relevant only for the basic level of digitalization. Similarly, barriers to digitalization had a weak effect on the levels of advanced and frontier digitalization, demonstrating a significant impact only at the basic level of digitalization in the companies studied.

Discussion

Digitalization can be defined as the conversion of analog information into digital data, enabling the transfer of digitized information in a quick, cost-effective, and accurate manner (Brennen & Kreiss, 2016). Digitalization is a global megatrend that has changed how people live, socialize, and work (Nyagadza, 2022). It directly impacts the internal and external value-creation activities of companies by requiring them to adapt their internal operations, processes (Vogelsang et al., 2018), business models, customer value propositions, and external offerings of products and services to remain competitive (Loonam et al., 2018; Martinez et al., 2022; Nyagadza, 2022).

With the advent of Industry 4.0, also known as the Fourth Industrial Revolution, improving employee skills and organizational capabilities is no longer a competitive advantage but a requirement for survival in an environment of constant change and innovation (Orero-Blat et al., 2022). Industry 4.0 poses significant challenges for the industry in terms of technology implementation and human resource development, as talent increasingly requires theoretical knowledge and practical skills in data acquisition, processing, visualization, and interpretation to fully exploit its digitalization potential (Büth et al., 2018). In this context, the digital transformation of workplaces has led companies to increasingly focus on employee development (Plumanns et al., 2019).

The SEM formulated in this study provided statistically significant evidence of the influence of digitalization training for human talent on the different levels of digitalization achieved by Ibero-American MSMEs (basic, advanced, and frontier levels). The study's results highlight the efforts made by companies to continuously train employees in digital transformation, enabling more employees to use ICTs in their jobs and ensuring they are adequately prepared for the digital development of organizations.

This finding aligns with a study conducted in Indonesia, which found a statistically significant relationship between knowledge acquisition and business performance in digital transformation using an SEM (Lukito et al., 2023). It is also consistent with research conducted in the banking sector in India, which concluded that digitalization has a

Table 6
R-squared Value.

Construct	R-square
Advanced_Digitalization Level (ADDI)	0.301
Basic_Digitalization Level (BADI)	0.340
Frontier_ Digitalization Level (BODI)	0.636
Training in digitalization Training of Human Talent (THTA)	0.645

Source: Author.

Table 5
Discriminant Validity.

Construct	BADI	ADDI	BADI	BODI	THTA	COGO	DILE
Barriers to Digitalization (DIBA)	0.730						
Advanced_ Digitalization Level (ADDI)	0.256	0.861					
Basic_ Digitalization Level (BADI)	0.299	0.571	0.712				
Frontier_ Digitalization Level (BODI)	0.341	0.730	0.604	0.773			
Talent Training (THTA)	0.330	0.513	0.518	0.766	0.904		
Centralized Technology Governance (COGO)	0.143	0.281	0.311	0.376	0.364	1.000	
Digital Leadership (DILE)	0.346	0.510	0.549	0.731	0.800	0.373	0.836

Source: Author.

Table 7
Significance Test Results of the Model Hypotheses.

Hypotheses			Path Coefficients	Standard Deviation (STDEV)	T-statistics (|O/STDEV|)	*P* Value	Result
H1	DILE -> BADI	Digital Leadership -> Basic Digitalization Level	0.323	0.011	28.357	0.000 *	Confirmed
H2	DILE -> ADDI	Digital Leadership -> Advanced Digitalization Level	0.241	0.012	20.621	0.000 *	Confirmed
H3	DILE -> BODI	Digital Leadership -> Border Digitalization Level	0.293	0.009	31.732	0.000 *	Confirmed
H4	THTA -> BADI	Training in digitalization of Human Talent -> Basic Digitalization Level	0.184	0.012	15.709	0.000 *	Confirmed
H5	THTA -> ADDI	Training in digitalization of Human Talent -> Advanced Digitalization Level	0.266	0.012	22.209	0.000 *	Confirmed
H6	THTA -> BODI	Training in digitalization of Human Talent -> Border Digitalization Level	0.480	0.009	53.036	0.000 *	Confirmed
H7	COGO -> BADI	Centralized technology governance -> Basic Digitalization Level	0.108	0.007	14.459	0.000 *	Confirmed
H8	COGO -> ADDI	Centralized technology governance -> Advanced Digitalization Level	0.083	0.008	11.029	0.000 *	Confirmed
H9	COGO -> BODI	Centralized technology governance -> Border Digitalization Level	0.082	0.005	14.946	0.000 *	Confirmed
H10	DIBA -> BADI	Barriers to Digitalization -> Basic Digitalization Level	0.111	0.007	15.328	0.000 *	Confirmed
Hypotheses	Path Coefficients	Standard Deviation (STDEV)	T-statistics (|O/STDEV|)	*P* Value	Result		
H11	DIBA -> ADDI	Barriers to Digitalization -> Advanced Digitalization Level	0.073	0.007	9.979	0.000 *	Confirmed
H12	DIBA -> BODI	Barriers to Digitalization -> Border Digitalization Level	0.069	0.005	13.263	0.000 *	Confirmed
H13	DILE -> THTA	Digital Leadership-> Training in digitalization of Human Talent	0.771	0.004	181.420	0.000 *	Confirmed
H14	COGO -> THTA	Centralized technology governance -> Training in digitalization of Human Talent	0.077	0.006	13.787	0.000 *	Confirmed

