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Digital Cultures, Ethics, and Corporate Responsibility: Perspectives in Contemporary Innovation

Yorberth Montes de Oca Rojas
Miriam Janet Cervantes López
Sendy Meléndez Chávez
Enrique Verdecia Carballo
Cyntia Lizeth Ramos Monsivais
Karen Cesibel Valdiviezo Abad
David Caldevilla-Domínguez

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Foreword

The book presented today to the academic and international community is a work of inestimable intellectual value, serving as a Living Archive of pedagogical and institutional thought in contemporary higher education. In an era marked by the complexity and interconnection of knowledge, this transnational compilation manages to articulate with astonishing clarity disciplines that have traditionally been analyzed in isolation, building solid bridges between public policy, digital transformation, human rights, ecological sustainability, and quality management. The work is not merely a collection of independent chapters; on the contrary, it functions organically as a conceptual framework that adopts a holistic and comprehensive vision of development, where human beings and their dignity are positioned as the axiological and indisputable cornerstones of all scientific, technological, and commercial practice. From the perspective of higher education, this text embodies the fundamental role of universities as autonomous platforms for the co-creation and transfer of knowledge to social and productive environments, validating the systemic principles of multilevel governance and proactively responding to the demands of a globalized and volatile environment.

One of the work's most significant and rigorous contributions lies in its ability to deconstruct and challenge the dominant paradigms within communication, economics, and education, replacing them with situated, critical, and reflective approaches. In the field of communication sciences and cultural studies, for example, the analysis of biographical discourse is highly enriching not as a mere exercise in marketing positioning or personal branding aligned with affective consumption, but as a space of resistance and symbolic struggle. By recovering the fragmentary, precarious, and collective narratives of Latin American punk in countries such as Argentina, Chile, and Peru, Foucault's notion of parrhesia is provocatively updated. This demonstrates how the act of speaking the truth at one's own risk can subvert the bourgeois and monumentalized biographical illusion, making way against the current for underground memories and dissident subjectivities that challenge the mandates of visibility and media hegemonies. This same analytical rigor is successfully applied to studies on political communication, where the authors use big data and transdisciplinary tools to precisely examine thematic saturation and populist rhetoric in government agendas, revealing the mechanisms of disintermediation, polarization, and control exercised by contemporary leaders through socio-digital environments and emerging platforms.

Likewise, the book delves with impeccable technical expertise into the convergence between technological innovation and the ethical imperatives of the twenty-first century, a field where the contributions of university faculty demonstrate first-rate scientific maturity. In the field of digital health and bioethics, the proposal to extrapolate the micro, meso, and macro levels of analysis toward roboethics and artificial intelligence constitutes a truly pioneering framework. This model allows for a step-by-step approach, starting with direct interactions between humans and autonomous systems analyzing dilemmas of algorithmic opacity, discriminatory biases, and informed consent and extending to global governance and the power asymmetries that widen the digital divide between the Global North and the Global South. The work urgently reminds us that artificial intelligence is not neutral, as it carries the biases of the data with which it has been trained, perpetuating stereotypes and structural inequalities if not implemented under an approach of substantive algorithmic justice and human rights by design. This balance between technology and humanism is also brilliantly realized in the

development of prototypes and embedded systems, such as the case study documenting logistics automation in university settings using microcontrollers, balancing hardware efficiency with international design standards and software processes, which demonstrates the viability of creating accessible, low-cost technological solutions.

The ecological dimension and the transition toward circular and low-carbon economies are addressed with the same depth and empirical rigor throughout the work. The analysis of value chains and agro-industrial supply systems specifically in demanding sectors such as fruit growing or livestock production within the context of treaties like the USMCA or the Pacific Alliance shows that current competitiveness cannot be separated from sustainability. The authors masterfully analyze the challenges of cross-border agrologists, customs interoperability, phytosanitary traceability, and the cold chain, warning of the high energy costs and ecological footprint that these systems impose on the planet. In response, the book offers alternatives of great scientific value, such as process optimization through artificial intelligence, the use of digital twins via photogrammetry and additive manufacturing in medical and veterinary education, reducing dependence on biological materials, and the development of bio-leathers and biomaterials from agro-industrial waste, promoting upcycling and minimizing environmental impact in line with the circular economy. The text consistently argues that digitization and software development must adopt green engineering standards and eco-codes, making energy efficiency and universal accessibility indispensable quality criteria.

The book's methodological approach deserves special mention, as it skillfully combines intrinsic case studies, action research, structural equation analysis, and system dynamics modeling to enrich and validate the theses presented. Through an analytical review of mutilating brands and companies that have achieved global success through the use of intelligent algorithms and sustainable value propositions, it is demonstrated that corporate social responsibility and the creation of shared value are not mere public relations strategies, but fundamental drivers of resilience and profitability. In these environments, transformational leadership emerges as an indispensable collective capacity to motivate human talent, foster collaborative learning, and drive dual innovation, enabling organizations to regenerate after suffering contextual disruptions or health crises. Likewise, research focused on the educational sphere demonstrates that when higher education training methodologies integrate formative assessment with learning and knowledge technologies, students' metacognition, critical thinking, creativity, and self-regulation are significantly enhanced, preparing them to successfully and meaningfully enter a dynamic and changing labor market.

Despite the indisputable theoretical and analytical strengths that establish this book as an essential reference work, a critical and constructive spirit prompts us to highlight certain areas for improvement that could be incorporated into future lines of research to further expand its explanatory scope. In some passages focused on statistical and econometric analysis, a certain regional disparity in data collection is evident, with samples concentrated in specific provinces or sectors and leaving out territories with complex informal or rural dynamics that would contribute highly valuable nuances to the discussion on economic dualism and subsistence markets. Similarly, while the text is thorough in describing technical feasibility and formal regulatory frameworks, there is at times a lack of deeper exploration of the perspective of recipient communities and the processes of social appropriation of technologies. Closing the gap between institutional design and citizens' daily practices, as well as developing public value metrics that reliably demonstrate the long-term impact of community telemedicine or

micro-credential programs on sustainability, are pending challenges that the academic community must address with the same rigor that characterizes the authors of this volume.

As a reviewer and member of the international academic community, my overall opinion of this volume is resoundingly positive and enthusiastic. We are faced with a seminal work, of unquestionable conceptual depth and contemporary relevance, which succeeds in drawing upon the knowledge and experience of university professors from diverse regions to restore a sense of ethical responsibility to the social and applied sciences. The book successfully avoids technical reductionism and blind productivism, offering instead a platform for critical thinking oriented toward the common good, social justice, and gender equity. The weaknesses noted do not detract from the work as a whole, but rather serve as open invitations to continue fostering a collaborative and transdisciplinary research agenda in the future.

For all these reasons, I extend a warm and essential invitation to immerse yourself in reading these pages. This work is intended not only for researchers, sociologists, economists, engineers, and public policy specialists seeking to update their theoretical frameworks with scientific rigor, but also for decision-makers, business leaders, and institutional actors who require operational tools to design more sustainable, efficient, and humanly just environments. The texts that make up this book are, ultimately, lessons in adaptability and intellectual commitment; an indispensable roadmap for navigating the uncertainty of the twenty-first century and for remembering that the future of development and technology will only be valid if it is built in accordance with human dignity and respect for our common home.

Dr. Roosevelt Barros Morales.

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Public Policy, Economics, Legal Frameworks, and Quality Management

Against the grain: biographical discourse as a critical response to communicational hegemonies

Simón Pérez Seballos
Universidad de Santiago (Chile), simon.perezse@usach.cl, https://orcid.org/0009-0009-8254-432X

Introduction

In an era of information overload, where discourses and images circulate incessantly, life stories occupy a paradoxical space: they proliferate across digital platforms and marketing campaigns, yet often lack depth, reduced to functional, emotionally standardized narratives. As McLuhan (1994) noted, the medium not only shapes the message it transforms perception.

While storytelling is celebrated as a "magical and powerful craft" (Miller, 2008, p. 4), it has been absorbed by market logic. Biographical discourse plays a key role in political campaigns, personal branding, and social media, reinforcing formats aligned with consumerism and affective impact.

Han (2024) names this shift storyselling: narratives crafted to drive consumption, from detergents to ideologies. In this context, what space remains for stories that resist persuasion and commerce, asserting their right to exist through dissonance or even uselessness? As Krenak (2023) reminds us, not all lives should be reduced to marketable sequences of meaning.

This leads to a central question: how do punk biographies challenge dominant forms of biographical representation in contemporary media culture?

Latin American punk biographies offer powerful counter-narratives. Rather than heroic or exemplary lives, they present fragmentary, affective, and collective accounts rooted in everyday experience. As Azerrad (2001) suggests, they reject the myth of the exceptional genius, affirming that every marginal story deserves to be told.

In a landscape shaped by personal branding, recovering narratives that enable alternative forms of subjectivity and memory becomes urgent. These "useless" biographies resist visibility mandates and activate non-hegemonic memories, revealing political force in their very dissonance.

This chapter proposes a critical reading of punk biographical discourse as a space of symbolic struggle. Drawing on cultural and communication studies, and framed within a critical-discursive approach, it analyzes three works from Argentina, Chile, and Peru, arguing that these biographies do not merely resist—they disrupt and rewrite the margins of narratability today.

This chapter examines how Latin American punk biographies function as counter-narratives to hegemonic self-representation in contemporary communication. It explores how they subvert linear, exemplary life structures, use fanzine-inspired visual strategies, and articulate parrhesiastic truth-telling to reclaim silenced memories and dissident subjectivities. Ultimately, it highlights punk biography as a space of symbolic, affective, and political struggle amid narrative commodification.

Conceptual framework

Biographical discourse has become a privileged way of narrating the world, whether as genre, method, or analytical tool. As Roseneil (2012) notes, it is particularly effective for exploring experiences that elude structural frameworks, such as those found in Latin American punk.

Increasingly aligned with performance and digital reputation, biography often functions as a positioning tool. As Pera, Viglia, and Furlan (2016) argue, self-narration is instrumental in the "sharing economy" (p. 53), where storytelling commodifies identity under visibility imperatives.

Biographies, however, also hold political potential. Prados Megías *et al.* (2017) underline their role in constructing reality through interwoven individual and collective dimensions. Bruno (2016) defines biography as a method capable of revealing social processes through personal trajectories. This liminality, between public and private, echoes Arfuch's (2007) notion of the entanglement between subject and society.

Nonetheless, the genre's popularity has led to tensions. Critics like Amaro (2022) and Franzke (1989) warn against its drift toward linear, exemplary lives, reinforcing what Bourdieu (1989) termed the "biographical illusion." Han (2024) and Salmon (2014) refer to this commodified turn as storyselling: persuasive narratives formatted for consumption.

By contrast, the punk biographies analyzed here adopt fragmentary, affective, and collective structures that unsettle dominant formats. As Clarke *et al.* (2014) propose, they "create paths in, and through, the structured spaces and cultures" where individuals navigate marginality (p. 121). These works function as living archives (Pizarro, 2021), embodying memory beyond the textual.

Such narratives align with the "genres of the self" (Arfuch, 2007), privileging dissonant and precarious lives over epic trajectories (Scott, 1991; Hall & Du Gay, 1996). Biography thus becomes a site of symbolic and political contestation. As Císař and Koubek (2012) observe, meaning in punk scenes emerges from ongoing negotiation across personal and collective spheres, precisely the terrain inhabited by these biographical works.

This chapter adopts a qualitative approach grounded in cultural and communication studies. It views biographical discourse not as a mirror of reality but as a site of meaning-making, where subjectivities and memory are constructed, often in tension with dominant visibility regimes. The selected works are read as cultural artifacts that challenge normative ways of narrating life, politics, and community.

The analysis applies a thematic-discursive method to three Latin American punk biographies El peor de Chile (2018), Más allá del bien y el punk (2017), and Eutanasia. Y Nosotros Ké? (2012) chosen for their break with hegemonic narrative forms. These works, part of a larger doctoral corpus, exemplify alternative strategies such as fragmentation, testimonial multiplicity, and visual experimentation.

The research involves an iterative reading of each text, focusing on narrative structure, visual aesthetics, and editorial materiality. Fourteen analytical categories were developed inductively, based on close engagement with the corpus and theoretical concepts such as parrhesia, non-linearity, and disruptive visuality. These categories capture both shared and distinctive features, revealing affective and political nuances that exceed structural approaches.

Table 1. Analytical categories applied to punk biographical works

Category	Focus
Structure and composition	Narrative form, fragmentation, montage
Hero's Journey	Presence or subversion of epic models
Narrative tone	Affective, poetic, testimonial, or oppositional registers
Conception of the political	Explicit, intimate, or everyday political expressions
Parrhesia	Risk, exposure, and disruptive truth-telling
Contextual references	Historical and socio-political allusions
Main themes	Recurring motifs and core conflicts
Color and symbolism	Chromatic use and symbolic codes
Photographs	Type, focus, and visual function
Typography and visual hierarchy	Font choices and layout emphasis
Materiality and format	Physical design and sensory impact
Visual references	Archival images and historical icons
Visual impact	Overall graphic strength of the book
Reflexive reading	Subjective impressions of the researcher

Narrative and aesthetic strategies in dispute

Within the corpus of Latin American punk biographical works analyzed, a tension emerges between two narrative models: the traditional exemplary life story, aligned with the "hero's journey" and the "biographical illusion" (Campbell, 2023; Bourdieu, 1989), and a fragmentary, disruptive form of writing that eschews linearity and moral closure. The former constructs coherent, teleological narratives centered on heroic transformation and uniqueness; the latter resists such closure through chaos, discontinuity, and polyphony.

Fragmentary biographies reject exemplary models and instead deploy dispersed microhistories, meaningful silences, collective voices, intervened images, and formal ruptures. As Arfuch (2007) suggests, these forms "disrupt and dissolve the very idea of autobiography, blur its thresholds, and wager on ambiguity, on identity and indexical confusion" (p. 98).

Here, fragmentation is not merely aesthetic but political. These narratives resist the monumentalization of the self and the neoliberal logic of success, affirming ordinary, unfinished, and contradictory lives. As Rancière (2010) argues, they reconfigure the distribution of the sensible, expanding what counts as political representation.

Aligned with a punk "do-it-yourself" ethic, these biographies break with conventional editorial norms and explore new ways of narrating from the margins. The political is not confined to organized activism but emerges as "wild politics" (Tapia, 2011), rooted in the everyday, the intimate, and the unpredictable.

Through dispersion and heterogeneity, these works do not seek to inspire or instruct but to affirm the right to narrate the irrelevant, the dissonant, and the unfinished. In that affirmation lies their critical force.

Punk graphics and material aesthetics as political expression

Punk graphics are not mere visual supplements but instruments of political intervention. Since its inception, this aesthetic has challenged design norms and dominant values. Marcus (1993) links it to Situationist détournement, where re-signifying images critiques the symbolic order. Rejecting the "proper" reflects resistance to commodification, not lack of skill.

Even in music hubs like San Francisco, independent zine and label networks thrived, mirrored in Latin America (Buchholz, 2019). Likewise, Císař and Koubek (2012) highlight how punk merges cultural and political resistance across contexts.

In the digital age, punk reclaims the physical: fanzines, collages, and photocopies assert marginality. Disalvo and Cuello (2015) describe fanzines as channels of urgency and affect, shaped by imperfection.

The book Eutanasia. Y Nosotros Ké? exemplifies this logic: its collage cover (featuring Fujimori, protests, and arrests) serves as a visual indictment of 1980s–90s Peru. El peor de Chile combines punk, cinema, and art through a personal lens, while Más allá del bien y el punk deploys archival materials to build memory.

Collage resists coherence. Hebdige (2004) sees in it chaos and urgency; Skov (2023) interprets its decay symbols as radical critique.

The DIY principle operates as creative ethic. Fanzines, demos, and homemade records reject industrial norms and decentralize authorship (Disalvo & Cuello, 2015), reshaping cultural production.

This aesthetic assumes local nuances: in Lima, rock subterráneo expressed urban anxieties via raw illustration (Greene, 2016); in Argentina, zines like Resistencia and Homoxidal 500 embraced queer aesthetics; in Chile, book and album covers echo these traditions.

Artists such as Gee Vaucher (Crass) and Jamie Reid (Sex Pistols) exemplify this ethos, drawing from Soviet samizdat and subverting mainstream media (Bestley & Binns, 2018; Poynor, 2003).

Ultimately, punk visuality does not represent dissent: it materializes it. Each collage or ruptured layout contests systems of cultural production and legitimacy.

Parrhesia, affect, and underground memories

Punk proposes a distinctive way of inhabiting and intervening in the political sphere. As Císař and Koubek (2012) note, "both the political and cultural elements complement one another […] creating a discursive space […] shaped by the outside environment and circumstances" (p. 2). Latin American punk biographies express this articulation between aesthetics and resistance, shaped by national histories and local struggles.

Through subjective and direct voices, these works update parrhesia, the act of speaking truth at risk, as a form of situated critique (Foucault, 2017). Far from heroic rhetoric, punk narratives embrace vulnerability, contradiction, and discomfort. This aligns with the analytical category of parrhesia proposed in the methodology, where truth-telling becomes an affective and political act of dissent.

The tension between disenchantment and idealism, which James (2009) identifies as constitutive of punk, also permeates these narratives. It is precisely that friction between utopia

and realism that enhances their critical potential.

Pogo, for instance, reveals his contradictory background: his father held a prominent role in a conservative newspaper and maintained ties with the political right (Pogo, 2018, p. 13). This gesture disrupts traditional punk authenticity codes and exemplifies a provocative parrhesia that unsettles stereotypes.

A similar case is Pil, whose voice refuses consensus or scene representation. He speaks from experience, without strategic calculation or political correctness, assuming the cost of his truth. In both cases, narration resists silence and the homogenization of experience (Kreimer & Chalar, 2017).

In Eutanasia, risk is central to both narrative and group identity. Their biography emerges from a radical gesture of exposure, rejecting equally the promises of the State and of its subversive challengers (Grijalva, 2019). Their name, logo, and imagery (dynamite, anarchy, resignation) embody parrhesia, affect, and contradiction turned into narrative.

In their rawness and fragmentation, these biographies assert the right to narrate the irrelevant, the dissonant, and the unfinished, challenging dominant visibility regimes and reaffirming biography as a space of symbolic and political contestation.

Conclusions

Rather than glorifying life paths or reinforcing personal brands, punk biographical discourse offers a distinct way of narrating from the margins. These works resist storyselling and biographical conventions centered on exemplary lives or closure, foregrounding fragmented, contradictory, and situated subjectivities.

The analyzed biographies reveal that biography is not merely a genre but a contested space of symbolic and political negotiation. They activate collective memory, challenge dominant regimes of authenticity and visibility, and propose alternative ways of inhabiting identity and selfhood. Through parrhesia, material aesthetics, and non-linear structures, these narratives act as critical interventions.

This invites a broader rethinking of subjectivity and memory within communication studies. Punk, as a disruptive gesture, generates counter-memories, dissonant voices, and unfinished narratives that resist commodified identities and narrative saturation.

Ultimately, punk biography emerges as an expanded, hybrid form textual, visual, sonic, and embodied that reclaims the DIY ethic not as nostalgia, but as a living method of cultural action. In doing so, it reaffirms biography as a space of resistance and reclaims storytelling as a tool for imagining life beyond hegemonic templates.

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On Copies and Reproductions: The Case of Digital Twins from the Osteotheque Laboratory

Luis García Lara
Catholic University of Temuco (Chile), lgarcia@uct.cl, https://orcid.org/0000-0003-0723-809X

This text arises from the course on Design "Rapid Prototyping" of the Catholic University of Temuco.

Introduction

Traditional veterinary education has relied on hands-on experience with live animals and cadaver dissection as primary methods for teaching anatomy. These approaches allow for the direct study of the animal body, its components, and physiological phenomena through dissection, extraction, and material analysis.

Currently, due to heightened awareness of animal suffering and evolving legal and cultural norms regarding animal rights, the Osteotheque Laboratory has reported a reduction in the number of animal cadavers available for academic study. Furthermore, conversations with faculty revealed that the current veterinary curriculum does not include training in manual or digital techniques for the creation of three-dimensional models. These models could enhance understanding of the complex morphology of animal bones and soft tissues critical for professional formation in the field. In recent decades, the processes for capturing the surfaces of physical elements have significantly evolved and become more widespread, primarily through surface scanning and photogrammetry (Waltenberger *et al.*, 2021). For the study of internal anatomical structures in both human and animal bodies, computed tomography (CT) can be added as a complementary technique. However, this method requires advanced software proficiency and access to high-cost equipment, which is currently unavailable at the university.

This context raises a key design challenge: How can anatomical elements of the animal body be accurately reproduced in a non-invasive manner?