* $p < 0.001$.
Source: Author.

significant influence on banking performance measured through Balanced Scorecard perspectives and that this influence is enhanced by the mediating effect of human talent training (Bahl et al., 2022).

Digital leaders face the challenge of guiding employees through digital transformation processes and supporting the learning required to successfully address the challenges of the digital era. They must also help seize the opportunities that arise in an environment characterized by a higher degree of VUCA (Jäckli & Meier, 2020; Schwertner, 2017; Westerman et al., 2012).

While the current state of scientific literature offers limited insights into the connection between digitalization and leadership (Faix, 2020), terms such as "digital leadership" or "leadership in the digital era" are associated with the new leadership challenges arising from the digitalization and transformation processes in organizations (de Araujo et al., 2021; Prince, 2018). This is particularly relevant as digital transformation has rendered many managerial capabilities once considered valuable obsolete (Korherr et al., 2022).

This study provides statistically significant evidence of the impact of digital leadership on different levels of digitalization in Ibero-American MSMEs (basic, advanced, and frontier). This highlights the importance of the digitalization process of companies, emphasizing the need for digital managers and leaders to enhance their level of knowledge about the possibilities and advantages of digitalization via training, as well as their focus on evaluating and updating business models in terms of digitalization. Additionally, they must allocate significant resources to these processes.

This finding is consistent with a study conducted in German Industry 4.0 companies, which found that managers' business skills—such as the ability to detect and seize opportunities and threats, tolerate ambiguity, and be receptive to change—enable companies to perform the digital transformation of business models. These are essential to address the challenges of the digital economy, exploit new technologies for business benefit, and achieve good financial performance in today's digital economy (Heubeck, 2023).

The two aforementioned findings—the importance of digitalization training for human talent and digital leadership in business digitalization processes—align with the findings of other authors. These studies demonstrated that top management support and technological readiness were significant factors in the adoption of technologies such as cloud computing (Lian et al., 2014; Oliveira et al., 2014; Raut et al., 2017) and mobile commerce and technology in different sectors and regions globally (Chaua & Denga, 2018; Doolin & Eman, 2008; Zeeshan et al., 2007).

Moreover, the SEM analyzed in this study provided statistically significant evidence of the influence of digital leadership digitalization training on human talent among Ibero-American MSMEs. This highlights the key role played by leaders with digitalization training, who understand its possibilities and advantages. These leaders are committed to evaluating and updating business models in terms of digitalization and allocating significant resources for this purpose. This enables companies to invest in digitalization training and ensure their human talent is prepared to use ICTs in their roles and contribute to digital development.

This finding aligns with the views of Jäckli and Meier (2020) and Tagscherer and Carbon (2023), who, based on a review of the scientific literature, argued that for digital leadership to drive successful digital transformation in companies, it must be characterized by several key dimensions. These include: acceptance of change, agility to act flexibly and adaptively, a culture that embraces learning from mistakes, adaptive planning based on a clear vision of the future, encouragement of

autonomy and employee empowerment, digital knowledge and support for employees' digital literacy, encouragement of internal cooperation for knowledge exchange, promotion of flat structures and digital governance for data protection, privacy and big data management, transparency toward stakeholders, participation in partnerships and ecosystems, a customer-centric mindset, and promotion of flexible work in time and space while respecting work-life balance.