This research sets out to explore available and accessible techniques for generating anatomically accurate models that replicate animal structures, promoting the replicability without the use of new cadavers (Chytas et al., 2024; Cone et al., 2017; Hsu et al., 2020; Jiang et al., 2024; Lima, 2019). The project aims to provide an initial methodological framework for the fabrication of 3D physical models starting with bone structures that can support anatomical education in a tangible, ethical, and replicable manner (Marouf, 2023, 2024). Based on prior experience in Rapid Prototyping courses, the use of computed tomography (CT) was excluded due to its complexity, and surface scanning with the Structure Scanner was also dismissed owing to its lack of precision. In Figure 1 Professor Oscar Venegas is seen explaining the traditional cleaning processes through which skeletal remains are prepared for inclusion in the Osteoteca.

Figure 1. Initial documentation of the Osteotheque. In the image, Professor Oscar Venegas explains the traditional cleaning processes that bone specimens undergo before becoming part of the Osteoteca collection. **Source:** Own elaboration.



Following this initial stage, students conduct research on photographic capture techniques, enabling photogrammetry software to establish pixel correspondences and accurately reconstruct the depth and spatial relationships of the scanned elements

The study was implemented as a four-week intensive project involving students enrolled in the Rapid Prototyping course within the Design program, the primary objective is to establish a workflow (Van Vlasselaer *et al.*, 2024) that integrates contemporary software and fabrication techniques to address a practical, context-specific problem within the university setting. The methodology was structured around the following phases:

Digital Capture

- 3D scanning through photogrammetry, using high-resolution photographic capture, initially comparing the results of two softwares, Meshroom and Polycam, one of the main differences between them was hardware computing versus cloud computing, and also the algorithm behind softwares.

Digital Processing

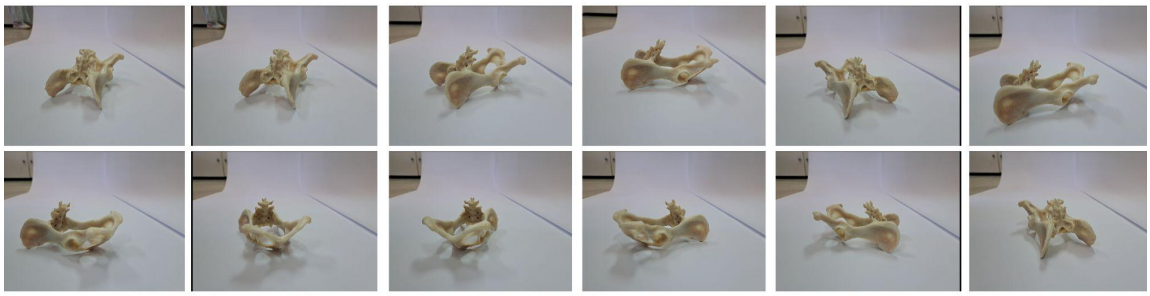
Correction of textures and retopology of 3D meshes using two main mesh modeling software, Meshmixer and InstantMeshes.

Physical Fabrication

Production of physical models using additive manufacturing (FDM) with PLA filament.

In Figure 2 a selection of photographs comprising the catalog for each specimen. This photographic dataset is essential for performing photogrammetric reconstruction of the elements.

Figure 2. Images of one of the jaws included in the Osteotheque collection, Veterinary School, UC Temuco. Photographs by student Jovanny Albarrán.



Each group of students was tasked with producing digital twins of animal bone specimens from the Osteotheque's collection, working from initial scans through to final prints. For this purpose, students selected various skeletal specimens currently used for the osteological study of animals. These specimens were in good condition, free of organic materials such as skin or other tissues. As part of the methodology, students arranged a small photographic setup using paper, which enabled image capture against a seamless background, facilitating object visualization. Figures 3 and 4 depict students preparing the workspace within the laboratory, as the specimens could not be removed from the Osteotheque due to preservation protocols.

Figure 3. Students carefully setting up a seamless paper backdrop to ensure consistent lighting and a uniform background during the photographic documentation of the bone specimens.



Figure 4. Set up for photograph capture.

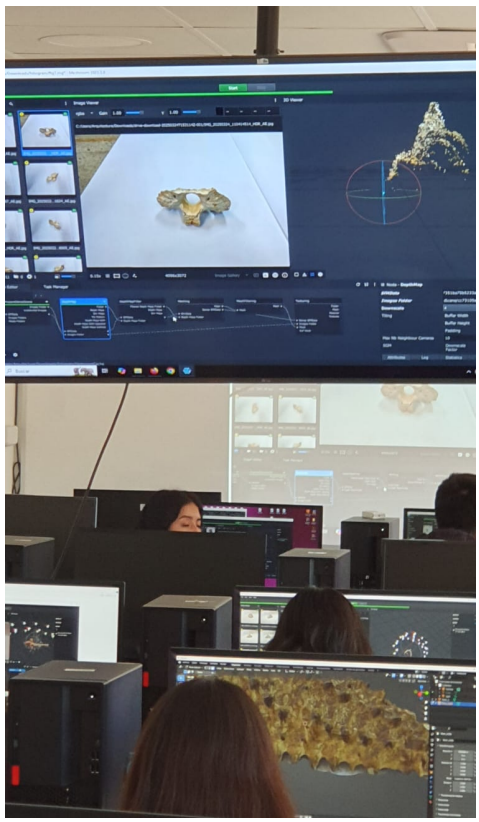


The compiled digital photographic data, as shown in Figures 5 and 6, were processed by the students according to the established workflow. During this phase, students critically assessed the reliability and quality of the results, which empowered them to independently determine the most suitable photogrammetry software for subsequent analysis.

Figure 5. Image of the computing laboratory showing students engaged in photogrammetric data compilation and mesh cleaning processes, under the instruction of Professor Maximiliano Milla Castillo.



Figure 6. Image of the FAAD computing laboratory where photogrammetry and mesh reconstruction processes were conducted.



The process yielded a series of PLA-printed anatomical models, accompanied by corresponding QR codes that linked to their digital versions hosted on Sketchfab. These models were publicly exhibited and made available in an open-access online repository, enhancing accessibility and educational reach.

The methodology proved to be effective in:

- Producing geometrically accurate representations of bone structures.
- Allowing iterative digital editing and scaling of models.
- Providing a material basis for anatomical study without the need for cadavers.

Moreover, the project demonstrated the value of interdisciplinary collaboration between veterinary and design fields in addressing emerging educational challenges. In Figure 7 we can see some of the QR codes created for the redirection to digital repository.

Figure 7. QR codes of the repository.

Figure 7. Image of the process applied, from photogrammetric meshing, mesh combing in Instamesh, to texture remapping in Blender. Student Diego Llanquiman.

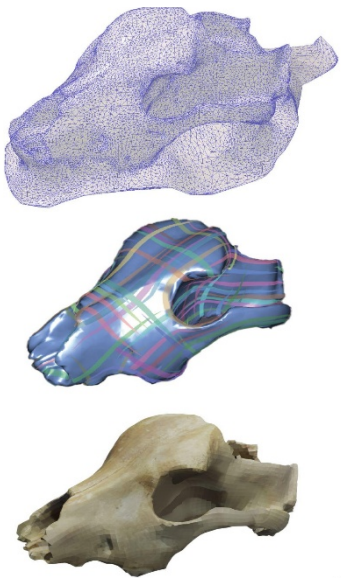


Figure 8. Different views of the digital three-dimensional model included in the repository created by the course. Model developed by student Sofia Castillo.



Figure 9. Image of the digital repository shared on Sketchfab, created by students Sebastián Antriao and Jovanny Albarrán. [https://skfb.ly/pvxN7 & https://skfb.ly/pyW7B].

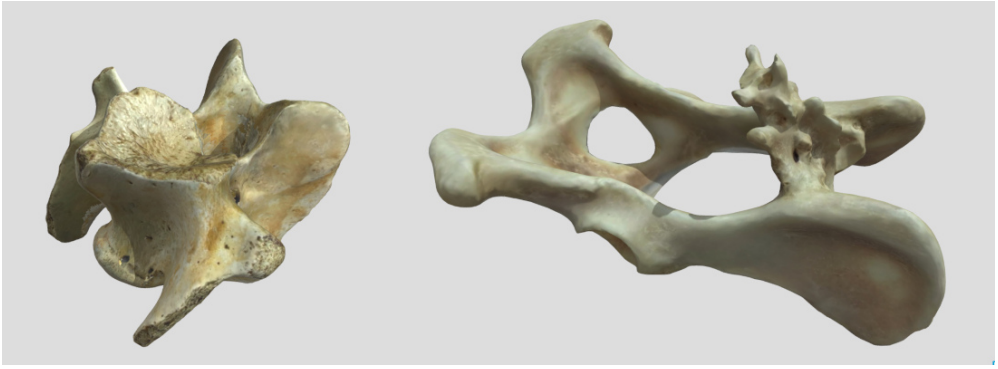


Figure 10. Image of the course exhibition setup. Upper section displays geometry sheets and post-processed meshes; lower section shows FDM models printed in PLA.



Conclusions

This preliminary study supports the hypothesis that: "Contemporary photogrammetric and additive manufacturing techniques enable the reproducibility of complex animal anatomical geometries with high fidelity."

The proposed methodology offers an ethical, scalable, and pedagogically valuable alternative to cadaver-based study. It opens new opportunities for interdisciplinary curriculum and resource-sharing across veterinary and design education. Furthermore, this approach fosters interdisciplinary collaboration between fields that until recently were difficult to envision effectively linked at the undergraduate level. As future work, we aim to conduct workshops involving participants from both the Design and Veterinary Medicine programs, promoting the development of complex, real-world, and context-specific problems that interdisciplinary teams can address within the timeframe established by these courses.

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The pre-raphaelite brotherhood: ephemerative victorian resistance

Laura Gemma Flores García
Universidad Autónoma de Zacatecas (México),
ars.flores@gmail.com
ORCID ID: 0000-0002-7405-4883

Introduction

Romanticism, according to some authors, constitutes a stubborn reaction against neoclassicism and is one of the essential signs of the 19th century, exalting individualism as the powerful force that would reach divine revelations on its own. This stage is interpreted as a reaction to the paradigm of reason where spiritualism and mysticism were the main ideas opposed to the rationalism of the previous era. It presupposes above all a state of rapture and passionate exacerbation where there is no room for serenity (Honour, 2010). The medieval period and other unknown and distant places were so fascinating, seducing the contemplation of the primitive and the natural world, that the taste for exotic cultures aroused a lively interest in painters as well as musicians and writers. The Romantic tendency would provoke a reevaluation of the nature of art and the role of the artist in society (Rosenblum, 2005). In this context, the Pre-Raphaelite movement emerged in England in 1848 and lasted barely five years until 1853. The artistic movement, in some way, shared time and space between the survival of the Academies and the various examples of European Romanticism that awoke from 1770 to 1870 (Vaughan, 1994). The short period in which the Pre-Raphaelites, inspired and - in some way - affected by other movements, manifested itself in a closely intimate and ephemeral tendency to situate it, value it and detach it from all its influences. The encrypted group of the Pre-Raphaelite Brotherhood is situated in a rapidly changing world such as the turn-of-the-century in Britain at the end of the 19th century, considering that there were many groups emerging at the same time, that there was a large influx of people concentrated in London and that artists were constantly moving to southern Italy, the Greek islands, the Turkish empire, the Middle East and many Mediterranean nations including Morocco, bringing with them other symbolic forms of representing reality (Prettejohn, 2000). The hypothetical question rests on the fact that of all these options to choose from, one predominated because it was the one that most forcefully rejected the coldness, formalism and detachment from spirituality that was academicism, we are referring to the look at the Middle Ages. This chapter helps to point out how the Pre-Raphaelite paradigm was distinguished by its Gothic tendency and here we will present the most relevant typologies that allowed it to distinguish itself as a movement: religious themes; Realism and naturalism; a return to the Old Masters; and symbols and allegories. All in open opposition to academicism. The study variables are: English Romanticism, Pre-Raphaelitism, Victorian aesthetics, and Gothic features .

For this study, an interdisciplinary qualitative methodology was employed, integrating tools from cultural history, art history, and aesthetic and literary studies. The study is based on documentary analysis of primary and secondary sources—prints, images, blogs—as well as a critical review of specialized literature. The methodological approach of iconographic analysis of the images allowed us to reveal the most important Gothic features in the Pre-Raphaelite Brotherhood's work, namely: religious themes alluding to biblical scriptures; the hallmarks of

realism and naturalism as tools that emerged in the late Middle Ages with the discovery of oil and the use of the brush, giving rise to the technique of detail; the return to the Old Masters as those that impacted their formal expressions; and the symbolic and allegorical content that characterized medieval works. The research was developed under a qualitative approach, using the following techniques: Documentary Analysis: Historical sources, chronicles, biographies, prints and visual records related to the Pre-Raphaelite movement were reviewed. This analysis made it possible to identify the historical and symbolic evolution of the artistic trend. Bibliographic Review: specialized literature on art history and Victorian aesthetics was consulted (Rosenfeld, 2012) with emphasis on the works of Gombrich, Reinach, Díaz, Anderson. This review made it possible to contextualize the phenomenon within the theoretical debates on Romanticism, Victorian aesthetics and the rejection of academicism.

Background: the German Nazarenes

The Nazarenes were a group of dissident students from the Vienna Academy who in 1809 had founded the League of St. Luke, in memory of the evangelist who, according to legend, painted the first portrait of the Virgin. Its main promoters were Franz Pforr, Johann Friedrich Overbeck, P. Cornelius, P. Veit, W. von Schadow, J. Fürich and J. Koch (Gossman, 1987). It was a movement of clear romantic inspiration influenced by the writings of the scholar August Wilhelm von Schlegel and the poet Wilhelm Heinrich Wackenroder, who in his *Sentimental Outpourings of an Art-Loving Monk* evokes an idealized medieval world, also recovering the work of Dürer (Gossman, 2008).

The Nazarenes were formed in Rome as a Brotherhood and lived in the convent of San Isidoro. In their paintings, it is easy to find the traces of Fra Angelico, Perugino, Luca Signorelli, Filippo Lippi and Raphael himself, in addition to medieval German art and Dürer (Gossman, 1987). The Nazarenes felt the wars that occurred in the 16th century as an interruption of art and urged their followers to pick up the lost thread of the medieval period. "True art does not want to be placed like an idol on the altar, but rather wants to be the servant of the tabernacle. There you can look for it and find it as an ornament that pleases God and men" (Johann Friedrich Overbeck in his essay on *The Triumph of Religion in the Arts-1830*) (Thimann, 2011a). This essay presents a compelling argument for the intrinsic relationship between religion and art, arguing that art serves as a vital expression of religious sentiment (Thimann, 2011b, pp. 7–28).

From 1850 the French school influenced the whole of Europe, only England formed an independent province in which the original talents had become exceptional. In the first half of the 20th century the greatest English artist was Turner (1775-1851), a painter ecstatically in love with light. Academic painting underwent a revolution in 1848 thanks to the efforts of three friends: Hunt, Rossetti and Millais, who formed the brotherhood of the Pre-Raphaelites (Preraphaelite Brotherhood, PRB). Millais later broke away from this group to become a good plebeian painter, but Rossetti had a brilliant disciple, Burn Jones and Watts. Violently attacked by the academicists, the PRB found a defender in John Ruskin (theorist and architect), who exerted a great influence on the art of his time (Bendiner, 1998). The most outstanding characteristic of this school was intellectualism, disdain for art for art's sake, they liked to tell, review and move the souls of the spectators (Reinach, 1979, pp. 347-348).

The Foundation of the Pre-Raphaelite Movement

Around 1848 the painters Gabriel Rossetti, William Holman Hunt and John Everett Millais formed a brotherhood of artists in London. This group, was joined by the sculptor Thomas Woolner, William Michael Rossetti, James Collinson and Georges Stephens (Hunt, 2013). The principles that sustained their brotherhood were a resounding rebellion against the Royal Academy and the aesthetic norms of Victorian society. The Royal Academy, founded in 1768, exercised a monopoly on the arts, basing its teaching on drawing, limiting both the nude and natural light (Prettejohn, 2000).

The Pre-Raphaelites based their painting on the direct imitation of nature and a certain mannerism derived from Italian models prior to Raphael (1483-1520). They saw in Raphael an apostate of the ideal and an apostle of procedure; they took Botticelli and Mantegna as models. The Pre-Raphaelites' protest stance also attempted to make art available to the largest number of spectators, due to the class that was emerging as a result of the Industrial Revolution, and in this sense it can be said that the revolutionary art of Pre-Raphaelitism was not born by chance in 1848 (Baxandall, 1985). This period corresponds to the European revolutions and the publication of Marx's *Communist Manifesto*, which is why their artistic stance leaned towards utopian socialism headed by William Morris (Thompson, 1988).

After its constitution as a Brotherhood, the founders presented works inspired by literary or religious themes to public competitions, including the PRB (Pre- Raphaelite firm Brotherhood). Two years later they decided to found a magazine called The Germ (4 issues) anticipated the avant-garde art magazines of the 20th century (Rosenfeld, 2012). Other artists joined this magazine: Ford Madox Brown, William Bell Scott and Walter Howell Deverell and poets like Coventry Patmore and Christina Rossetti. In April 1850, the date of the magazine's publication, Gabriel Rossetti presented his *Ecce Ancilla Domini* (Tate Gallery, London) at the *Free Exhibition*. Walter Howell Deverell also presented his *Epiphany Night* (Hunt, 2013). Both were harshly criticized as "repellent paintings" "pictorial atrocities" etc., especially *Christ in the House of His Parents*, which Charles Dickens wrote deeply critical reviews. It was denounced that all elements of the paintings were given equal importance (that is there were no secondary and central elements) and that all were illuminated in the same way, without points of light and points of shadow. The concept of brotherhood, group or society was also criticized due to the revolutionary groups that existed at the time (Prettejohn, 2000). However, John Ruskin (Cook and Alexander Wedderburn, 1903-1912) - an art essayist of undisputed prestige in London circles - wrote an article in *The Times* that contained a nuanced defense of the young painters. From then on, and after a conference given by this same character in 1853, the recognition of the Brotherhood began (Díaz, 2020, p. 13).

Gothic characteristics of Pre-Raphaelitism

If art had to be reformed, it was necessary to go back beyond Raphael, to return to the time when artists were still craftsmen faithful to a God for whom they did their best to copy nature, not thinking of earthly fame but of the greater Glory of God. Believing that art had become insincere under Raphael's influence and that its mission was to return to the age of faith (Anderson, 2025). The best member: Dante Gabriel Rossetti shows in the painting of *The Annunciation* the model of medieval images. Returning to the spirit of the Middle Ages does not mean that he wanted to imitate the paintings of that time; what he desired was to emulate

their attitude by fervently reading the biblical story and imagining this scene in which the angel appeared to the Virgin, addressing her his greeting (Barringer, 1991, pp. 253-277). We can see how Rossetti strove to be simple and sincere in his new conception and how much he sought to show the ancient tale in the purest spirit, but precisely because of his attempt to capture nature as faithfully as the admired Florentines of the Quattrocento, some will consider that the Pre-Raphaelite Brotherhood set an unattainable goal for itself (Gombrich, 2001, pp. 391-392). His creations are full of medievalism, Gothic details, architectural and chromatic descriptions, symbols. In short, a deeply sensual world that inspired the imagery of the PRB. The Pre-Raphaelites delighted in this medievalism, because they shared the qualities that these artists sought and transferred that atmosphere to their paintings. The chivalric medievalism of the Pre-Raphaelites also has its roots in *The Deeds of King Arthur* and the ballads that had already influenced the Romantic poets (Díaz, 2020, p. 14).

Religious themes

From his earliest works, Rossetti began incorporating sonnets into his paintings, seeking to link poetry and image. The innovation of interweaving visual and verbal images to create meaning was a medieval legacy, based on the books of hours and medallions that accompanied church frescoes. This movement is understood as a unique intertext for the painter-poet. In 1849, Rossetti's *The Childhood of Mary the Virgin* was the first painting exhibited with the initials PRB at the Hyde Park Corner Free Exhibition. Gallery (Helsinger, 2008). Rossetti wrote two sonnets for the painting, which are now inscribed together at the bottom of the frame, both under the title "The Childhood of Mary (for a painting)". The following year, Rossetti painted another painting of the Virgin Mary, *Ecce Ancilla Domini !,* which depicts the moment of the Annunciation. Linked primarily by their subject matter, the paintings and sonnets together provide an opportunity to develop a reading of the intertextual relationships present in Rossetti's visual and verbal constructions (Donnelly, 2010). The *Tate Catalogue Gallery* for the 1984 Pre-Raphaelite exhibition, where the paintings were displayed side by side and the sonnets inscribed below, includes an extensive entry devoted to "The Childhood of the Virgin Mary" by Rossetti specialist curator Alistair Grieve (Donnelly, 2010). In may 1849 at the Royal *Academy of Arts Summer Exhibition*, John Everett Millais exhibited *Isabella* and William Holman Hunt presents *Rienzi* crying out for justice for his brother's death (Ramiro, 2021, pp. 18). Another emblematic painting of the society was *Christ in the Parents' House* (1849-1850) by John Everett Millais, which shows six human figures in the carpentry shop of the Lord Saint Joseph. Jesus, being comforted by Mary, raises his hand showing his wound, an image that foreshadows the crucifixion, as well as Christ's passion and death, such as the tongs, the nail, and the ladder on the wall behind Jesus. A small child, has been interpreted as John bringing a bowl of water to wash the wound, but it also probably serves as a rough symbol for Christ's baptism (Landow, 2015). This painting presents a distant rural atmosphere on the left, emulating the landscape perspective of the Middle Ages. And the entire composition intentionally lacks arithmetic perspective, thereby revealing a detachment from the Academy. The work is in the *Tate Britain* (United Kingdom), is an oil painting on canvas and measures 86.4 x 139.7 cms. (Carabaño, 2017).

Realism and naturalism

As an empirical discipline, painting in this movement was associated with efforts to understand the physical and spiritual structure of the world. Its methodological rigor, based on studies of physical science and history, can be demonstrated by its rejection of the conventional rules of the previous generation among Romantic art critics (Holmes, 2015). In the intervening years, the intellectual climate of England had changed decisively, and by the late 1840s, the serious advocacy of humble, naturalistic study as the basis of art was a polemical contribution to a specific contemporary debate. In this context, the Pre-Raphaelites became Realists, arguing, like all Realists, that art should present a truthful picture of things and address the concerns of modern everyday life (Murdoch, 1974). Allen Staley's book, *The Pre-Raphaelite Landscape*, addresses in detail the theoretical questions that Pre-Raphaelite artists had regarding the representation of the natural world" (Staley, 1973). The Pre-Raphaelite movement sought to capture and represent nature in their artwork through their paintings. William Holman Hunt was a key proponent of the Pre-Raphaelite commitment to "truth to nature" and meticulous detail. He emphasized moral and spiritual symbolism in his art, believing in the didactic power of painting. His rigorous adherence to Pre-Raphaelite principles, including painting in the open air and the pursuit of absolute realism in representation, set a high standard for the Brotherhood's technical execution (Des Cars, 2000). The motive of this Brotherhood compels us to suggest an analytical approach to art history, for by examining the movement's aims, we can infer how these artists sought their own creativity while resisting social mechanization (Marsh, 2006). Just to mention one example of his references to the transition between the Middle Ages and the Renaissance - and therefore the deep realism and naturalism - can be found in the works of the Van Eyck brothers and specifically the *Arnolfini Portrait* (1434) by Jan van Eyck (Yearwood, 2014). The details of the peaches in the window frame, the facial features of the couple and the series of tiny hairs on the dog that accompanies the couple are examples of the faithful copy of nature that the Brotherhood wanted to rescue. Likewise with *The Mystic Lamb* one can locate the realistic imperfections of Adam's arms and how these principles were emulated in the Pre-Raphaelite circle.

Return to the Old Masters

The Pre-Raphaelites argued that academic teaching had become "mechanistic" after the rise of the Mannerists, and that the repetitive copying of classical models impeded true expression and the direct study of nature. They also rebelled against the trivial and decorative themes that predominated in academic painting, advocating for an art with moral, spiritual, or symbolic depth, which is why they thought it ideal to turn their attention to the Old Masters. The Pre-Raphaelites frequently returned to medieval, religious, mythological, and literary themes, such as archaic legends, biblical stories, and works by writers such as Shakespeare and Dante Alighieri. This allowed them to work with motifs charged with symbolism and spirituality, in contrast to modern or purely realistic themes. Several of Rossetti's sonnets are dedicated to Old Master painting, and his artistic work reflects diverse influences at different times in his career. This author began to emulate Titian and the Venetian School, and later discovered Botticelli, who subsequently became an icon of the Aesthetic movement. During the 19th century, art students in Western Europe were encouraged to revere their predecessors. Whether detailed drawings of classical sculptures or copies of the Old Masters, a "sense of the past" was always with them. The Pre-Raphaelite Brothers were not alone in championing what

had previously been dismissed as "primitive" art (Paxman, 2009). Charles Lyell gave Rossetti a copy of Anna Jameson's *Memoirs of the Early Italian Painters*, first published in 1845. Reprinting a series of articles originally published in Penny Magazine, the book ranges from Cimabue painters to Titian and the Venetian School. The same author published Sacred and Legendary Art in 1848, with descriptions and illustrations of early paintings (Ormond, 2006). Three of Dante Gabriel Rossetti's medieval fantasy paintings – The Melody of the Seven Towers, The Blue Wardrobe, and A Christmas Carol – took their themes from history, legend, religion, or poetry, focusing on moral or psychological issues, and expressed a fascination with beauty as a value of a spiritual nature. Rossetti's works posed a meditative and imaginative response through their enigmatic references and thus attest to the mysterious characteristic of medieval Pre-Raphaelite imagery (Ujszászi, 2015).

Symbolism and allegories

In Pre-Raphaelite painting, objects, colors, gestures, and compositions are used to represent abstract ideas or divine figures. For example, light often symbolizes divinity, and certain animals or plants may have specific meanings. From the Christian tradition, Byzantine icons are used, seeking spiritual connection through frontality and stylization, in Gothic altarpieces that narrate the life of Christ and the saints, in majestic Renaissance domes that elevate the gaze toward the divine, and in Baroque drama that seeks emotion and the participation of the faithful (Werner, 2005).

As examples in specific works, in Rossetti's "The Childhood of the Virgin Mary" The books representing the virtues are symbolically colored. The lamp is an emblem of piety, the rose is the flower of the Virgin, the vine alludes to the coming of Christ, and the red cloth, embroidered with the Tri -point, beneath the cross-shaped trellis symbolizes her mantle in the Passion. The palm- and thorn-shaped branches prefigure the seven joys and seven sorrows of the Virgin (Alistar Grieve in Donnelly, 2010).

Fragment of the sonnets inscribed by Rossetti below "The Childhood of Mary"

These are the symbols. On that red cloth

In the center is the Tripoint, each one perfect

Except for the second of your points, to teach

That Christ has not yet been born. The books (whose head

Is charity golden, as Paul said?

These virtues are those in which the soul is rich:

That is why the lily rests on them,

Is it innocence, being interpreted?

The seven-thorned bramble and the seven-leafed palm

They are his great pains and his great reward.

(https://rossettiarchive.iath.virginia.edu/docs/s40.rap.html)

Medieval imagery had heroes and archetypal figures (such as knights, saints or legendary characters) that were represented in literature and art as models of virtue and social values (Helsinger, 2008), which inspired Pre-Raphaelite themes and compositions, which sought to revalue these models.

Pictorial formal laws

To create a truly dramatic effect in their Gothic paintings, they used the technique of true fresco, returning to small panels rather than the large neoclassical canvases. They preferred refined drawing to color. They rejected or limited the use of chiaroscuro and the effects of depth and volume, which promoted the flat panel, without depth as in the Middle Ages. They used intense primary colors, and their technique was controlled and impersonal (Dapazzi, 2016). The result was a precious and luminous art, with brilliant and striking colors, the fruit of working with natural light (which had been a characteristic of Pre-Raphaelite painters due to the Gothic stained-glass technique). They returned to the medieval, vindicating craftsmanship in the face of the crudeness of the era's machinery and class differences. Allusions to the dark nature of the meaning behind the beauty of naturalistic paintings were found in the gardens: red poppies stand out and accompany the figures in their affliction (Treuherz, 1993). Indeed, the symbolism of flowers was one of the characteristic features of Pre-Raphaelitism. In this case, the red poppy, already used by Millais in his well-known representation of *Ophelia* or by Rossetti in his *Beata Beatrice*, is a symbol of sleep, but also of death (Díaz, 2020, p. 20).

The dissolution of the Brotherhood

James Collinson, who found his religion incompatible with the principles of the group, decided to withdraw in 1850. Collinson was replaced by Walter Howell Deverell, and after this entry, the members proposed that each individual should write a manifesto explaining why they considered themselves Pre-Raphaelites. No one wrote such a manifesto. Later, in 1852, Woolner went to Australia, disappointed by the English art scene (Treuherz, 1993).

In 1853 the last session of the Brotherhood took place, meeting so that its members could make portraits of each other to send to Woolner. In 1854, Millais was admitted to the Royal Academy, which broke his ties with the movement; Rossetti, in a letter to his sister Christina, informed her that he was bringing the Brotherhood to a close. Shortly afterwards Hunt went to the Holy Land. The Brotherhood had barely lasted; however, its influence was felt by many artists such as: Arthur Hugues, John William Inchbold, John Brett, Henry Wallis, William Lindsay Windus, William Shakespeare Burton and even by older painters such as William Dyce (Barringer, 2005).

In the late 1950s, a second Pre-Raphaelite phase was reborn with Dante Gabriel Rossetti, William Morris, and Edward Burne-Jones. In Morris's work, Pre-Raphaelitism had a commercial face, with his signature decorative objects such as furniture, tiles, tapestry, wallpaper, stained glass, ironwork, jewelry, etc. Burne-Jones imbued his work with a strong idealism that would emerge as a clear precedent for later artistic trends such as Symbolism and Art Nouveau.

Conclusions

The Pre-Raphaelite Brotherhood, born in England in 1848, represented a short-lived but significant Victorian resistance to the prevailing academicism, which they considered cold, formal, and detached from spirituality. This artistic movement, which lasted approximately five years until 1853, emerged in the context of European Romanticism and in a British world undergoing rapid transformation in the 19th century. Its founders, John Everett Millais, William Holman Hunt and Dante Gabriel Rossetti, along with other artists, rebelled strongly against the Royal Academy and its aesthetic standards, which limited art teaching to drawing and restricted the use of the nude and natural light. The Pre-Raphaelites were distinguished by a marked Gothic tendency, seeking to reform art by "going back beyond Raphael" to emulate the sincerity and fidelity to nature of pre-Renaissance and medieval artists. This manifested itself in several key typologies:

- Religious themes: They incorporated biblical stories and the lives of saints, linking poetry and images in the medieval style, as seen in "The Childhood of the Virgin Mary" and "Christ in the House of His Parents."
- Realism and naturalism: They sought a direct and meticulous imitation of nature, inspired by masters such as the Van Eyck brothers, emphasizing detail and visual truth to address concerns of everyday life.
- Return to the Old Masters: They rejected academic "mechanistic" teaching and advocated an art with moral, spiritual, and symbolic depth, drawing inspiration from Botticelli, Mantegna, and early Italian painters.
- Symbolism and allegories: They used objects, colors and compositions to represent abstract or divine ideas, such as light symbolizing divinity or the specific meaning of flowers and elements in their works.

On a formal level, they preferred small panels and the technique of true fresco, refined drawing over color, and rejected chiaroscuro, resulting in precious, luminous, and intensely colored works with a profound medievalism. Although they faced harsh initial criticism, especially for the lack of hierarchy in their compositions and their concept of brotherhood, they found a crucial defender in the influential essayist John Ruskin, who promoted their recognition from 1853 onwards.

Despite its short life as a Brotherhood, which officially dissolved in 1853–1854, its impact was lasting. A second phase of Pre-Raphaelitism emerged in the late 1950s with figures such as Dante Gabriel Rossetti, William Morris, and Edward Burne-Jones. Morris brought Pre-Raphaelite principles to the commercial sphere with decorative objects and crafts, revaluing craftsmanship as opposed to industrial machinery. Burne-Jones's work, meanwhile, with its strong idealism, became a clear precedent for later artistic trends such as Symbolism and Art Nouveau. Thus, the Pre-Raphaelite Brotherhood, in its search for truth, beauty, and spirituality in art, left an indelible mark on the history of British and European art.

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Philosophical Currents Applicable to Modern Management in Contexts of Uncertainty

Saúl Alfonso Esparza Rodríguez
Universidad Anáhuac Querétaro (México),
https://orcid.org/0000-0002-9900-6159

Introduction

Contemporary organizations face increasingly complex challenges in a changing environment, which demands integrative approaches to organizational management and development. The roots of philosophical thought have contributed decisively to shaping the principles, values, and structures of modern administration (García, 2024). In this sense, it is possible to identify substantial shifts in administrative approaches throughout history, considering that, from the earliest forms of hierarchical organization in slave societies to modern proposals of conscious leadership derived from existentialism and phenomenology, philosophy has offered valuable conceptual frameworks for interpreting and transforming organizational practices. These frameworks have substantially influenced modern management as we know it, orienting it not only toward the efficient production of goods and services but also toward the social and environmental contribution of various social entities (Sánchez Delgado, 2020).

Thus, Management, considered by various authors from different perspectives (as a technique, an art, and/or a science), has historically developed as a response to the needs of planning, organization, direction, and control required to manage and coordinate—both efficiently and socially responsibly—social organisms composed of complex human structures, designed for organizations of diverse nature, scope, industry, and environment (Burbano et al, 2025).

Following this line of reasoning, this article contributes to a better understanding of the degree of influence identifiable in every administrative theory, which is underpinned by an ontological vision of the human being, a theory of knowledge, and an implicit ethic. This, in turn, represents a necessary proposal for comprehending the ideological frameworks that significantly influence internal organizational processes (García García & Vélez Salamanca, 2024).

Analysis of Philosophical Currents and Their Application in Management

The analysis of philosophical currents applicable to management is substantiated by a wide diversity of documentary sources, ranging from academic expositions to historical syntheses of thought, from which it is possible to identify a set of philosophical currents that maintain a profound influence on the evolution of organizational thinking. Beginning with the ancient traditions, represented by Stoicism, which emphasizes self-discipline, serenity in the face of adversity, and duty as the core of the ethical life. These are characteristics reflected in resilient leadership and emotional control within organizational contexts. For its part, Epicureanism promotes an ethics of balance and the pursuit of moderate pleasure, an idea later incorporated by administrative models focused on well-being and quality of work life (Waltman, 2025).

Regarding the slave-based model, this organizational approach represents an archaic form founded on absolute control over the enslaved, designed in terms of instrumentalist exploitation of the human being based on a sense of property (Moulier-Boutang, 2006).

Scholasticism contributes a rationalist-theological vision that underscores order, obedience, and the legitimization of authority as guiding principles. These principles are reflected in bureaucratic and normative management models, where formal rules and hierarchy hold a central place, and organizational structuralism represented an institutionalized way to achieve organizational efficiency (Arregui, 2015).

The current underpinning Humanism places the human being at the centre of philosophical reflection and proposes an administration based on dignity, freedom, and the integral development of the individual. Its influence is traceable in models related to empathetic leadership, continuous training, and the promotion of emotional well-being (Mancebo, 2023). Empiricism, on the other hand, grounds knowledge in sensory experience and systematic observation. This current has profoundly influenced the development of scientific management, which is based on measurement and experimentation, as well as modern techniques for evaluation and statistical process control (González & Ruiz, 2025).

Phenomenology proposes a deep understanding of subjective experience, representing a philosophical root that allows comprehension of the importance of perceptions of leadership, organizational culture, and work climate from the lived experiences of the administrative actors (Barroeta, 2020). Furthermore, Existentialism highlights individual freedom, responsibility, and authenticity. These ideas are reflected in various management approaches centered on the meaning of work, intrinsic motivation, and personalized decision-making (Pulido & Fernández, 2024).

Regarding Positivism, it prioritizes verifiable knowledge and objectivity, shaping quantitative methods applied in quality control, market research, and performance evaluation, through the predilection for quantitative methods and the extensive use of mathematical and statistical tools as the principal means for achieving verifiable knowledge (Castrillo, 2024).

Pragmatism introduces a functionalist perspective where the value of a theory depends on its practical consequences. Its influence is evident in methodologies such as benchmarking and management by results, which are necessary for maintaining an organization's responsiveness in competitive environments (Castrillo, 2024). Historicism emphasizes the relevance of understanding organizations as historical and cultural phenomena. This approach has contributed to institutional analysis and the critique of universalist management models. Conversely, Skepticism promotes an attitude of constructive doubt, which is relevant for critical thinking and organizational innovation (Agoff et al, 2020).

In what corresponds to Socialism as an organizational model, it posits an administration oriented toward collective well-being, equity, and democratic participation, applicable to public sector organizations and cooperatives, considering the government as the primary driver of social and economic development (Alonso, 2007).

In contrast, Capitalism promotes private property, efficiency, competition, and profit maximization. These values have structured the dominant thinking in business schools and global corporate management, where the predominance of economic and organizational freedom is sought for value generation (Robinson, 2014)];

As can be observed, this theoretical diversity constitutes a source of richness for a complex, reflective, and adaptive administration, capable of responding to contemporary challenges from multiple horizons of meaning.

The present investigation is based on a qualitative, documentary methodology, with an interpretative and contrastive approach. This methodology addresses the interest in exploring meanings, interpreting complex ideas, and constructing conceptual relationships between philosophical frameworks and administrative practices. The goal is to deeply understand how philosophical thought systems have shaped and continue to influence the development of administrative thought and action.

The first phase of the study consisted of a thematic coding of various selected academic documents, including presentations, essays, and elaborate analyses that systematically address the main Western philosophical currents. This allowed for the identification of the recurrent conceptual categories within each current, which were then systematized and grouped into analytical axes that served as the basis for the subsequent comparative analysis, that considered a searching strategy based on identifying relevant literature (measured by total citations), using the following keywords as categories for searching relevant papers: "Ancient traditions; Stoicism; Epicureanism; Slavery; Scholasticism; Humanism; Empiricism; Phenomenology; Existentialism; Positivism; Pragmatism; Historicism; Skepticism; Socialism; and Capitalism", with no restrictions in publication date, and with a linking concept regarding "Contribution to management theories", constrained by quotations marks in the search used as special control operators for literal concept search. In that sense, the bibliography consulted for this comprehensive analysis is listed as follows:

Table 1: *Literature analysis identifying the most significant contributions to management theories from Philosophical schools during history.*

Philosophical School	Core Principles	Contribution to management theories	Reference
Ancient Traditions	Hierarchy and Order	Division of Labor, Centralized Control	Kennedy, M. (2015).
Stoicism	Inner Virtue and Control	Resilience, Emotional Intelligence, Ethical Conduct	Brown, A. M. C., Sowcik, M., & Stedman, N. L. P. (2023); Sellars, J. (2014); Georgiadis, V., & Sarigiannidis, L. (2025); Long, A. A. (2002); Hadot, P. (1998).
Epicureanism	Sufficiency and Balance	Sustainable Business Ethics, Critique of GrowthP	Imamkhodjaeva, E. (2021); Spence, E. (2012); Laertius, D., Apelt, O., Reich, K., & Zekl, H. G. (1968); Garófalo, L. (2024); Sedley, D. (2018).
Slavery	Coercive Efficiency	Critique of Instrumental Labor Relations, Power Analysis	Giraudeau, M. (2019)

Scholasticism	Universal vs. Nominal Truth	Just Price, Purpose of Private Property	Das Neves, J. C., & Melé, D. (2013); Nider, J. (1952); De Roover, R. (1967); Wren, Daniel A. (1972); Lantos, G. P. (2001).
Humanism	Dignity and Well-being	Capability Development, Anti-Instrumental Knowledge	Melé 25; Pirson (2019) 26; Pirson (2017/2020) 27; Davies 24; Di Carlo & Cervi 29; Research on IT dignity culture.28
Empiricism	Observable Reality	Measurement, Data Collection, Evidence-based Practice	Park, Y. S., Konge, L., & Artino Jr, A. R. (2020); Comte, A. (1975); Simon, H. A. (1973); Mulaik, S. A. (1987); Bull, J. J., & Lauring, A. S. (2014); Hahn, H., Neurath, O., & Carnap, R. (1929).
Positivism	Realism (Independent Reality)	Prediction, Causal Linkages, Nomothetic Laws	Park, Y. S., Konge, L., & Artino Jr, A. R. (2020); Comte, A. (1975); Simon, H. A. (1973); Mulaik, S. A. (1987); Bull, J. J., & Lauring, A. S. (2014); Hahn, H., Neurath, O., & Carnap, R. (1929).
Phenomenology	Lived Experience (Consciousness)	Meaning-making, Experience of Work Engagement, Anti-Abstraction	Holt, R., & Sandberg, J. (2011); Gill, M. J. (2014); Merleau-Ponty, M., Landes, D., Carman, T., & Lefort, C. (2013); Heidegger, M. (1962); Van Maanen, J. (1979)
Existentialism	Freedom and Responsibility	Authenticity, Meaning of Work, Critique of Perfection	Pines, A. M. (2002); Klenke, K. (2007); Hassan, S., et al. (2021); Koehn, C. V. (1986);
Pragmatism	Instrumental Truth (Adaptive)	Problem-Solving Focus, Organizational Change Buy-in	Ralston, S. J. (2009); Lincoln, Y. S., Lynham, S. A., & Guba, E. G. (2011); Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2011); Polk, L. (2016); Doyle, T., & Brady, M. (2018); Campbell, J. (1995).
Historicism	Contextual Contingency	Evolution of Thought, Path Dependence Analysis	Wineburg, S. (1999); Maclean, M., Harvey, C., & Clegg, S. R. (2016); Rowlinson, M., Hassard, J., & Decker, S. (2014); Dunbar, R. L., & Statler, M. (2010); Bresser-Pereira, L. C. (2019).
Skepticism	Doubt (Unverifiable Info)	Risk Management, Calibrated Trust, Moral Hazard Mitigation	Nayeem, O. A. (2017); Prendergast, C. (1993); Hofmann, C., & Van Lent, L. (2017); Sinnott-Armstrong, W. (2006); Kurt T. Dirks, Donald L.