The rapid expansion of digital technologies also presents considerable challenges in designing effective governance and organizational mechanisms that facilitate greater data and knowledge exchange between individuals and organizations. Governance involves the establishment of control mechanisms to verify inputs and outputs, coordination mechanisms to divide and assign tasks, incentive mechanisms to align competing interests and mitigate relational vulnerabilities, and trust mechanisms in transactions (Hanisch et al., 2023).

In this regard, this study found that creating centralized technology governance, with internal managers responsible for digitizing companies and outsourcing external companies to support ICT and digitalization processes, is not significantly relevant for reaching advanced and border levels of digitalization in Ibero-American MSMEs. This is relevant only for reaching a basic level of digitalization. Similarly, this study did not find evidence of centralized technology governance influencing the level of human talent training in digitalization.

Some authors have categorized various governance mechanisms into analog and digital mechanisms to address the challenges of control, coordination, incentives, and trust (Hanisch et al., 2023). Analog governance mechanisms include the creation of bureaucratic organizations with the necessary authority and hierarchy to make decisions (Powell, 1990; Williamson, 1991), the use of contracts to enforce legal agreements (Grossman & Hart, 1986; Hart & Moore, 1990; Tirole, 1999) and the creation of relational bonds and networks for collaboration and exchange for the emergence of trust (Gulati, 1995; Uzzi, 1997).

SMEs have been hampered by adopting rigid organizational structures and cultures that resist experimenting with state-of-the-art technology (Lizarralde et al., 2020; Matarazzo et al., 2021). Structures with multiple hierarchical levels and a top-down approach, frequently used by SMEs (Matarazzo et al., 2021), tend to be ineffective in rapidly changing digital environments because bureaucracy affects response speed and reduces innovation (Verhoef et al., 2021). In contrast, in complex and dynamic environments, adopting organizational structures that favor cross-functional collaboration has become crucial to moving forward in digital transformation processes. These flexible structures allow for quick adaptation, making it easier to detect business opportunities and threats early and implement changes (Chan et al., 2019; Holbeche, 2018).

Since the onset of the digital era, new mechanisms have emerged to manage exchange relationships, leveraging novel forms of competition and collaboration among competing interests, such as developing algorithmic protocols using open-source software codes (Hanisch et al., 2023; Taulli, 2022). Similarly, digital governance has experienced significant advancements in recent years, relying on digital technologies to automate decisions on issues such as task schedulability to improve the control of input and output processes, automation of task division and assignment to facilitate coordination, conditioning incentives, and the transactional transparency required to build trust (Al-Breiki et al., 2020; Hanisch et al., 2023).

Aligned with the findings of this study, some scholars view digital governance as a category of governance that underpins innovative ways of organization, value creation, and value capture, reducing reliance on human intervention and driving efficiency, certainty, and transparency among exchange participants compared to analog governance mechanisms (Hanisch et al., 2023).

Finally, regarding the barriers to digitalization faced by companies, this study found no statistically significant evidence on the incidence of technological (insufficient broadband connection, demanding information security requirements, and lack of technology suppliers), financial (lack of financial resources and high investment costs), human (prevention of workers from digitalization and difficulty in finding and retaining well-qualified personnel), or business culture (lack of corporate culture to drive digital transformation) barriers on the advanced and frontier levels of digitalization in Ibero-American MSMEs. The only statistically significant relationship identified was between these barriers and the basic level of digitalization.

Although multiple authors in the scientific literature have addressed the barriers to digitalization in companies, studies on this topic in the context of MSMEs or in relation to the different levels of digitalization of companies are relatively scarce. However, small companies typically face greater barriers to digital innovation than large companies due to their limited resources and lack of skills (Ramilo & Embi, 2014). In this regard, a qualitative study involving in-depth semi-structured interviews with top management of small service firms in Taiwan identified four primary barriers to digital transformation: lack of funding, lack of digital capability, lack of human resources, and technical barriers (Chen et al., 2021).

Consistent with the findings of this study, research conducted within companies in the engineering sector in Germany concluded that companies with higher standards of digitalization perceive barriers to digital transformation associated with leadership, culture, employees, and skills at lower levels compared to those with lower standards of digitalization (Brink & Packmohr, 2022).

The main contribution of this study lies in the analysis of the determinants of digitalization at different levels (basic, advanced, and frontier), particularly in MSMEs—two approaches that have rarely been addressed in the scientific literature.