			Ferrin, (2001);
Socialism	Collective Ownership	Centralized Planning, Democratic Governance Models	Bresser-Pereira, L. C. (2012); Frieden, J. (2020); Restuccia, D., & Rogerson, R. (2017); Zheka, Y. (2007); Jensen, M. C., & Meckling, W. H. (1976);
Capitalism	Private Property/Market	Profit Motive, Competition, Resource Allocation	Bresser-Pereira, L. C. (2012); Frieden, J. (2020); Restuccia, D., & Rogerson, R. (2017); Zheka, Y. (2007); Jensen, M. C., & Meckling, W. H. (1976);

Source: Own elaboration based on the bibliography (2025).

To complement the analysis, comparison criteria were established, such as the conception of the human being, the foundation of knowledge, the decision model, the power structure, the relationship with the historical context, the ethical perspective, and the purpose of the organization.

From such criteria, convergences, tensions, and contradictions among the different philosophical traditions were identified. In this manner, the documentary perspective allowed for work with a diversity of primary and secondary sources, integrating theoretical data with empirical examples of administrative application. Likewise, the interpretative dimension was supported by a hermeneutic framework that recognizes the symbolic nature of language and the necessity of understanding texts in their entirety, including their implicit presuppositions and ethical implications.

The results obtained through the documentary and comparative analysis allow for the construction of conceptual maps regarding philosophical influences on management. These maps demonstrate how the different philosophical currents have not only offered worldviews but also provided concrete models for organization, leadership, decision-making, ethics, and institutional structure.

Based on the preceding analysis, the following structures for critical documentary analysis are considered, drawing upon the contributions identified in the consulted works. Initially, a process of conceptual mode*l*ling designed to identify predominant discursive elements reveals distinct central tensions implicit in the construction of a modern administrative paradigm capable of effectively responding to the challenges and contextual circumstances pertinent to current times. Subsequently, a set of figures will be presented, referring to various conceptual dynamics between different theoretical poles. These poles represent a set of approaches related to distinct administrative perspectives, including instrumental and humanist approaches, normative and situational rationality, rationality and decision-making, empiricism and pragmatism, in addition to the political and historical dimensions that represent the evolutionary richness of administrative thought throughout history. Thus, the first comparative figure, which highlights the tensions between the instrumental and humanist poles, is presented below:

Figure 1. Central Tension: The Instrumental Pole vs. The Humanist Pole

Axis: Understanding of the human being



Source: Own elaboration (2025).

Regarding the concept of the human being, three major paradigms are identified. The first is the instrumental paradigm, represented by slavery and positivism, in which the human being is understood as a resource at the service of the productive order. In this model, the worker loses their status as a subject and becomes an object of management, resulting in authoritarian, disciplinary, and alienating practices. The second paradigm is the existential and phenomenological paradigm, in which the human being is seen as a free, reflective, and situated subject, whose concrete experience is the basis of organizational meaning. This paradigm gives rise to humanistic, participatory management models focused on holistic well-being.

Figure 2. Tension on the Decision: Normative vs. Situational Rationality



Source: Own elaboration (2025).

For what it comes to rationality and decision-making, the present contrast study reveals a clear distinction between normative and pragmatic approaches. Stoicism, Scholasticism, and Existentialism propose a principle-oriented rationality, where decisions are guided by virtue, morality, or authenticity. In contrast, empiricism and pragmatism favor a situational and adaptive rationality, where decisions are evaluated based on their effectiveness and the results achieved. Skepticism lies between these two poles, introducing a critical rationality oriented toward methodical doubt, continuous evaluation, and the avoidance of dogmatism. With

respect to historicity, the analysis shows that approaches such as historicism and socialism offer a dynamic, evolutionary, and situated view of organizational phenomena. In these traditions, all forms of management must be understood as the product of historical development, not as the mechanical application of abstract models. This perspective contrasts with the positivist and capitalist view, which tends to universalize the principles of efficiency, competition and rationalization, ignoring the cultural, historical and social particularities of organizations.

Figure 3. Structural Tension: The Political and Historical Dimension

Axis: Historicity and Organizational Structure.



Source: Own elaboration (2025).

The third paradigm is the historical-collective paradigm, which considers the individual as a social and historical agent, a bearer of rights, and part of structural processes. Here,

administration is understood as a means of social transformation, not merely as a technical instrument. Capitalism and positivism consider it a factor of production, whose purpose is the generation of wealth and efficiency. These differences have direct implications for how working conditions, incentive systems, and labor relations are conceived.

Conclusions

The contrastive analysis offers a contrasting overview of the influence of philosophical currents on administrative thought and practice, focusing on three central aspects: the epistemological relevance of each current in the construction of organizational knowledge, the ethical and political pertinence of their proposals for contemporary challenges, and the possibility of articulating an integrative approach that transcends the limitations of each tradition separately. In this way, it is confirmed that administration cannot be reduced to a neutral and universal technique, but rather that every organizational decision is permeated by ontological, epistemological, and axiological assumptions. From this perspective, philosophy provides critical tools to unmask the implicit paradigms operating in administrative theories and to open new possibilities for thought. Positivism, for example, has been fundamental in shaping a scientific administration, based on measurement, prediction, and control, but its pursuit and predilection for absolute objectivity and its disdain for subjectivity have been challenged by phenomenological and existentialist approaches, which insist on the need to understand the lived meaning of organizational experiences. On the other hand, while empiricism prioritizes concrete experience as a source of learning, rationalism, as proposed by Stoicism or Scholasticism, relies on reason as a normative guide for action. Pragmatism, for its part, offers an intermediate path, proposing that the value of a theory or decision depends on its practical consequences—a view that has been highly influential in results-based management and performance evaluation systems.

On the ethical level, philosophical currents allow us to rethink the meaning and purpose of work beyond the logic of productivism. These currents are strongly represented by movements such as humanism and existentialism, which promote a people-centered approach to management, understanding the individual not as a means but as an end in themselves. For its part, Stoicism offers an ethic of resilience and individual responsibility, useful for dealing with uncertainty and stress in complex organizational environments, while Epicureanism emphasizes balance, moderate pleasure, and harmony, which can enrich current debates on workplace well-being, mental health, and quality of life at work. In terms of proposals stemming from historicism and socialism, it is evident that organizational forms, leadership models, and efficiency criteria are not neutral, but rather expressions of power relations, social struggles, and dominant ideologies.Thus, this theoretical and conceptual suggest a re-evaluation of philosophical thought in the field of administration, highlighting the need for a meaningful administration capable of integrating reason and emotion, efficiency and justice, logic and ethics, where administrative models tend toward the development of leadership oriented toward a critical thinking by open reason.

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Education, art and technology

Dos Santos Cunha, Marla José
mjscunha@net.sapo.pt

Introduction

In view of the numerous transformations in various areas, education currently faces new challenges and the need for support from other fields that can help enhance the education of individuals. Given the above, this article seeks to shed light on the contribution that these areas, when combined with education, can offer to help ensure that education is more than just the provision of knowledge. Indeed, educating is, above all, about paying attention to diversity, the different rhythms of students and being committed to the overall development of the human being. In this context, and targeting innovative teaching approaches, art can be one of those areas which, because it can act as a catalyst in creative educational processes – to start a joint journey with education and share its goal of helping young people to become successful learners, confident, active and responsible – can make a major contribution to education. Likewise, technology is another area which, as it offers richer and more diverse teaching and learning possibilities, should be taken into account when educating individuals. Thus, what prompted the production of this article – supported by a qualitative, exploratory methodology and grounded on the work of authors who have study the topic under analysis – was the desire to address important aspects that may result from the intersection of art and technology with education, ascribing the latter another contribution, since both art and technology are components capable of promoting more meaningful and lasting learning, and are, therefore, pivotal for a complete education, that is, an education capable of leading to the full development of the individual.

Methodology refers to a systematic approach for examining reality in order to understand and explain it better. Through reflective action, it also seeks to improve the situation being studied. This research adopts a qualitative methodological strategy, relying on bibliographic research that involves reviewing published works relevant to the topic at hand.

Art in the holistic development of the human being

Art, which was once viewed as a basic form of expression, is now perceived in a new light. Its ethical, aesthetic, poetic, and philosophical elements enable it to document not just its era but, in many ways, to anticipate and go beyond it. Art can be defined as

> […] a skill or technique developed by human beings in a conscious and rational way. In the broadest sense, art is anything that evokes human thought intended to produce something with identity. If it were possible to classify them, writing, music, communication, theatre, literature and even politics could be considered art. (Scherch, 2021, p. 15)

According to Proença (2007), art is a cultural phenomenon fraught with complexity that opens up perspectives for the creation and production of communicative processes, insofar as it favours subjective processes of conveying/transmitting values and signs.

Art serves as a medium for reflection, discussion, questioning, and, most importantly, interaction. It is a form of knowledge developed through experimentation. Moreover, art

possesses the ability to highlight the pressing issues that impact the environment in which humans live. The points emphasised, along with the understanding that art in its various forms can significantly enhance students' learning, support its inclusion as a vital component of school curricula at different educational levels. In this context, Ferraz and Fusari (2009) argue that art education adds to the development of creative skills and the formation of critical citizens.

> […] due to the subjectivity of the common understanding of art and people's lack of artistic experience, interpretations arise that disregard the value of art as an area of knowledge, resulting in simplistic views that interfere with school practice. (Meira & Formiga, 2018, pp. 1-2)

Art, in its many forms, serves as a powerful tool that combines emotions and beliefs. It allows individuals to express their thoughts and feelings freely, as well as to convey their perceptions of the world. This creative expression helps people develop their thinking. Educating individuals through art provides them with the opportunity to unlock their creative potential and enhance their skills in production and execution. Additionally, Meira and Formiga (2020) state that "playful elements applied to learning can be an excellent way to achieve positive outcomes, as they promote relaxation, enjoyment, and integration within the school environment. These factors are critical for both social and cognitive development" (p. 8). On the other hand, according to Nobre (2013), "art conceived as educational work, as a form of learning, characterised by freedom to do and create, developed through projects, makes autonomy a reality" (p. 34), were it not for the fact that it is a form of knowledge that permeates the body and allows us to reason and reflect.

The possibilities of art – which is characterised by pleasure, a pleasure that, developed through activities that provide delight and enjoyment, is closely related to playfulness, artistic experiences and experiences that promote students' well-being and contribute to learning (Meira & Formiga, 2020) – allow for the discovery of a wide variety of techniques and forms of expression, as well as the full development of the individual's personality.

Art is, in fact, an expression of life and, when associated with the creative process, it becomes the individual's ability to fully exercise their condition as a human being, since by experiencing the creative process, that is, by giving shape to materialities, the individual becomes more confident of their potential and aware of their limits, and this contributes to them becoming more authentic and freer to make their own choices.

The connection between art and elements that are part of human nature, such as feeling and pleasure, and the fact that it can be associated with human expression and creative freedom, mean that art has always had a strong alliance with individuals, namely by enabling them to channel their productive energies through it. In addition to this, Vianna (2011) considers that, through art education, it is possible to develop skills such as attention, motor coordination, focus, creativity, and affectivity. For these reasons, art promotes the integral development of the individual and, in certain situations, emerges as a vital necessity, not a necessity of the body, but of the spirit. By establishing a link between different human beings and enabling us to materialise what we are not, but have the possibility of being, art humanises us. Furthermore, as Ugino (2013) points out, today's young people want to be protagonists and, to achieve this, they need to learn from the new school, a new way of seeing, a new way of listening, a new way of acting in the world. In this regard, it is important to consider the

importance of art and its creative processes, which lead individuals to feel involved in meaningful experiences that will enable them to gain knowledge and establish relationships. These interactions are transformations that change their behaviour.

An education with art: A journey towards life

Today, education has a broader scope, as it encompasses global learning objectives that integrate transversal competencies across various areas of individuals' lives. Furthermore, according to Castro and Brazão (2022), "[…] education should play a humanising role, aiming to improve society through the people it educates" (p. 2). On the other hand, discussing education leads us to the concept of school, a place where knowledge is conveyed in a systematic way and where a cluster of ideas, values, attitudes, habits and rules are instilled. As a space and time for systematic teaching and learning, school is one of the places where students have the opportunity to establish links between the knowledge they have acquired and social and cultural knowledge. In fact, it is the public space that society has chosen to achieve its educational goals through its actions, as it is in this space that the education of each individual is built. Indeed, as Kenski (2023) reflects, "knowledge offered by schools, of all levels and types, reflects society's desires regarding the knowledge and actions that all people, especially the younger generations, need to learn" (p. 22). However, despite the major educational changes currently being seen in various sectors of human activity, these changes are not significant, particularly in terms of the organisational structure of schools and the teaching practices developed within them. This is why educational processes continue to reproduce traditional models, even though schools now incorporate new technologies, curricula and more dynamic methodologies into their daily routines. On the other hand, it is well known that the knowledge attained at school must be applicable to the student's personal and professional life.

> In the educational environment, teachers play a key role. Their decisions and actions, for example, based on their expression, methodology, way of prioritising content and curriculum, form of assessment, values, social vision and attitudes, among others, directly influence the results of the teaching-learning process. (Meira & Formiga, 2018, p. 10)

To carry out their task, teachers therefore need to develop methodological strategies that allow them a certain degree of dynamism and connection with the reality of the young people who attend school, a reality that is currently shaped by the culture of technology. Moreover, and because it is the role of education to enable a balance between the hand and the mind, between doing and being, schools must provide competencies development that responds to the challenges facing society in training capable and autonomous citizens who are able to think critically and creatively, without forgetting that, as teachers will determine the right path for students to follow in the face of the countless possibilities they encounter when they immerse themselves in social and entertainment networks, it is essential to take their preparation into account.

Art and artistic practices and methodologies serve as powerful tools for representing and reshaping human experience, holding significant transformative potential. We believe that when these methodologies are employed effectively, they can help achieve important objectives, especially given their ability to form the foundation of knowledge production. Furthermore, according to Meira and Formiga (2020), "[...] playful elements applied to

learning can be an excellent way to achieve good results, as they bring relaxation, fun and integration to the school environment, which are fundamental aspects for social and cognitive development" (p. 8). This explains why research centres in areas such as social sciences, arts, or education have resorted to artistic practices and creative processes, which allow for different ways of data collection and interpretation, synthesis of results, and communication of knowledge, and which can, therefore, even if they are sometimes given less importance, be ways of addressing educational issues. Indeed, creative educational processes not only seek to establish a balance between the self-referential dimension and the connection to the surrounding reality but are also driven by a deconstruction of preconceived ideas about areas related to art. However, it is precisely because these creative processes are rooted in art-based research methodologies that they have such cross-cutting value, i.e., they can be integrated into educational research. Furthermore, as Pereira and Portugal (2018) point out, the production of knowledge through practice, which gives voice to its actors, is accompanied by well-founded reflection that is central to the entire process, as it allows for the constant evaluation of each stage and the need to readjust the action in progress. This is what happens when theatre is used, through activities that, as Pereira and Portugal (2018) state, can stimulate reflection on the specific processes of this area, in which the temporal, bodily, visual, symbolic and communicational dimensions interact in the same space of action and can establish a new perspective on art education. These possibilities arise from the fact that these creative educational processes propose, above all else, a deconstruction of preconceived ideas about the arts and enable their understanding as dynamics of transformation.

> Through reading and critically analysing texts, physical and vocal exercises, and group dynamics structured around objects that induce performative action, it is possible to gain an understanding of the globalising dimension of theatre through the way it invokes the presence of the body in the act of communication, empathy, and the social dimension that individual action entails. (Pereira & Portugal, 2018, p. 737)

Given the above, it makes perfect sense to consider education through art, as it allows students to develop their creative potential, their ability to produce and execute their activities, and become more confident, authentic and free to make their own choices in the course of their lives.

Technology: An agent of innovation and education

In the search of a conceptual definition, the term technology, according to Scherch (2021),

> […] is the study of the technique, it should be said that this, in turn, is the means of achieving something. Often, terms such as technique, art, skill, craft, manner, talent, gift, and speciality can appear as synonyms in a context of the same meaning (p. 17).

According to Souza (2018, p. 10),

> The term technology has an imprecise meaning, sometimes being confused with advanced or improved techniques, and, moreover, the use of the term differs in various countries. The word technology has Greek origins: *tekne* means "art, technique or craft". The suffix logos means "body of knowledge". Thus, the word means the body of knowledge that, when combined, allows producing objects, modifying the environment in which we live, and establishing new situations for problem-solving.

> These stem from the human need to improve knowledge and facilitate human life and tasks; in short, they arise from the need for knowledge specialisation.

As Alves (2022) argues,

> If we look back at history, we see that techniques have existed since ancient civilisations. The first milestone occurred when humans began to use their reasoning abilities and walk upright, since, by freeing their hands and using their reasoning abilities, they started creating techniques that helped them survive. By gathering in groups, they secured the right to solve the challenges imposed by nature. Various tools were created, along with techniques for using them, and subsequent generations perfected them (p. 4229).

Given the above, technological developments and changes are not new to our time, as they have been driven by different needs and scientific discoveries, which justify their presence alongside humankind for millennia. Furthermore, and as the technological revolution is capable of handling the production and transmission of information at an extraordinary speed, it is not surprising that the use of technology has emerged in a constantly evolving universe, resulting in the development of new forms of artistic, technical and aesthetic design through human-machine interaction, which allow for involvement and interaction in the creation of diverse artistic objects, even though, in today's society, the excess of technology is responsible for a mechanistic and impersonal expression. In short, in the opinion of Santos and Garcia (2023),

> [...] technology is the result of human creativity, curiosity and the search for solutions to challenges and needs. Its origins date back to prehistoric times, and over the centuries, it has evolved to meet the demands of each era, driving the evolution of society. (p. 27104)

On the other hand, according to Zamperetti and Rossi (2015), technology has decisively changed resources and means of communication, access to information, and entered the school environment to modernise it, bringing it into line with the technological advances that have been felt by society, in which both society and education have had to adapt to the process of introducing new technologies. To this, Scherch (2021) adds that "technology is a human creation that may one day become self-improving, but whether it will be fully emancipated is still an open question" (p. 21).

The constant presence and ease of access to technology mean that young people, who are a potential audience for social media and online entertainment, are exposed to diverse types of content and visual and audio stimuli. Furthermore, as Costa Júnior et al. (2023) argue, "[...] new information and communication technologies (ICTs) offer new possibilities for teaching" (p. 126). For these reasons, in an educational context, technological culture is an issue that should be observed and given greater attention, as it has had an impact on student profiles, given that, as Meira and Formiga (2020) state,

> Today's young people are surrounded by technological elements that did not exist in this form in previous centuries; therefore, when working within the context of those involved, it is impossible to ignore technological tools as part of students' daily lives (p. 390).

In this new context, computer technologies, which are increasingly present alongside other techniques and easily accessible, enable increasingly creative work, which is why computers are considered powerful tools for creation. In fact, in the educational context, technologies, according to Teixeira et al. (2021), "[...] offer pathways for the development of cognitive and socio-emotional competencies, while keeping students engaged and motivated" (p. 440), thereby enabling richer learning because it increases dialogue and interaction between the educational content taught and those involved in the process. It follows from the above that the relevance of technology in education cannot be denied. For the reasons outlined above, because it enables personalised learning, provides real-time feedback and access to additional resources, technology currently plays a paramount role in the classroom. Furthermore, according to Moran (2015), educators can leverage the benefits of technology to create a more engaging and effective learning experience, thus preparing students for an ever-evolving digital world. This is, therefore, one of the many reasons why teachers believe that the use of ICTs can help face the challenges that schools currently need to address, particularly in terms of changes in the teaching-learning process and the education of young people, not least because technology, driven by the imagination of contemporary man, continues to advance.

Technology and art: What relationship?

Establishing a relationship between technology and art is no easy task. However, it is well known that both are important areas of knowledge for human development. In the words of Scherch (2021),

> […] art can be seen as a broad concept, ranging from the cognitive threshold expressed in cave paintings to the development of a digital canvas by artificial intelligence. No less broad, technology can range from the tip of a chipped stone spear to a drone that has the ability to identify and shoot down its target (p. 14).

In the field of education, art has played a fundamental role in promoting creative expression, cultural development and critical analysis ability. However, with the emergence of technology in education, art teaching has undergone significant changes, in that "[...] technology offers a range of resources and tools that can enrich art teaching, providing new perspectives and possibilities for students" (Santos & Garcia, 2023, p. 27 101).

It is known that art is linked to feeling, which is expression, enjoyment, appreciation and interpretation, while technology enables the development of creative potential, production and execution of artistic activities; that both areas are autonomous and, although different, one does not cancel out the other, and that the fact that they influence each other is one of their main features. In addition to the many connections between technology and art and the fact that their relationship can lead to more knowledge and innovation, another situation that links them is the possibility of one explaining the other, although, according to Agamben (2004), as both have flaws and merits, harmonisation and improvement can be an important means of escaping the technology of domination. However, in Scherch's opinion (2021),

> […] the important thing is to note that art and technology can go hand in hand, which was explained in the 18th century using heat chambers, valves and the working of the steam engine, is explained in the 19th century using gears and the improved combustion engine, in the 20th century, the allegory of transistors, radio waves and

> the computer as the supreme machine is used, which, in the 21st century, is overtaken by circuit paths representing artificial intelligence (p. 20).

In the field of education, it is therefore not surprising that the relationship between art and technology, as the latter provides more interesting, dynamic and interactive lessons, results in students' more active engagement and participation, which, in turn, enables them to develop certain skills and, consequently, better prepare for the future. Technology can also play a role in contact with the arts and, in the educational sphere, as a resource that enhances this contact.

Concluding remarks

Given that we live in a time when society is placing new demands on schools, forcing them to rethink a new reorganisation that will enable them to change, this article, entitled 'Education, art and technology', seeks to understand the importance that the teaching of art and new technologies can have for the education of individuals. Indeed, change can, in the opinion of many, come about by embracing an education in which art and technology have a place, that is, a quality education that offers students learning situations using diverse materials, including their bodies, which represents a relevant advance in education, as we need to understand that the concept of education has changed, that art and technology have also changed, and that the aim is therefore to leverage them as possible added value for education. The analysis concludes that this type of education will enable students to develop their potential to create, produce and carry out their activities, given that, as Scherch (2021) points out, art has the ability to go hand in hand with technology. In addition, students need essentially active learning, in a process of guided discovery, group interaction and integration of theory and practice, where "[...] playful elements applied to learning can be an excellent way to attain good results, as they bring relaxation, fun and integration to the school environment, which are fundamental aspects for social and cognitive development" (Meira & Formiga, 2020, p. 8). Understanding art and technology, which is increasingly accessible and offers countless possibilities, as a new form of learning and offering it to students, is therefore paramount, given that it brings significant benefits to education, in that it increases student engagement; personalises learning; offers possibilities for creation; provides access to quality content; fosters the development of skills; stimulates creativity and critical thinking, and interaction and collaboration between them. In summary, this new way of learning helps to make these students more aware and educates them to receive, understand and build values, given that art and technology adopted in the educational sphere and explored therein for the benefit of student learning can be a relevant support base for today's young people, who want to be protagonists, to learn a new way of seeing, hearing and acting in the world, which they want to change for the better.

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The Solar Pendulum: Solar Cycles and Leadership Styles

Alfredo Behrens
FIA Business School (Brazil), alfredob@fia.com.br, https://orcid.org/0000-0002-1042-0485

Introduction

Contemporary scholarship faces a fundamental challenge in explaining the synchronized emergence of similar leadership styles across geographically and culturally distinct societies. The Arab Spring (Alianak, 2014), Latin America's "pink tide" (Sotomayor, 2022; Feierherd, 2023), and Europe's postwar oscillations between social democratic and conservative governments demonstrate that political movements often transcend national boundaries in ways that traditional economic or institutional explanations struggle to fully account for, though Machiavelli had suggested, five centuries ago, a pendular oscillation between political regimes (Corradetti, 2024).

Intriguingly, while scholars refer to cyclical metaphors like "seasons" or "tides" when referring to changes in leadership styles, conventional frameworks for understanding changes in political leadership do not use cyclical approaches.

Instead, conventional Left-Right frameworks rely heavily on materialist interpretations rooted in economic conditions, class dynamics, and institutional pressures. However, recent political developments worldwide—from the rise of populist movements to the emergence of technocratic governance—often defy traditional ideological classifications, indicating that deeper psychological orientations may drive political preferences.

Alternatively, because the Sun is the only natural and cyclical force powerful enough as to impact human behavior across the world and over long periods of time, we propose the "Solar Pendulum leadership hypothesis", which addresses what is metaphorically referred to as a cyclical phenomenon in political leadership enactments across the world.

The Solar Pendulum hypothesis fits into an expanded ecological interpretation of change (Healy, 1998) in the sense that the Solar Pendulum hypothesis accepts that the impacting factor changing the environment may be beyond the system. In this sense, because the Sun's impact is cyclical, the Solar Pendulum hypothesis also transcends the irreversible Darwinian evolution convention to explain intra-species competition.

The Solar Pendulum hypothesis rests on three interconnected theoretical pillars: solar cycle variability, solar-driven geomagnetic effects on leadership styles, and social homeostatic responses (Billman, 2020). The Solar Pendulum hypothesis recognizes that solar cyclical activity nudges the human organism off equilibrium, to which the organism seeks to return, driven by the homeostatic principle, thus enhancing the pendulosity of the phenomenon.

Solar cycle

The sun's magnetic field undergoes regular cycles of approximately 11 years, alternating between periods of intense activity (characterized by numerous sunspots, solar flares, coronal mass ejections) and quieter phases with minimal sunspots. These cycles generate varying levels

of electromagnetic radiation and charged particle emissions that interact with Earth's magnetosphere.

Emerging research in heliobiology suggests that solar-driven geomagnetic disturbances can influence human physiological systems, (Palmer, Rycroft, & Cermack, 2006), potentially impacting behavior (Behrens *et al.*, 2025). While these effects remain contested, they provide biological plausibility for solar influences on human behavior and decision-making.

Leadership styles

Political leadership operates along fundamental psychological dimensions that transcend traditional ideological categories. Bakan's (1966) Agency-Communion framework identifies two primary orientations that shape human behavior and, by extension, leadership approaches.

Agency encompasses the drive toward autonomy, self-assertion, and individual achievement. Agentic leaders prioritize decisive action, hierarchical control, and competitive advantage.

Communion emphasizes connection, cooperation, and collective welfare. Communal leaders prioritize consensus-building, institutional stability, and collaborative problem-solving.

This framework offers several advantages over traditional Left-Right classifications. First, it captures leadership styles that may manifest across different ideological positions—an agentic leader might be politically progressive or conservative while maintaining similar decision-making and communication patterns. Second, it recognizes that effective leadership often requires situational adaptation between agentic and communal approaches.

The homeostatic hypothesis

Drawing on Parsons' (1951) social systems theory, we propose that societies maintain dynamic equilibrium through adaptive responses to environmental stressors (Billman, 2020). When solar-induced geomagnetic disturbances create physiological and psychological stress within populations, collective political preferences may shift toward leadership styles that restore homeostatic balance. We propose the Geomagnetic Homeostatic Burden index to estimate the mounting pressure and its release.

The Geomagnetic Homeostatic Burden Index (GHBI)

To quantify the relationship between solar activity and potential biological stress, we developed the Geomagnetic Homeostatic Burden Index:

$$GHBI = (A \times W_1) \times (F \times W_2) \div (R \times W_3)$$

Where:

A = mean amplitude of geomagnetic disturbances

F = frequency of disturbances over defined periods

R = recovery value, triggered by larger than 10% drops in peak sunspot numbers

W_1, W_2, W_3 = weighting factors

This index captures three essential dimensions: the intensity of geomagnetic disruptions, their frequency, and the recovery periods available for biological systems to re-establish equilibrium.

In that it is multiplicative and not additive, it allows us to consider that disequilibrium in some dimensions may have a greater overall impact.

Solar Activity Data: Sunspot numbers were sourced from the Royal Observatory of Belgium (WDC-SILSO), providing continuous yearly sunspot number measurements from 1960-2024.

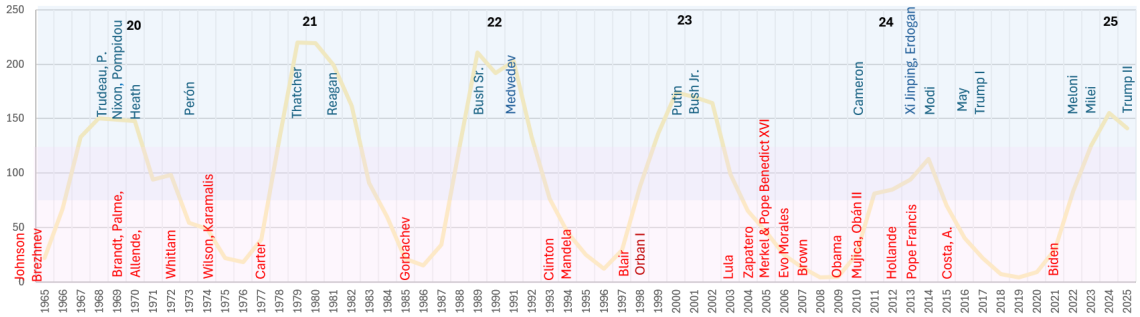
Leadership Classification Criteria: Political leaders were selected based on the following criteria:

Heads of state or government, taking office between 1960-2025, in major world economies of the Global North group, plus a selection of heads of large countries of the Global South, as per the United Nations Conference on Trade and Development (UNCTAD 2024).

Leader Classification Protocol: leaders were classified as primarily "Agentic" or "Communal" based on documented behavioral patterns, communication styles, and policy approaches close to their first year in office.

We selected 46 prominent mostly western leaders and classified their agentic or communal leadership style by consulting with Artificial Intelligence (AI) agents ChatGPT and Claude.ai. We asked those AI agents to rank between 1-3 the strength of their perception as to the leaders' styles, and the author resolved the few discrepancies. This data is available in (Behrens, 2025a) and summed up in Figure 1.

Figure 1. Distribution of Agentic (blue) and Communal (red) leaders on the years they took office, with number of sunspots per year (LHS) by solar cycles, spanning six decades



Statistical Analysis Plan and Results

A visual appreciation of Figure 1 portrays high solar activity on cycles 21-23, preceded and followed by the relatively less active cycles 20 and 24, respectively. That is why we applied the same statistical tests to an extended period, cycles 20-23, and to the high activity cycles 21-23.

The relationship between solar activity, as per the number of sunspots, and leadership type was analyzed using two statistical approaches for each of the two sets:

- Point-biserial correlation between sunspot numbers and leadership classification
- Mann-Whitney U tests comparing solar activity distributions

The comparison in Table 1 between the test results for the two datasets reveals a striking intensification of the solar-leadership relationship when focusing on the peak solar activity periods. Moving from the broader 44-year span (cycles 20-23, 1963-2007) to the concentrated high-solar activity years (cycles 21-23, 1977-2007) transforms what was a moderate association into a remarkably strong one.

Table 1. *Comparative Statistical Test Results.*

Dataset	Test	Statistic	Value	p-value	Effect Size	Median/Mean Difference
Extended (1963-2007)	Point-Biserial Correlation	r_pb	0.404	0.024*	R^2 = 0.163	-
High Activity (1977-2007)	Point-Biserial Correlation	r_pb	0.817	<0.001*	R^2 = 0.667	-
Extended (1963-2007)	Mann-Whitney U	U	46.0	0.017*	r = 0.43	Mdn diff = 122.50
High Activity (1977-2007)	Mann-Whitney U	U	6.0	<0.001*	r = 0.72	Mdn diff = 144.17

*p < 0.05

The point-biserial correlation nearly doubles in strength, jumping from r = .404 in the extended dataset to r = .817 in the high-activity subset. This represents a dramatic increase in explained variance from 16.3% to approximately 66.7%, suggesting that the relationship between solar activity and leadership type becomes increasingly pronounced during periods of elevated sunspot activity. The statistical significance also strengthens considerably, moving from p = .024 to what would be p < .001 based on the Z-score of -3.071.

The Mann-Whitney U results tell a complementary story of amplification. While the broader dataset showed medians of 170 for Agentic and 47.5 for Communal leaders with an effect size of r = .43, the high-solar activity subset reveals means of 199.5 versus 55.3 with a much larger effect size. The tests results suggest that the solar-leadership relationship operates with particular intensity near high solar maximum periods, where the differentiation between leadership types becomes more pronounced.

The years 1977-2001 show a predominant pattern of Agentic leadership during high solar activity, while 2003-2007 shift toward Communal patterns despite still being classified as high-activity years. This inflection point coincides with the transition from Solar Cycle 23's maximum phase to its declining phase, suggesting that the relationship may be sensitive not just to absolute sunspot levels but to the solar cycle's directional momentum.

These results dovetail with those of the GHBI formula (Behrens, 2025b), which draws on the volatility of the solar cycles, greater on cycles 21 and 22, when the number of sunspots per unit of time grew and dropped faster than in the following cycle 23. The latter has a larger footprint, almost 13 years between solar minimums, instead of the usual near 11 years. On the GHBI formula, Cycle 23 also shows an inflection point, around 2000, suggesting that the homeostatic pressure built over the preceding two cycles begins to release after 2000, priming the population to seek more diverse distribution of leader types, as if it were time for healing. We see this in the greater number of communal leaders as from 2003. Yet, during cycle 24, the

number of sunspots was so low that the correlation between sunspots and leadership styles did not render statistically significant results. The observed robust correlation between solar activity and political leadership emergence patterns suggests that solar-geomagnetic influences may represent a previously underexplored factor in collective political behavior. The large effect size indicates not only statistical significance but substantial practical importance.

Potential Mechanisms and Implications

Solar driven geomagnetic disturbances may directly influence neurochemical systems, affecting mood, decision-making (Zilli-Viera, 2025) and risk tolerance in both leaders and voters, suggesting how the latter may exert their preferences for the former, primed by solar activity and its near regularity. For instance, after completing the long-term analysis of solar cycles, Wolf concluded in 1862 that two or three solar cycles of decreasing maxima appeared to be followed by a similar number of solar cycles of increasing maxima (Peristykh & Damon 2003). This lends itself for speculative forecasting.

If validated through further research, the Solar Pendulum hypothesis could significantly expand political, economic and business science by introducing heliobiological factors into models of behavior, including homicides (Behrens, *et al.*, 2025), riots (Behrens, 2025c), or even corporate leadership (Behrens, 2025d). This could enhance understanding of:

- The timing and emergence of political movements.
- Cross-national synchronization of political trends.
- The effectiveness of different leadership styles under varying environmental conditions.
- Long-term cycles in democratic governance.

Contemporary relevance: Solar cycle 25 (2019-2030)

The current 25th solar cycle, which began in 2019, offers a natural laboratory for testing the Solar Pendulum hypothesis. Early indications suggest increasing solar activity through 2024-2025, potentially favoring agentic leadership emergence globally.

In Iberia, the Solar Pendulum hypothesis may also explain why during a period favoring agentic leaders, Pedro Nuno Santos, the Portuguese communal contender failed so drastically, his party lost almost 26% of its seats in parliament, when calling a snap election against the Portuguese agentic incumbent Montenegro on April 2025.

Globally, the Solar Pendulum hypothesis may illuminate why two agentic leaders like U.S. President Trump and Israeli Prime Minister Netanyahu, teamed up to attack Iranian nuclear facilities in 2025, while the same agentic Prime Minister Netanyahu did not find in communal U.S. Presidents Barack Obama or Joe Biden the same degree of partnership, and had to accept the 2015 nuclear surveillance of Iranian activities agreed as per the Joint Plan of Action under the U.N. umbrella.

Limitations

The GHBI formula is still under development and has not yet been validated. In addition, this initial investigation faces several important limitations that future research must address on several dimensions namely: a) correlation does not establish causation, and multiple alternative explanations remain plausible; b) sample constraints: The analysis includes only 46 leaders

mostly from major economies, potentially missing important patterns in smaller nations or different political systems; c) classification challenges: the Agency-Communion classification, while objectively grounded, relies on subjective assessments that require more rigorous validation; d) temporal resolution: the study does not specify optimal time windows for correlating solar activity with political events; e) solar activity proxies: while in our analysis we settled for the number of sunspots, finer grade leadership data could benefit from using solar-derived geomagnetic stress-related variables such as Kp, ap, or Dst; f) confounding variables: The analysis does not control for economic cycles, demographic transitions, technological changes, or other factors that might correlate with both solar activity and leadership preferences.

Future Research Directions

In addition to the methodological limitations mentioned above, Future studies may engage in deepening the understanding on through which specific neurobiological pathways geomagnetic disturbances might influence human behavior and decision-making. This might open a therapeutical avenue to modulate solar activity influence on human behavior. Future studies may want to focus on a larger sample of political leaders across more diverse political systems. This might also raise questions about the cross-cultural possible limitations of the applicability of this study's approach. A rudimentary approach to forecasting was hinted here, but future studies would want to check whether the approach holds.

Conclusion

The story that emerged here - showing how the solar-leadership relationship intensifies during peak solar activity periods and the fascinating threshold effect around 2000 - makes compelling research findings. The Solar Pendulum hypothesis offers a novel perspective on political leadership emergence by proposing correlations between solar cycles and collective preferences for agentic versus communal leadership styles. While the observed statistical relationships are persuasive, they only represent initial evidence, requiring extensive validation and mechanistic investigation. In all, this innovative work is highly heuristic, and its main contribution is likely to be its capacity to raise further questions.

The current 25th solar cycle provides an unprecedented opportunity for real-time hypothesis testing. If the Solar Pendulum framework proves valid, it could enhance our understanding of political cycles and potentially improve our ability to navigate the complex interplay between cosmic forces and human governance. Not least because the current solar cycle seems to announce a sequence of two or three cycles of increased solar activity, when the Solar Pendulum hypothesis favoring the emergence of more agentic is likely to be further validated, as it was already for solar cycles with a high number of sunspots.

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Entrepreneurial mindset: a bibliometric analysis of its conceptual evolution, theoretical approaches, and research trends

Gonzalo Teófilo Moya-Bejar
Universidad Tecnológica del Perú (Perú), c16446@utp.edu.pe, https://orcid.org/0000-0003-2769-181X
Sinoe Geofrey Bahamondes-Garcia
Universidad Tecnológica del Perú (Perú), c16109@utp.edu.pe, https://orcid.org/0009-0000-4444-2837
César Augusto Medrano-Rodríguez
Universidad Tecnológica del Perú (Perú), c16150@utp.edu.pe, https://orcid.org/0000-0001-9379-3668
Erika Leny Cano-Valencia
Universidad Tecnológica del Perú (Perú), c31322@utp.edu.pe, https://orcid.org/ 0000-0002-3391-8040
Julio Augusto Sobenes-Salas
Universidad Tecnológica del Perú (Perú), c21933@utp.edu.pe, https://orcid.org/ 0000-0003-2516-7168

Introduction

In recent years, the entrepreneurial mindset - EM has evolved as a cross-cutting concept within the social sciences, associated with the ability to act strategically in uncertain environments (Haynie *et al.*, 2010; Kuratko *et al.*, 2021). Recent studies highlight its trainable and multifactorial nature, integrating cognitive, dispositional, and emotional dimensions (Pidduck, 2021, Daspit, 2023, Lynch & Corbett, 2023). Authors such as Bachmann *et al.* (2023) and Dheer & Castrogiovanni (2022) agree that digitalization has strengthened this competence, as digital skills are linked to entrepreneurial intention when mediated by self-efficacy and individual orientation. This connection has sparked growing interest in understanding how digital education fosters entrepreneurial thinking (Ashari *et al.*, 2022, Cui *et al.*, 2021, Debarliev *et al.*, 2022).

From an educational perspective, the literature reveals a clear trend toward developing the EM in higher education through active, collaborative, and interdisciplinary methodologies (Baggen *et al.*, 2022, Liao *et al.*, 2022, Secundo *et al.*, 2021). Studies by Báez et al., (2025) Otache *et al.* (2021), Rodriguez & Lieber (2020), and Karyaningsih *et al.* (2023) emphasize the importance of curriculum design, entrepreneurial inspiration, and faculty guidance. However, theoretical and practical challenges remain regarding the design of educational programs that effectively and sustainably strengthen EM (Mukhtar *et al.*, 2021, Blankesteijn *et al.*, 2023). Additionally, there is a pressing need for conceptual consensus, as numerous studies adopt divergent approaches and differing operationalizations of the construct (Ikonen & Nikunen, 2019, Brunhaver *et al.*, 2018).