One limitation of this study is the limited number of variables analyzed regarding technology governance at the time of measuring its impact on companies' digitalization levels, concentrating on centralized organizational structures. This presents an opportunity to conduct studies that broaden the focus of analysis by incorporating different organizational structures, such as mechanisms focused on the human factor, in addition to other analog mechanisms, such as contracts, protocols, collaboration networks, and digital mechanisms that leverage the benefits of technology.

Likewise, the number of variables studied in relation to digital leadership is another limitation, especially when compared to the wide range of digital leader characteristics analyzed in the scientific literature. This paves the way for future research to broaden the scope of this concept.

Finally, this study opens new opportunities for future research by examining the behavior of the variables and model across different industries or economic sectors, company sizes, and companies of different levels of seniority. It also provides the possibility of contrasting the results between the different Latin American countries studied, from which a statistically representative sample was obtained.

Conclusions

Digitalization is a global megatrend that challenges MSMEs by requiring them to adapt their processes, business models, and range of products and services to survive in the market. Acknowledging this, this study sought to identify the factors that have played a key role in the digitalization process and digital transformation of MSMEs in Ibero-America.

The proposed SEM leads to the conclusion that the various digitalization levels of the analyzed companies were affected by training in the digitalization of human talent. The practical implication of the study's conclusion is that it encourages companies to increase their efforts to continuously train employees in digital transformation and organizational development, while promoting the use of ICT across different roles.

Digital leadership is another crucial factor contributing to the digitalization of MSMEs in Ibero-America. This underscores the importance

of managers and digital leaders prioritizing digitalization training to fully understand its potential and advantages. Furthermore, it encourages managers to actively evaluate and update their business models to align with digital advancements and allocate the resources necessary to support these processes. This study also concludes that digital leadership is instrumental in promoting the training of human talent in digitalization within the companies studied. This leadership acts as a catalyst, further emphasizing the importance of this factor in the successful digitalization of Ibero-American MSMEs.

In contrast, this study concludes that analog technology governance focused on human factors is not relevant for companies to reach advanced or frontier digitization levels. This type of governance relies on assigning internal managers to oversee the digitalization of a company while outsourcing support for ICT and digitalization processes. This study found that this approach is only relevant for achieving a basic level of digitalization. This suggests that companies should explore new and innovative forms of technological governance to generate better results. Adopting analog mechanisms that are not solely focused on human factors and the leveraging of technology to implement digital mechanisms are potential avenues for improvement.

While the literature has documented various barriers to digitalization, including technological, financial, human, and business culture issues, these barriers were significant only at the basic level of digitalization for Ibero-American MSMEs. This study found no clear relationship between these barriers and the advanced or frontier levels of digitalization. This suggests that companies at more advanced stages of digitalization have successfully overcome these obstacles and no longer perceive them as significant. In contrast, companies in the early stages of digitalization must make considerable efforts to overcome these barriers.

Thus, the study suggests that, regardless of the potential obstacles to the digitalization process faced by companies and the centralized technology governance focused on human factors, appropriate digital leadership and adequate efforts to train human talent in digital knowledge and skills become key success factors in reaching advanced and border levels of digitalization by MSMEs in Ibero-America.

In conclusion, the adoption of basic, advanced, and frontier technologies is favored when organizations possess competent human talent in ICTs and digital development and regularly organize training for digital transformation.

Likewise, the presence of digital leaders trained in digitalization who recognize its possibilities and advantages, and are willing to allocate significant resources for business digitalization is a key factor in achieving various levels of digitalization. Such leaders also play a key role in evaluating and updating the business model to align with digitization goals, thereby enhancing training in digitalization within the organization.

Analog corporate governance focused on human factors may be sufficient for companies at the early stages of digitalization, using basic technologies. However, it is inadequate for companies with advanced or frontier levels of digitalization that are committed to digital transformation.

Finally, while companies in the early stages of digitalization must overcome barriers to technological, financial, human, and business cultures, these barriers cease to be relevant when companies adopt advanced and frontier technologies.

It is expected that these conclusions will not only guide businesses in taking key actions for successful digitalization and transformation but also help governments formulate public policies that stimulate these processes in companies seeking greater regional competitiveness.

CRediT authorship contribution statement

Elsa Beatriz Gutiérrez Navas: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jaime Enrique Sarmiento Suarez:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Julio Ramírez Montañez:** Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Yanyn Aurora Rincón Quintero:** Writing – original draft, Validation, Formal analysis, Conceptualization.

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