On the other hand, the practical application of EM has expanded into areas such as social entrepreneurship, sustainability, and business internationalization. Authors like Ndou et al. (2019), Utoyo et al. (2020), and Thanasi-Boçe (2022) emphasize that EM not only enables business creation but also drives organizational transformation and social value generation. In this context, recent studies show how digital infrastructures and university incubators foster EM development, promoting innovation in Generation Z and university students through socio-cognitive factors, intellectual capital, and institutional strategies that respond to complex and interdisciplinary environments (Saeedikiya *et al.*, 2024, Mele *et al.*, 2024).

Review of Theoretical Models

The EM is a flexible cognitive-metacognitive competence that emerges from the interaction between the individual and their environment, experiences, and education. It is expressed through a proactive disposition to identify opportunities, plan, act, and evaluate under conditions of uncertainty (Cui & Bell, 2022). This way of thinking is shaped by factors such as inspiration, education, and the formative context. The model proposed by Shiri *et al*. (2025) identifies two dimensions: the elaborating mindset, focused on reflection and strategic analysis, and the implementing mindset, centered on action and the effective execution of goals.

The EM is a cognitive, action-oriented capacity that enables individuals to identify opportunities, make resilient decisions, and create value in dynamic and uncertain environments. It is characterized by the integration of judgment, proactivity, and strategic reasoning to effectively respond to contextual demands (Daspit *et al.*, 2023, Akbari *et al.*, 2024). Unlike trait-based approaches, this model emphasizes its development through higher education, shaped by curriculum design, content, and instructional methodologies (Cui *et al.*, 2021). EM is conceived as a key transversal competence for problem-solving, risk-taking, and leading social and economic processes.

The model proposed by De la Gala-Velásquez *et al*. (2024) conceptualizes the EM as a disposition shaped by educational and personal factors that influence academic formation and socioemotional skills in university students. It is measured through three dimensions: (1) curriculum relevance, which integrates practical content and promotes entrepreneurial experiences; (2) teaching competence, which assesses the faculty's ability to inspire, connect theory and practice, and stimulate critical thinking; and (3) problem-solving capacity, understood as the use of cognitive, emotional, and behavioral skills to face challenges with creativity and resilience.

According to Gabrielsson *et al*. (2025), the EM is conceived as an individual predisposition that guides interpretation, action, and strategic decision-making in response to global challenges. This cognitive and attitudinal framework aligns with individual entrepreneurial orientation and business model practices, enabling the development of flexible and sustainable responses in competitive environments. The model identifies three key dimensions: innovation (generating novel ideas), proactivity (anticipating and creating opportunities), and risk-taking (acting under uncertainty), all of which influence the internationalization of small firms and the design of adaptive business models.

This research is based on the assumption that the entrepreneurial mindset (EM) is a transversal, complex, and trainable competence influenced by cognitive, educational, and contextual factors. Its objective is to conduct a bibliometric analysis of the scientific output between 2000 and 2025, identifying the conceptual evolution, theoretical approaches, and existing gaps. Techniques such as keyword co-occurrence, author co-citation, and bibliographic coupling are employed to construct a structured map of knowledge. The review is organized into six sections, ranging from the introduction to the conclusions, including the PRICO methodology, results, discussion, and future recommendations aimed at non-traditional contexts.

The research question posed is: How has the scientific knowledge on the entrepreneurial mindset evolved in terms of thematic structure and interdisciplinary projection within the indexed academic literature from 2000 to 2025? This question guides the resolution of the

study's scientific problem and, in turn, justifies the use of bibliometric analysis as a method to synthesize and project the development of knowledge related to EM.

This research employs a bibliometric approach to systematically review the scientific output related to the EM variable. Through quantitative indicators and network analysis, it identifies publication patterns, thematic evolution, and cognitive structures (Aria & Cuccurullo, 2017, Ellegaard & Wallin, 2015). The combination of bibliometric techniques and science mapping enables the identification of influential authors, key journals, conceptual relationships, and gaps in the literature, providing a comprehensive overview of the field under study.

Data collection was conducted in Scopus over the period 2000-2025 to justify academic rigor, relevance, and the identification of emerging trends. The search strategy was implemented using the following query: The search strategy was implemented using the following query: TITLE-ABS-KEY ("entrepreneurial mindset") AND (LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Mindset") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurship") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurship Education") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Intention") OR LIMIT-TO (EXACTKEYWORD, "Innovation") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Education") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneur") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Skills") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Intentions") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Culture") OR LIMIT-TO (EXACTKEYWORD, "Sustainable Development") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Orientation") OR LIMIT-TO (EXACTKEYWORD, "Intrapreneurship") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Leadership") OR LIMIT-TO (EXACTKEYWORD, "Strategic Entrepreneurship") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Learning") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Behavior") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Cognition") OR LIMIT-TO (EXACTKEYWORD, "Family Business") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial University") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurialism") OR LIMIT-TO (EXACTKEYWORD, "Entrepreneurial Self-efficacy") OR LIMIT-TO (EXACTKEYWORD, "Social Entrepreneurship")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "DECI")). This strategy was replicable and designed to capture both conceptual and applied aspects of the variable.

VOSviewer was used to analyze and visualize bibliometric maps through keyword co-occurrence, co-citation, bibliographic coupling, and country collaboration (Van Eck & Waltman, 2010). The nodes represent the analyzed units and their thematic relationships. This combination enabled a comprehensive understanding of the field from both quantitative and qualitative perspectives, identifying research gaps and guiding future studies on the EM within educational contexts and diverse initiatives.

The PRISMA protocol, adapted to the PRICO approach, was applied to ensure rigor and replicability in the selection of studies. Out of 1,439 records identified in Scopus, 449 were excluded for not belonging to relevant subject areas. After evaluating 607 documents, 443 articles were selected that included key terms such as entrepreneurial mindset, entrepreneurial intention, and entrepreneurship education. The bibliometric analysis, conducted using RStudio, covers the period from 2000 to 2025 and includes publications across 220 sources. An annual growth rate of 20%, an average document age of 4 years, and an average of 16 citations per article highlight the field's current relevance. A total of 24,859 references confirms the

theoretical density of the corpus, allowing for a detailed mapping of the evolution and scientific maturity of the EM construct (Moher *et al.*, 2009).

According to the table 1, the analysis of scientific productivity on EM highlights Kraus as the most influential author, with 414 publications, an h-index of 86, and nearly 30,000 citations. He is followed by Del Giudice and Kuratko, each with over 11,000 citations and h-indices above 50. At a second level, authors such as Secundo, Jabeen, and Shams combine high publication output with moderate influence.

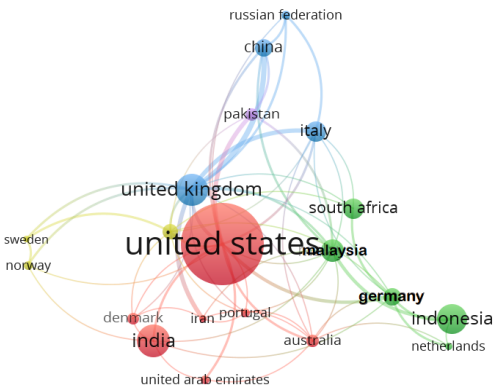
Table 1. *Most Productive Authors*

Ranking	Authors	Documents	h-index	citations
1	Kraus S.	414	86	29711
2	Del Giudice M.	167	54	11323
3	Kuratko D.F.	130	52	11542
4	Secundo G.	142	40	5129
5	Jabeen F.	134	34	3661
6	Shams S.M.R.	110	27	2289

Source: Information extracted from SCOPUS, may 2025.

The co-authorship network visualization in figure 1 positions the United States as the central node in EM-related scientific production, leading the densest cluster and exhibiting strong connections with India, the United Arab Emirates, Iran, and Portugal. In the blue cluster, the United Kingdom, China, and Italy stand out for their bilateral collaboration, consolidating their influence across Europe and Asia. The green cluster, led by Germany, Indonesia, and South Africa, reflects an expanding network between developed and emerging countries, highlighting the growing internationalization of research on EM.

Figure 1. Countries with the highest productivity



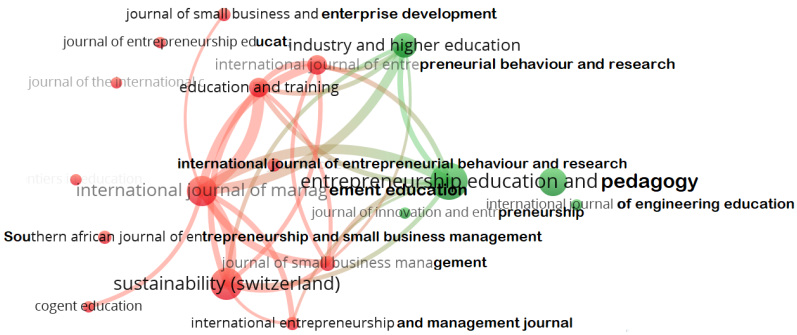
Source: data processed by VOSViewer.

The four main keyword clusters reveal a thematic structure surrounding the EM. Cluster 1

emphasizes the educational approach, with entrepreneurial mindset as the central node. Cluster 2 links technical skills and innovation within educational contexts. Cluster 3 addresses sustainability as a key dimension of entrepreneurship. Cluster 4 focuses on organizational and cultural factors, such as leadership and entrepreneurial culture, reflecting the diversity of approaches in the study of EM.

The network mapping (figure 2) reveals two main clusters. The red cluster groups journals such as Sustainability and Journal of Business Research, which focus on EM from an applied and interdisciplinary perspective, emphasizing sustainability and organizational behavior. The green cluster, including journals like Entrepreneurship Theory and Practice, centers on theoretical and strategic approaches. The strength of the connections between the two clusters indicates a growing integration between theory and practice, reinforcing the scientific and social relevance of the entrepreneurship field.

Figure 2. Journals with the highest productivity



Source: data processed by VOSViewer.

Conclusions

Research on the EM shows sustained growth, supported by a solid theoretical foundation grounded in cognitive-metacognitive, dispositional, and educational approaches. EM is recognized as a trainable and multifactorial competence linked to innovation, leadership, self-efficacy, and risk management. Scholars such as Haynie *et al*. (2010), Kuratko *et al*. (2021), and Shiri *et al*. (2025) emphasize its development across diverse educational and sociocultural contexts. The bibliometric analysis reveals an active scientific community, led by the U.S., with an interdisciplinary focus spanning business, education, and sustainability. A clear gap remains, highlighting the need for more integrative and applied research in non-traditional contexts.

This bibliometric study deepens the theoretical understanding of the EM, identifying it as a multidimensional and adaptable construct influenced by personal, educational, and contextual factors. While entrepreneurial intention is a key antecedent, it is not sufficient on its own to explain entrepreneurial behavior. Research highlights the importance of self-efficacy, education, and risk tolerance as complementary elements. Among the theoretical models reviewed, the framework by Shiri et al. (2025) stands out, articulating the elaborating and implementing mindsets by integrating reflection and action. This approach provides a comprehensive framework for future research and training programs aimed at strengthening entrepreneurial thinking from a cognitive and strategic perspective.

Practical Implications

The findings demonstrate that the entrepreneurial mindset (EM) has significant practical applications across multiple sectors. In education, it enhances youth employability and helps bridge the gap between academic training and labor market demands. In the business sphere, it promotes intrapreneurship by fostering innovation and distributed leadership. In vulnerable contexts, EM facilitates social mobility and sustainability. Fields such as engineering, tourism, and sustainable development benefit from integrating technical skills with strategic vision. At the individual level, EM strengthens self-efficacy, proactivity, and decision-making; at the organizational level, it promotes innovation and adaptability, positioning itself as a key competence for socioeconomic development.

Limitations and Future Research

This bibliometric study identifies geographic bias as the main limitation in the scientific production on entrepreneurial mindset (EM), which is heavily concentrated in countries such as the U.S., the U.K., Italy, and India, while overlooking emerging contexts such as Latin America and Africa. Expanding research to rural communities or regions with high informality is recommended to incorporate intercultural perspectives. Additionally, since the study relies on secondary data from Scopus, it lacks direct empirical evidence, limiting the validation of theoretical models. It is therefore advisable to complement the analysis with case studies, longitudinal surveys, and mixed-method approaches. Finally, structural barriers persist, such as limited entrepreneurial training and a lack of entrepreneurial culture in certain settings. Future research should explore educational, organizational, and policy conditions that support the development of EM—particularly among youth, women, and vulnerable populations—linking this mindset to inclusion, resilience, and social transformation.

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Digital Transformation in Microenterprises: Applications That Boost Productivity and Competitiveness

Álvarez Flores Lorena
Autonomous University of Baja California, Mexico, alvarez.lorena@uabc.edu.mx
https://orcid.org/0000-0002-9670-6264
Pérez Chavira Seidi Iliana
Autonomous University of Baja California, Mexico, seidi@uabc.edu.mx
https://orcid.org/0000-0001-9707-0520
José Cupertino Pérez Murillo
Autonomous University of Baja California, Mexico, cuper@uabc.edu.mx
https://orcid.org/0000-0002-4939-654X

Introduction

Digital transformation has established itself as an essential process for the survival and growth of microenterprises, particularly in emerging economies such as Mexico's. In Mexico, micro, small, and medium-sized enterprises (MSMEs) account for more than 99% of economic units and generate around 52% of the national Gross Domestic Product (GDP), in addition to providing nearly 68% of formal employment, which highlights their importance in the country's productive structure (Inter-American Development Bank [IDB], 2023). However, their level of digitalization remains low: only 17.2% of microenterprises report using the internet for business activities, compared to 81% of small enterprises, reflecting a significant internal digital divide (Mexico Business News, 2024a).

The adoption of digital tools—ranging from inventory management, accounting, customer service, and digital marketing systems to e-commerce applications—is a key strategy for increasing productivity and competitiveness. According to Grand View Research (2025), the digital transformation market in Mexico reached a value of $10.5967 billion in 2023 and is expected to grow to $61.8783 billion by 2030, with a compound annual growth rate ( ) of 28.7% between 2024 and 2030. This growth reflects an opportunity for microenterprises to become more actively integrated into the digital economy.

However, structural obstacles remain. According to the Federal Telecommunications Institute (IFT), the main constraints for MSMEs are the lack of technological infrastructure, a shortage of trained personnel, and limited investment in digital innovation. Only 47.9% of companies use cloud services, and 44% have stable internet access, which limits their potential for modernization (Mexico Business News, 2024a). Likewise, a study by the Chamber of the Transformation Industry (Ministry of Economy, 2024) indicates that only 26% of Mexican companies have initiated a formal digitization process, and of these, less than 12% are MSMEs.

Empirical evidence shows that microenterprises that adopt digital technologies are able to improve operational efficiency, reduce costs, and expand their marketing channels. For example, a study conducted in the regions of Guanajuato and Jalisco highlights that companies integrating digital tools reported increases in sales and greater visibility in local and global markets (Tiburcio-Sánchez, Lozano-Montero, and Godínez-López, 2023). In this sense, digital transformation involves not only the adoption of new tools but also a reorganization of business models and organizational culture.

The potential of digital applications is particularly high in the context of micro-enterprises, which require accessible and adaptable solutions. Tools such as Trello, QuickBooks, Canva, WhatsApp Business, or Shopify allow for the management of basic operations, improved communication with customers, and the optimization of limited resources. According to a recent study, 94% of Mexican entrepreneurs consider digitalization key to their growth, while 90% recognize that the combination of physical and digital channels will be decisive for their success (Mexico Business News, 2024b).

In this context, digital transformation represents a strategic opportunity for Mexican micro-enterprises to strengthen their competitive position. Analyzing the use of applications that boost productivity helps us understand how companies can adapt to new environmental demands, increase their operational efficiency, and reap the benefits of the digital economy. Therefore, this research aims to identify the degree of digital transformation among micro, small, and medium-sized enterprises, with the goal of helping them distinguish, from the universe of available applications, those that enhance their competitiveness and organizational efficiency. The study employed a quantitative, empirical, and cross-sectional approach, conducting 221 surveys of business owners in the San Quintín Valley, Baja California.

The methodology used in this research was organized into two stages. In the first stage, a survey was administered to entrepreneurs of micro, small, and medium-sized enterprises (MSMEs) to assess the degree of digital transformation and the use of technological applications that enhance their competitiveness. This study employed a quantitative, empirical, non-experimental, cross-sectional approach, using a non-probabilistic sample of business owners located in the San Quintín Valley, Baja California (Mexico).

For data collection, a survey instrument was developed based on a review of specialized academic literature, in which the variables were adapted to the local context. Data were measured using Likert-type items on a five-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Regarding data analysis, descriptive statistical techniques were applied, which allowed for the identification of patterns of technology adoption and an understanding of the main factors influencing the digital competitiveness of MSMEs in the region. During this process, 221 valid surveys were obtained, administered between February and May 2025.

In the second stage, an online search was conducted to identify digital applications that help optimize the basic operational functions of microenterprises, such as inventory management, sales tracking, finance, customer service, and digital marketing. This stage allowed for the collection of documentary information on the digital strategies and technological tools used by companies in their daily activities.

Systematization of Operations

Digital transformation is conceptualized as the strategic and systematic process by which organizations comprehensively implement digital technologies in their internal processes, product and service offerings, and the redefinition of their business models. The primary purpose is to optimize organizational performance, generate superior value, and proactively adapt to the demands of the competitive environment (Westerman, Bonnet, and McAfee, 2014).

This phenomenon involves a structural and cultural reconfiguration, in which companies not only adopt technological tools but also transform their strategies, operations, and business

mindset (Bharadwaj et al., 2013). In essence, digital transformation constitutes an organizational evolution catalyzed by technology, focused on enhancing operational efficiency and competitive advantage through continuous innovation and a strong customer-centric approach as a strategic pillar (Vial, 2019).

In the era of the digital economy, organizations face the strategic imperative to adapt and respond proactively to highly dynamic and uncertain business environments through the integration of advanced technologies. Technological applications have established themselves as essential tools for improving organizational performance and strengthening competitiveness (Barros-Bastidas & Gebera, 2020), (Hernández and Ríos, 2020).

The adoption of digital platforms enables companies to systematically optimize their internal processes, substantially improve interdepartmental communication, and enhance the quality of the customer experience and service. By using these tools, organizations can leverage the strategic value of data, automate routine tasks, and ensure agile adaptation to the changing demands of the globalized market (Meraz, 2024).

Microenterprises are defined as economic units characterized by a small number of employees, generally ranging from one to ten workers, and operating with limited financial and technological resources (OECD, 2020). Despite their scale, these entities play an essential socioeconomic role, particularly in developing economies. In these regions, microenterprises constitute the bulk of the business sector and are a crucial source of employment and income generation (ECLAC, 2021).

However, these productive units face significant structural challenges. Among the most common obstacles are limited access to financing mechanisms, insufficient technological training, and weak digital infrastructure. These barriers undermine their capacity for growth and hinder their competitiveness in markets that demand progressive digitalization (Kumar, et al., 2024).

Productivity is canonically defined as the quantitative relationship between the results obtained and the resources employed in a production process (Drucker, 1999). This essential concept measures the efficiency with which an organization transforms its inputs—such as capital, labor, and technology—into goods or services. Consequently, increasing productivity involves the rigorous optimization of processes and the strategic use of technology with the aim of maximizing production or the value generated, while maintaining or reducing resource consumption (Chiavenato, 2017).

Competitiveness, on the other hand, refers to an organization's inherent capacity to generate and sustain a comparative advantage in the market. According to Porter (1990), this capacity manifests itself in the ability to offer products or services whose perceived value—whether in terms of quality, price, or innovation—systematically exceeds that of competitors. Organizations considered competitive are those that achieve a differentiated market position, supported by pillars such as continuous innovation, superior operational efficiency, and the resulting customer satisfaction and loyalty (Pérez and López, 2022).

Information and Communication Technologies (ICT) are a key factor in organizational transformation. According to the Inter-American Development Bank (IDB, 2021), companies that implement digital tools increase their productivity by up to 30% and improve their ability to adapt to changes in the environment.

ICT enables the automation of processes, the integration of work areas, and access to real-time information, thereby facilitating strategic decision-making (Castañeda, 2020). Furthermore, it helps reduce operating costs and improve the overall efficiency of companies (Organization for Economic Cooperation and Development [OECD], 2022).

ICT manifests itself in a wide spectrum of applications designed to optimize performance and strengthen the company's competitive position. These tools can be classified into various functional categories based on their impact on the organization; technological infrastructure plays an essential role, offering a diverse range of tools known as programs or applications that provide solutions for administrative efficiency. When classifying applications, the first group consists of Enterprise Planning and Management Systems (ERP/CRM), which function as the backbone of the organization by centralizing critical areas such as accounting, inventory, sales, and human resources; this integration offers a unified view of operations that is indispensable for improving decision-making and boosting administrative efficiency (Romero, 2021).

To facilitate remote work, organizations rely on the second group of applications, grouped as Collaboration and Unified Communication Platforms (such as Microsoft Teams or Google Workspace), which ensure operational continuity by facilitating synchronous and asynchronous interaction among teams, eliminating geographical barriers, and consolidating remote work models (Fernández and Torres, 2022). Complementarily, and to optimize human capital time, Robotic Process Automation (RPA) applications are implemented. These solutions take on the burden of repetitive tasks, allowing employees to refocus on strategic and creative activities, which directly increases productivity (López et al., 2025).

The information generated by these operations is leveraged through Data Analytics and Business Intelligence (BI) systems, essential tools for transforming raw data into timely and reliable insights, enabling real-time performance evaluation for proactive management (Vargas, 2021). Finally, the digital cycle closes with Digital Marketing and Customer Relationship Management tools, which manage online presence and advertising campaigns to ensure brand visibility and optimize the consumer experience in the digital marketplace (Jiménez, 2022).

The adoption of digital technologies represents a strategic opportunity of great significance for Micro and Small Enterprises (MSEs), acting as a factor that reduces the resource gap with large corporations.

These tools allow MSMEs to optimize resource allocation by facilitating the efficient use of inputs, enabling more agile and less costly management than traditional methods (Sánchez and Molina, 2021). They also promote market expansion, providing access to broader market segments through e-commerce and digital *marketing* platforms, overcoming geographical limitations, and improving the customer experience by enhancing service quality through more effective communication channels and management tools.

Empirical evidence confirms the positive impact of this adoption. Data from the Organization for Economic Cooperation and Development (OECD, 2022) indicate that microenterprises that integrate digital technologies experience a significant increase in their sales levels and their capacity for innovation.

In addition to direct economic benefits, digitalization has a positive influence on social and development aspects, fostering sustainable development by contributing to the creation of business models that are more efficient in their use of resources and energy. It also promotes

economic formalization, which supports the transition of small businesses toward the formal sector, improving transparency and access to financing (IDB, 2021).

Ultimately, the digital inclusion of MSMEs is not only crucial for their individual survival but also stands as a fundamental pillar for the resilience and growth of the broader economic fabric, especially in developing economies.

Digital applications have established themselves as a fundamental pillar for increasing productivity and strengthening business competitiveness. A methodological and strategic implementation of these tools allows organizations to rigorously optimize operational processes, reduce structural costs, and, crucially, improve their capacity for proactive adaptation to environmental disruptions (Meraz, 2024).

Therefore, digital transformation must be redefined: it is not merely a passing trend, but an essential strategy that ensures the long-term sustainability and systematic growth of organizations in the modern economy (OECD, 2022).

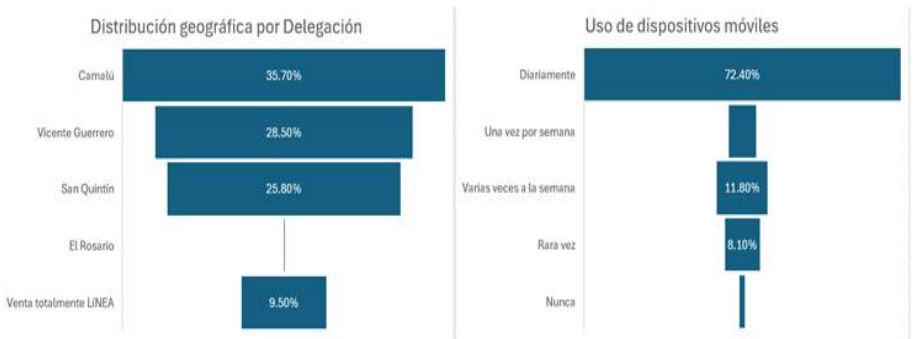
García-Estrada et al. (2025) demonstrate that digital transformation and marketing are strategic factors for the growth and sustainability of microenterprises. Technology adoption, combined with digital marketing strategies, improves productivity, market positioning, and competitiveness. However, a lack of resources, training, and institutional support remain structural obstacles that must be addressed through comprehensive policies and business development programs.

Medina Santillanes et al. (2024) demonstrate that digitalization not only increases productivity and efficiency but also strengthens organizations' competitiveness, resilience, and sustainability. Overcoming the challenges associated with a lack of resources, resistance to change, and digital divides will be crucial to establishing a more agile, innovative, and sustainable business model in the long term.

Overview of Technology Adoption Among Microentrepreneurs

According to the survey, 74% of microenterprises have been engaged in commerce for just over 3 years and are located in the municipality of San Quintín, Baja California, as shown in Figure 1. Eighty-five percent of microentrepreneurs reported using a mobile device to maintain active communication with customers. These businesses have the necessary equipment to manage, monitor, and run their operations, using mobile devices as their primary tool and relying on an app that enables them to be efficient in their daily activities.

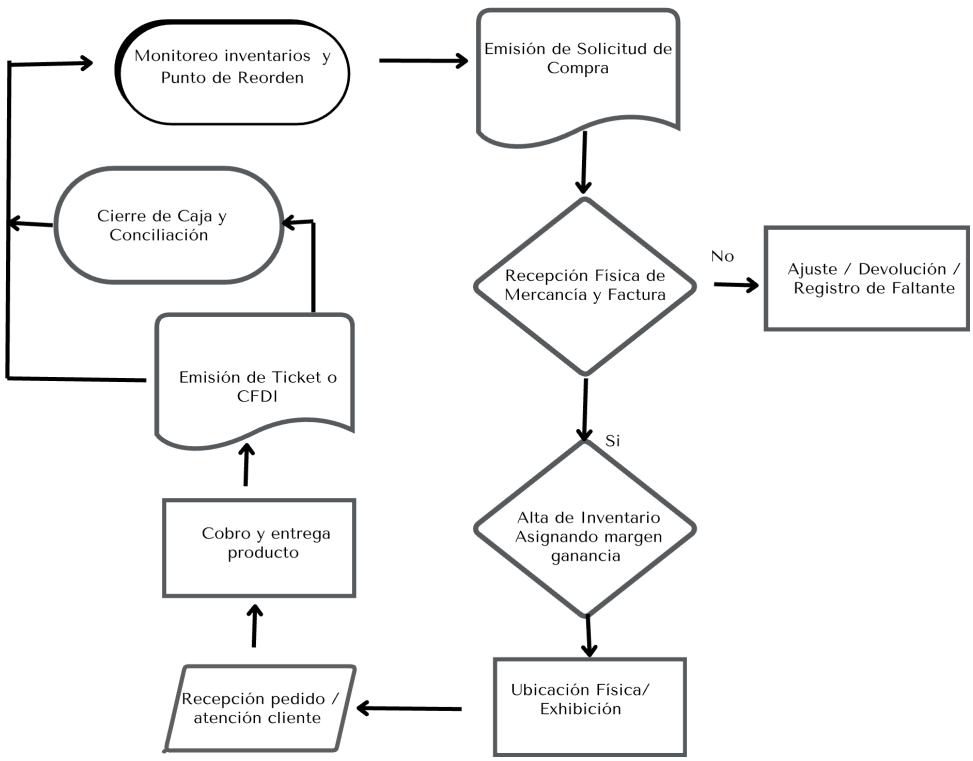
Figure 1. Location of the representative sample



The ISO 9241 standard developed by the International Organization for Standardization (ISO) measures the quality of human interaction with computers or mobile devices based on usability, which comprises three key dimensions: effectiveness, efficiency, and satisfaction. While a mobile app is considered effective when it enables microentrepreneurs to successfully complete their tasks, efficiency is achieved when it allows them to complete business-specific tasks with minimal effort and time. Satisfaction, meanwhile, is measured in terms of self-learning, experience, and self-recognition.

For the implementation of information and communication technologies, the context of the microenterprise must be identified, and a flowchart of operations must be generated, as shown in Figure 2. The processes, documents, and evidence required must be specified, as well as the controls for each activity, in order to identify the mobile application that meets existing needs.

Figure 2. Flowchart of activities for a commercial microenterprise



In light of the daily activities of the commercial microenterprise, a mobile application is required that allows it to:

a) Create, update, and maintain a product catalog in which the method of assigning costs to products can be selected, as well as determining the selling price based on a profit margin.

b) Capture a customer catalog segmented by cash and credit customers, with the latter allowing for up-to-date tracking of accounts receivable. Even for a small business, customers may request a Digital Tax Receipt (CFDI), so the app must allow for adding tax information to each customer, such as Federal Taxpayer ID, tax address, CFDI usage, and payment method.

c) Maintaining a supplier catalog allows for control of accounts payable. Generally, micro-businesses place orders for the goods they need, and payment is made upon receipt or the following week. Whether or not there are open lines of credit with suppliers, it is necessary to record purchases and orders to identify the daily cash requirements.

d) Making sales via a mobile device allows you to select the product directly or scan it using the phone's camera.

e) The minimum daily, weekly, and monthly reports required by the microenterprise are: the cash count, which identifies the day's sales, verifies cash on hand, and records amounts collected by card or to be deposited in the bank. On a weekly basis or according to the agreed-upon frequency, balances of accounts receivable from customers are required. And on a monthly, semi-annual, and annual basis, financial information is required that allows the microenterprise to make decisions and evaluate its financial health; the steps are illustrated in Figure 3.

Figure 3. Workflow of activities that mobile applications should support



To measure efficiency, it was considered that the mobile application should have sections or areas for recording, controlling, and updating product, customer, and supplier catalogs; allow for recording costs and tracking profits; manage sales; issue Digital Tax Receipts; and control cash and credits granted to customers. A database of 100 points of sale was analyzed; those considered efficient, effective, and satisfactory according to the usability description in ISO 9241-11:2018 are shown in Table 1.

Table 1. *Mobile applications for managing commercial microenterprises that meet usability objectives*

Trade Name	Description	Acquisition Method	Number of Downloads
Siigo (Mobile App)	Accounting and electronic invoicing	Subscription	500k+
Holded	Modern ERP for SME management	Subscription	500k+
Pulpos - Point of Sale	Complete POS system for businesses	Transaction fee	100k+
Yimi POS	Easy sales/expense tracking, works offline	Monthly fee	100k+
Zobaze Point of Sale	All-in-one POS + inventory app	Subscription	100k+

My Business Mx	Solution for Mexican businesses	Subscription	100k+
Siigo POS	Integrated with Siigo Accounting	Subscription	100k+
Tax Accounting	Invoicing and tax compliance for Latin American businesses	Subscription	100k+
Bind ERP	Complete business ERP system	Subscription	50k+
Tiendana POS: Point of Sale	Solution for small stores	Subscription	50k+
Pulso eleventa	Sales and inventory management	Subscription	50k+
EPOS Now	Advanced Retail System	Subscription	50k+
Apprecio - Point of Sale	App for shopkeepers, flow control	Subscription	10k+
BerstaPOS Point of Sale	POS for restaurants and retail	Subscription	10k+
Infrasys POS	For restaurants and hotels	Subscription	10k+
NetSuite	Full-featured enterprise ERP	Enterprise	10k+
INTAC SME	For small and medium-sized businesses	Subscription	10k+
DESS Point of Sale	Stable and reliable system	Subscription	10k+
QuickBooks	Small Business Accounting	Subscription	10k+
Britix24	CRM for projects and internal communications	Per user	10k+
INTAC SME	POS and inventory management for SMEs	Subscription	10k+

All applications identified as high-quality according to usability standards have a monthly, per-activity, or annual cost. Since handles confidential information regarding the entity's resources, it is understandable that there is a cost, and this provides certainty for the micro-entrepreneur.

Conclusions

Digital transformation is an indispensable strategic process for the resilience and growth of microenterprises, especially within the context of emerging economies such as Mexico's, where these productive units play a substantial role. Despite their economic importance, national data reveals a significant internal digital divide, with only 17.2% of microenterprises using the internet for business activities. The results of this study indicate that 85% of the microentrepreneurs surveyed reported using a mobile device as their primary tool for communicating with their customers. The adoption of these technologies serves as a determining factor in the reconfiguration of business models and directly contributes to improved operational efficiency and reduced structural costs. The incorporation of technology generates a substantial increase in productivity, but mobile applications must be implemented as part of the business model; this will enable cost control, operational efficiency, as well as the management of accounts receivable and payable. Digitalization is a fundamental strategic pillar

for the competitiveness and sustainability of microenterprises; however, structural obstacles that hinder the implementation of mobile applications undoubtedly persist. Although access to devices exists, there is a lack of digital literacy and organizational culture. Evidence indicates that insufficient staff training and limited investment in digital innovation are the main obstacles. Therefore, to bridge the gap between basic mobile phone use and true digital transformation, it is necessary to promote policies and strategies that foster not only the acquisition of technology but also the development of digital skills that enable microentrepreneurs to leverage these tools for strategic decision-making.

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Human Rights Regulation and Legislation for Business Development in Mexico

Martínez Hernández Melissa Lizbeth
Autonomous University of Tamaulipas, Tamaulipas, Mexico
melissa.martinez@uat.edu.mx
https://orcid.org/0000-0002-9503-4443

Introduction

Central to the approach of this study is the interpretation of what the research understands by "regulation" and "legalization." In the field of human rights, these constitute distinct yet complementary regulatory frameworks that seek to guarantee the protection of human dignity; however, there are differences in their origins, hierarchy, scope, and enforcement mechanisms. Legislation refers to formal legal norms issued by competent state bodies, such as constitutions, international treaties, and ordinary laws passed by the legislature. These are binding and hold a higher rank in the legal hierarchy. In contrast, regulations encompass lower-ranking norms, such as decrees, administrative resolutions, or guidelines issued by executive authorities or specialized agencies, which detail or implement legislation without creating new rights. The international historical evolution of human rights paved the way for the formation of the League of Nations, a pioneering body that sought to promote peace among states (Villán Durán, 2009). To bring World War I to a close, the Treaty of Versailles was signed on June 28, 1919, and at the end of World War II, the Charter of the United Nations was adopted on June 26, 1945, leading to the creation of the United Nations (UN), which replaced the League of Nations. This Charter establishes the rights and obligations of member states, while also defining the principal organs—such as the General Assembly, the Security Council, and the International Court of Justice—and the procedures for international cooperation.

At the end of World War II, the movement toward the globalization of human rights began, culminating in the adoption of the Universal Declaration of Human Rights (UDHR) in 1948. This declaration, inspired by the 1789 Declaration of the Rights of Man and of the Citizen, has been criticized by some authors for its predominantly Western and Eurocentric foundation; however, this does not affect its universal character, recognized as a minimum ethical and legal standard for all humanity.

In addition to the above, the International Labour Organization (ILO) was established, which, as its name suggests, seeks to protect labor rights as well as the collective rights of peoples—whether economic, social, cultural, or, more recently, environmental (Villán, 2009). It has been argued that individual human rights can be lost within that collective framework. However, the Office of the High Commissioner for Human Rights (2016) states that "human rights are the sum of individual and collective rights established in national constitutions and international law."

These rights stem from a philosophical conception of humanity that positions the individual as a subject entitled to a set of rights, which precede and supersede the State and shape the State's actions toward those it governs (Martínez, 2013). Consequently, human rights are founded on human dignity, the positive tion of which is essential for the individual's

comprehensive development; therefore, respect for and the guarantee of dignity constitute "the ultimate purpose of the State's political and economic activity" (Bellver, 1996: 56). Human rights are inseparable from people; that is, they are inherent without any distinction of nationality—regardless of sex, place of residence, origin, religion, nationality, race or ethnicity, language, or other conditions that may arise. Furthermore, they are interrelated, interdependent, and indivisible. Currently, these rights permeate the Mexican legal system (CNDH, 2019).

At the World Conference on Human Rights, held in Vienna in 1993, the principles of universality, indivisibility, interdependence, and interrelatedness of human rights were established, which are enshrined in paragraph 5 of the Vienna Declaration and Programme of Action, which also states that, in accordance with these principles: human rights must be applied equally to every person throughout the world; furthermore, these rights do not form a hierarchy, but rather each is equal—whether civil, political, economic, social, or cultural. On the other hand, the main difference between human rights and fundamental rights lies in the territory where they apply; that is, given the universality of human rights, their application is not limited to any specific territory. In contrast, fundamental rights are those explicitly enshrined in the Constitution or in the legislation of each state, and are therefore limited by territory; they may also be subject to other limitations established by law.

Human rights are progressive, meaning they evolve in response to social changes and historical events in countries; their existence stems from the needs and conditions of the reality faced by individuals, groups, and peoples so that they may live with dignity. Decades after the Universal Declaration of Human Rights, states are not the only active actors in the defense of human rights; today, we can also mention international non-governmental organizations, as well as transnational and local groups, among others.

Although the narrative of human rights has permeated nearly the entire world, improvements in people's lives have not been achieved to the same extent in all countries. This is due to differences in each state's historical development, largely its ideology and culture, and the application of its laws, judicial mechanisms, and public policies. Human rights seek to protect people's dignity, achieve the common good and equity; however, achieving this is no simple task, especially given the vast diversity of religious, philosophical, and cultural traditions—and even legal frameworks—that exist around the world and within each country.

The objective of this research was to analyze human rights regulations and legislation for business development in Mexico, considering the legal framework of human rights in Mexico, identifying the State as the guarantor of human rights, and examining how human rights are key to business development in Mexico.

The methodology used was selected and classified by topic; general methods were employed to structure the research from a human rights perspective. In this case, the interpretive, deductive, and historical-logical methods were specifically selected, utilizing the hermeneutic method to analyze human rights regulations and legislation pertaining to business development in Mexico. A historical and cultural perspective was selected as the research technique, which, through content analysis—applied specifically to the analysis of legal documents and specialized studies—examined specific legal provisions on human rights.

Human Rights in the Mexican Legal System

According to Carbonell (2007), "fundamental rights are constitutionalized human rights," that is, for a fundamental right to be established in a state's legislation, a human right must first exist. Thus, the application of fundamental rights is limited to the territory governed by a constitution; in this sense, individuals within this jurisdiction may enjoy such fundamental rights (González, 2018).

According to Linares (2006:63), "human rights serve as a limit on the state's actions toward individuals, creating a sphere of freedom for them, free from interference by the authorities, naturally in accordance with their inherent status as human beings," which suggests that one of the purposes of these rights is to prevent arbitrary actions by governments at any level toward their citizens and, in general, toward those they govern; consequently, they also aim to protect human integrity and ensure it remains unaffected (Vernaza and Cruel 2024).

Since the Political Constitution of the United Mexican States (CPEUM) of 1917 (CPEUM, 1917), human rights have become individual guarantees, which were granted to persons residing within a specific territory. To establish this, the notion of "guarantee" within public law was analyzed, understood as the protective measures recognized under the rule of law (Inter-American Court of Human Rights, 1999). Thus, when referring to individual guarantees, the text alluded to those fundamental rights protected by the Constitution. This trend led to the replacement of the concept of individual guarantees with that of human rights, which meant not only placing civil and political rights on the same footing as economic, social, cultural, and environmental rights, but also enabling them to be enforced through both judicial and non-judicial channels (Cancino *et al.*, 2018), as we will see shortly.

In Mexico, the constitutional reform in question was published in the Official Gazette of the Federation (hereinafter, DOF) on June 10, 2011; this Decree amends Chapter I, Title I (DOF, 2011) of the Political Constitution of the United Mexican States, thereby changing its title: "On Guarantees" to "On Human Rights and Their Guarantees." The amendment states, in Article 1, that all persons shall enjoy the human rights recognized and the guarantees contained in the Constitution itself, as well as in the international treaties to which the Mexican State is a party. Likewise, it states that the criterion for interpreting human rights norms shall always be the broadest protection, whether found in the Constitution or in any international human rights treaty to which Mexico is a signatory (CPEUM, 2011).

This reform binds the Mexican authorities and obligates the State to comprehensively adapt its legislation in accordance with human rights principles: universality, interdependence, indivisibility, and progressivity, taking human dignity as the guiding principle and interpreting provisions in accordance with the broadest possible protection (CPEUM, 2011). Therefore, it can be asserted that human rights have a substantive status, establishing guarantees as means of defense for their protection. This strengthens the Mexican constitutional system by putting an end to the constant controversy over the scope of the legal framework for the protection of human rights through individual guarantees; that is, the changes should not be viewed as mere constitutional rhetoric, but rather as a structural modification of our legal system that obligates the State to effectively safeguard human rights and, where appropriate, to remedy the negative impacts of violations thereof; Furthermore, international human rights treaties are expressly included to protect citizens from the hegemony of the State; this is the applicable legal policy today.

As for the principle of universality, it establishes that human rights belong to all people, regardless of their status or particular characteristics. This sets the standard for their enforcement in any jurisdiction and before everyone. Human rights are inherent to every person; therefore, every State can and must enforce them within its jurisdiction—that is, they are universal. Furthermore, they are interdependent and indivisible, as there are no hierarchies among human rights. The infringement of one right often leads to the violation of others; that is, they are interdependent. For example, an infringement on the human right to life may stem from a violation of the right to health or to food, and even to a healthy environment; therefore, all human rights—civil, political, economic, social, and cultural—must be understood collectively.

Bastidas & Sánchez, (2025) Regarding their inalienability and imprescriptibility, human rights are inseparable from the person, so no authority may deprive a person of their rights unless the suspension or restriction is explicitly established in the Constitution, as is the case with Article 16 and Article 29 (CPEUM, 2011). However, the Constitution also establishes exceptions regarding the non-suspension or restriction of the exercise of the right to non-discrimination, the right to life, the prohibition of the death penalty, the prohibition of enforced disappearance and torture, and the judicial guarantees essential for the protection of such rights, among others (CPEUM, 2011).

As for the principle of progressivity, it not only prohibits regression but also ensures that, once a human right is recognized, it "is definitively and irrevocably integrated into the category of those rights whose inviolability must be respected and guaranteed" (Nikken, 2010). In this sense, it also implies gradualism and progress; its effectiveness is not immediate, but rather involves a process in which goals must be established at different timeframes for it to be fully realized, and this must go hand in hand with the expectation that its enjoyment must continually increase (SCJN, 2019).

This encompasses international instruments issued by judicial bodies, such as the rulings of the Inter-American Court of Human Rights; in this regard, these rulings become binding even in cases where Mexico is not a party. Furthermore, another change in the reform relevant here is the incorporation of the legal concept of interpretation in accordance with the text and the *pro persona* principle regarding the protection of human rights established in international instruments; thus, it marks a turning point by moving away from conceiving of rights as individual guarantees.

In summary, this reform brought about extremely important updates in the area of human rights, such as the adoption of the principles of interpretation in accordance with and *pro persona*; the principle of granting the State a role as a guarantor, with the obligation to promote, respect, protect, and guarantee human rights, as well as the principles of universality, interdependence, indivisibility, and progressivity of said rights.

The State as the guarantor of human rights

The Mexican State has the obligation to promote, respect, protect, and guarantee human rights, in accordance with the principles of universality, interdependence, indivisibility, and progressivity; that is, the State's obligations apply to all rights and are referred to as generic obligations, encompassing the duties to promote, respect, protect, and guarantee human rights. As for preventing, investigating, punishing, and providing redress for human rights

violations—which are called specific obligations—this distinction does not imply a hierarchy among them (Ortega *et al.*, 2013).

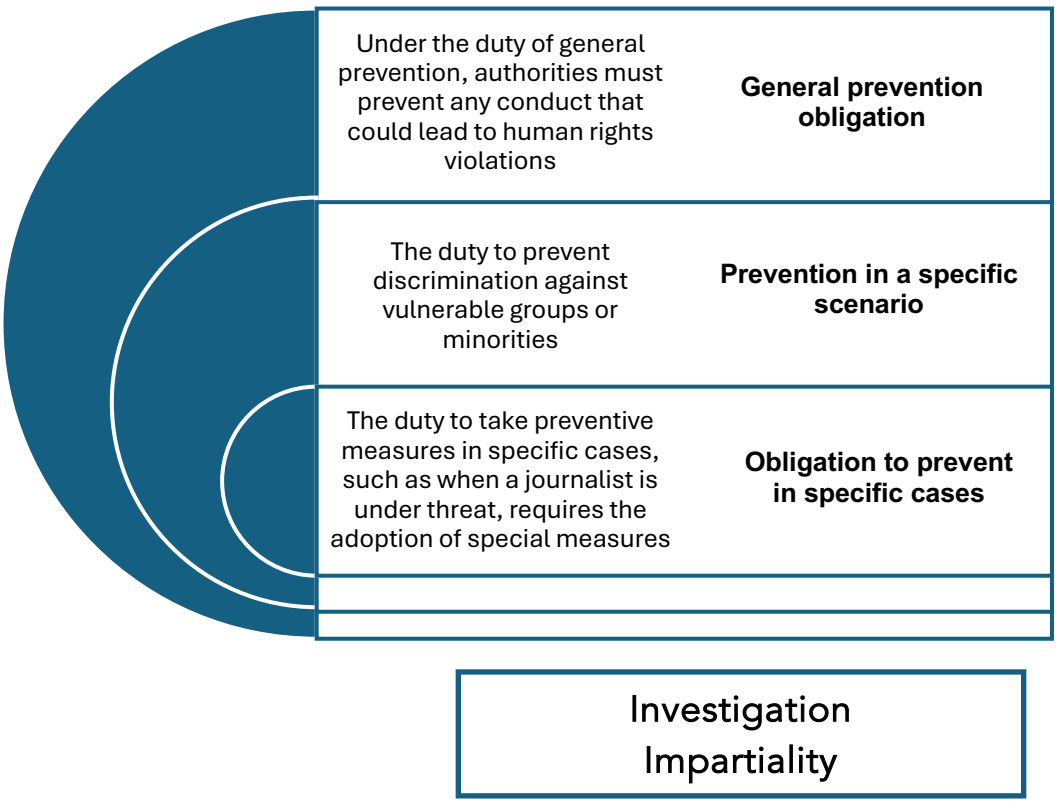
The generic obligations and principles included in the Constitution's reforming power are harmonized with the main international human rights instruments to which Mexico is a party. Furthermore, the obligation to promote human rights is aimed at raising awareness of human rights, not only among authorities but also within society itself. Therefore, the State has an obligation to create programs, campaigns, and public policies aimed at fostering a culture grounded in human rights.

This obligation to promote human rights can be classified into three main parts according to the contributions of Serrano and Vázquez (2013): a) providing society with the relevant and necessary information so that they may enjoy their human rights; b) raising awareness within the community so that they first respect human rights, and at the same time promote them; and c) the respect for and enforcement of human rights by the three branches of government. Recognition of these rights by private individuals. In this context, one of the State's primary objectives regarding human rights is to raise awareness in society about the application of these rights and the defense mechanisms available to them, thereby empowering civil society.

The duty to guarantee human rights under the American Convention on Human Rights requires the State to organize the entire set of institutions through which it exercises its public power, from a human rights perspective, thereby ensuring the full exercise of these rights. Likewise, States must prevent, investigate, and punish violations of the rights recognized by the Convention, and must also, , seek to remedy the violated right through reparation for the harm caused (Inter-American Court of Human Rights, 1988).

Consequently, one of the key issues in ensuring human rights is that the State adopt the necessary measures, conditions, and processes to maintain the level of realization, while simultaneously seeking improvement and thereby ensuring that individuals effectively enjoy these rights (Salazar, *et al.*, 2014). The State's obligation to prevent human rights violations can be categorized into three types, which are presented below in Figure 1:

Figure 1. Types of State prevention of human rights violations



Furthermore, the State has an obligation to investigate in the event of a human rights violation, and to do so impartially and effectively, through its entire institutional apparatus and all legal means at its disposal. Regarding the State's obligations to punish and provide redress for harm caused by human rights violations, examples include compensation for victims or sanctions against the perpetrators of such violations (Salazar, *et al.*, 2014).

Human Rights for Business Development

The Inter-American Court of Human Rights, through its jurisprudence, asserts that the State's human rights obligations are specifically embodied in the obligation to guarantee; on the other hand, the United Nations Human Rights Committee holds that these obligations center on the obligation to protect . Both assertions aim to ensure that human rights are not violated.

In this regard, the Supreme Court of Justice of the Nation, in its protocol for the administration of justice in cases related to development and infrastructure projects (SCJN, 2014), outlines the State's human rights obligations as enshrined in the Constitution.

First, it states that the State must not interfere with or hinder the realization of human rights; in other words, if a community or individual exercises their human right to water through a lake or river, the authorities must ensure that no project or program violates this right, whether by diverting, reducing, or contaminating this vital resource. Second, it specifies what the State

must protect; that is, public authorities must prevent third parties, such as companies, from hindering or violating the realization of human rights, since, in line with this, the United Nations Committee on Economic, Social and Cultural Rights, in its General Comment No. 2, specifically in paragraph 22, asserts that these human rights violations stem not only from the State but also from local and even foreign companies.

In addition to the above, the protocol of the Supreme Court of Justice of the Nation (2014a) establishes that the elements to be considered in a situation of conflicting rights are that arguments regarding the "common good"—used primarily in the extractive industry—or "overall impact" cannot take precedence over the enjoyment of human rights by individuals. The principle of the common good is correctly applicable once it has been verified that the implementation of projects will not have negative impacts on the communities where they are carried out. However, this protocol stipulates that, if there is a possibility of such impacts on these communities, they must be consulted. Therefore, no project may proceed without first consulting the people who may be affected.

In this regard, civil society organizations addressed, during Session No. 154 of the Inter-American Commission on Human Rights, the human rights that are generally violated by extractive activities in Latin America: a) the right to a healthy environment, due to environmental pollution and the right to a dignified life; b) the human right to water, in terms of its affordability and quality for human consumption; c) the right to health, due to environmental pollution and exposure to chemical mixtures during extraction or due to chemical leaks; d) the right to adequate food, as leaks contaminate the land used for cultivation and the crops intended for human consumption; e) the right to adequate housing, as the safety of homes is compromised by earthquakes caused by extraction when techniques such as *fracking* are used, or by accidents caused by these extractive companies.

It follows from the foregoing that the Mexican legal system has incorporated the obligation to respect, at all times, human rights and labor rights, which are grounded in the dignity of the human person as a principle of equality, equity, and social justice. Thus, the State has the primary duty to safeguard human rights to ensure dignified and equitable labor relations and to enforce them through both national and international judicial bodies, while also safeguarding them to promote business productivity and contribute to the country's social development (Araujo and Araujo, 2025).

Within the constitutional framework, Article 1 establishes the prohibition of discrimination and requires the State to regulate and protect rights in business contexts, such as labor relations under the Federal Labor Law enacted in 2025, the General Law on Ecological Balance and Environmental Protection, enacted in 1988, and the Federal Law on the Protection of Personal Data Held by Private Parties, enacted in 2010, impacting sectors such as mining and manufacturing. The National Human Rights Commission, through the Business and Human Rights Program (2018), oversees compliance, while initiatives such as the General Law on Corporate Responsibility (2020 draft) seek direct sanctions for violations.

Business development guided by regulatory and legal frameworks offers practical and technical benefits for business growth in Mexico, including enhanced reputation and access to global markets, and encourages corporate social responsibility in training and financing. that is, from this general perspective, it is the obligation of companies to adopt ethical and

sustainable practices that respect rights in their daily operations; these constitutional elements drive responsible growth by reducing legal risks and improving the corporate image.

Cantú Rivera (2016) argues that the adoption of human rights standards optimizes the management of business operational risks, strengthens corporate governance, and improves the social license to operate, generating technical advantages such as more resilient supply chains and reduced litigation costs in extractive sectors, that is, practical benefits such as retaining qualified talent, alignment with the Sustainable Development Goals, and preferential access to international financing through ethical labor practices that enhance the global reputation of Mexican companies.

Conclusions

The trend regarding human rights is toward recognition and expansion across the globalized world; an increasing number of countries are explicitly incorporating human rights into their constitutional texts, as is the case in Mexico. In this regard, human rights regulation and legislation in Mexico represent a strategic pillar for sustainable business development, as they require companies to integrate due diligence and ethical practices that mitigate operational risks and strengthen governance in key business sectors such as mining and manufacturing. This regulatory and legislative framework, anchored in the Constitution and the UN Guiding Principles, not only prevents violations in labor relations and environmental preservation but also generates competitive advantages such as preferential access to international markets, talent retention, and financing—transforming legal obligations into opportunities for innovation and responsible growth that position Mexican businesses within the global economy of the 21st century.

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Public policies to restore economic growth and social development

María de la Luz Guevara Calderón
Autonomous University of Tamaulipas, Mexico mlguevara@uat.edu.mx
https://orcid.org/0000-0002-4599-9263
Abimael Bolaños López
Autonomous University of Tamaulipas, Mexico abolanos@uat.edu.mx
https://orcid.org/0000-0001-7270-5374
Luis António Vázquez Ochoa
Technological Institute of Cd Victoria*, Tamaulipas, Mexico luis.vo@cdvictoria.tecnm.mx
https://orcid.org/0000-0002-2142-8394

Introduction

In light of the devastation caused by the COVID-19 pandemic, it has become necessary to establish a state-led course of action that involves citizen participation in order to create public policies that enable economic growth and sustainable social development. The pandemic was an unexpected event that emerged in mid-2019 on an international scale in China, but in the case of Mexico, the Federal Government declared its presence on national territory in early 2020. At that time, the public did not fully grasp the scope, changes, and crises the virus would generate across social, economic, and cultural dimensions; it was an event that, at the time, represented something new for the population, and there were no similar precedents to provide insight into what would unfold in our country.

After the arrival of the COVID-19 virus in Mexico was confirmed, a pandemic was declared, and the government implemented a series of measures aimed at reducing transmission among people. One of these actions was the suspension of all in-person activities in society, leading to a lockdown, meaning social interaction was restricted, and the population had to shelter in their homes, afraid to go out, get infected, and die from the disease.

In addition to the chaos caused by the COVID-19 pandemic and the government-mandated lockdown to prevent the spread of infections within social structures and dynamics, the public administration was also affected in terms of how to proceed administratively with existing processes. Most importantly, it was forced to modify public policies conceived and designed for a time that had passed, that is, their creation, implementation, and evaluation had taken place prior to the pandemic. This presented an interesting challenge for the government: transforming its public policies to make them relevant to the pandemic and social lockdown scenario, and in a way that could have a positive impact on overcoming the economic crisis and social hardships faced by the Mexican population.

There are various definitions of public policy in the literature. For Aguilar (2012), it is a "set of structured, stable, systematic actions that represent the way in which the government permanently and consistently carries out public functions and addresses public problems: a pattern of action" (p. 29). For his part, according to Vargas (2007), it is "a process that begins when a government identifies the existence of a problem that, due to its importance, warrants its attention, and ends with the evaluation of the results of the actions undertaken to eliminate, mitigate, or alter that problem" (p. 128).

This suggests that public policies should be understood as the set of actions carried out by the government to address public issues within the community—that is, issues that affect or are of interest to the general population—with the intention of resolving these issues through strategies that require significant cognitive capacity, effort, and resources from members of the public administration. Furthermore, the work performed is evaluated based on citizens' satisfaction.

In this regard, during the pandemic, the government was compelled to rethink existing public policies and conduct an assessment of its actions to determine which were no longer relevant to the current context and which should be retained. What happened was that the context of social lockdown created serious challenges within the government regarding decision-making on the actions to take to address the health crisis due to the differing perspectives that emerged at the time, as they originated from various sectors of society.

Thus, chaos was not only present in citizens' daily lives as they tried to understand what was happening as their social and economic reality changed, but a crisis also arose within the public administration due to the government's lack of experience in reformulating its public policies in the face of unexpected situations such as the COVID-19 pandemic.

Faced with the social and economic crisis, the government had a responsibility to try to reduce uncertainty among the population by reformulating and creating public policies aimed at maintaining a balance that would allow for a solution to the various problems that had spiraled out of control in the country. The crisis is understood as the prolonged period people experience when they struggle to make sense of the radical changes unfolding around them, demanding that the government step in with policies designed to mitigate or eliminate the moments of "shock" individuals face, ensuring they can survive and adapt to the new alternatives offered to maintain their standard of living (Gutiérrez, Urrego, and Carmona, 2016).

After the government made decisions to implement certain public policies during the pandemic, the results have been evaluated by members of society; however, it is even more important to understand how the government has approached the post-pandemic phase by issuing a series of public policies aimed at charting a course toward economic growth and social development. In this regard, it is worth referring to Flores-Tapia et al. (2024), who state that many decisions are made without sufficient information or technical tools to help prioritize public and private investment (p. 67).

There is no doubt about the difficulties society faced during the lockdown and the negative effects that weighed heavily on the population, but it is interesting to understand citizens' perceptions of what the federal government is doing to emerge from the crisis and improve people's living conditions.

Therefore, it becomes necessary to investigate and document through research studies the perceptions of members of society regarding the work being carried out by government decision-makers; in this case, to understand the perceptions of law students, who, due to their field of study and practice, are closely connected to public administration and are thus better positioned to evaluate the actions taken by the authorities responsible for ensuring the social and economic security of Mexican families.

Public policies as a mechanism for economic and social improvement

Public policies are meaningful when they have a significant impact on different aspects of citizens' lives, primarily on economic growth and social development; however, achieving this ideal is not easy when such actions must be designed and implemented amid the complexities of the post-COVID-19 pandemic era, and a logical and relevant approach is required to ensure that new policies serve as an opportunity during times of crisis and generate positive change in society to move forward. In this regard, it is worth recalling that economic development involves a prolonged process of real growth in national income, and that only when such growth exceeds population growth does it translate into a genuine improvement in per capita income (Meier and Baldwin, 1964, p. 512, cited by Castillo-Nazareno et al., 2024, p. 476). In this context, it is important to recognize that various economic sectors have moved toward sustainable practices; for example, Mireles Rodríguez et al. (2024), drawing on Álvarez and Ramírez (2023) and Sánchez (2024), note that both the industrial and service sectors have increased their interest in sustainable development due to greater awareness of the need to adopt practices that protect natural resources and promote present and future well-being (p. 67). This trend reinforces the importance of economic and social public policies being oriented toward responsible and sustainable " " models that, in addition to driving post-pandemic recovery, contribute to long-term development.

Regarding economic growth policies implemented at the national level, some of these policies include: reducing public debt, increasing public investment, exercising fiscal discipline in the management of public resources, international cooperation, lowering tariffs, increasing personal loans, providing loans to small family-owned businesses in both the formal and informal sectors of the economy, revitalizing local commerce through loans for SMEs, the creation of temporary and permanent jobs through SMEs, the creation of temporary and permanent jobs in the public administration, temporary government hiring for reforestation, waste collection, and sanitation activities, investment in the tourism sector, and investment in the energy sector, among others.

The public debt reduction policy seeks to avoid increasing the government's debt to the private sector, while the policy to increase public investment aims to raise the amount of available economic resources so that the public administration is better positioned to carry out its activities and implement economic and social programs more effectively, without financial constraints. The policy of republican austerity in the management of public resources also consists of "reducing the current spending of federal agencies, decentralized bodies, and state-owned enterprises relative to the budget" (Rivero, 2019, p. 6). This policy has been in place since the beginning of AMLO's six-year term and, following the pandemic, gained wider public acceptance as a measure that would help the government reduce operating costs across its various agencies, thereby freeing up more resources for social programs and helping to revive the economy.

International cooperation policy seeks to maintain economic and trade ties with various countries and, by fostering good diplomatic relations across the board, to advance tariff reduction policies. Having other countries as allies represents a opportunity to overcome the economic crisis together; it means knowing that in the economic sphere we are not alone and have the support of a number of countries internationally that are also facing difficult times. However, being aware of this reality is the first step toward establishing a series of economic measures, as tariff reductions facilitate imports and exports, which liberates the economy and

allows for the smooth flow of goods and economic resources that will reach families, generating employment and purchasing power so that people can improve their living conditions in the post-pandemic era (Baena, 2018).

Meanwhile, following the lockdown, policies for personal loans, loans to small family businesses, and loans for SMEs emerged with greater force, aiming to provide financial assistance tailored to individuals' repayment capacity with the promise of repayment at low interest rates. Credit refers to "debts incurred with creditors or financing granted to various debtors" (Rodríguez, 2008, p. 37) with the aim of reviving the economy and commerce by providing economic resources to individuals and businesses to facilitate the flow of money among the population.

Likewise, the policy of creating temporary and permanent jobs in the public sector aims to hire, to the extent possible, personnel for various roles within government agencies to promote employment. Meanwhile, the policy of temporary hiring for reforestation, garbage collection, and sanitation activities is a government initiative to employ the population that lost their jobs due to the pandemic and address social needs that were neglected because street activities were prohibited—as people were at risk of infection, which would further increase the chain of COVID-19 cases.

The policy of investing in the tourism sector is very important for countries like Mexico, which has a diversity of natural and cultural attractions that help boost the economy through the arrival of tourists, ; therefore, tourism is key to economic growth because it is "a multisectoral activity in which productive areas of the public and private sectors participate to provide the goods and services used by tourists" (Morillo, Rosales, and Cadenas, 2014, p. 88). On the other hand, investment policy in the energy sector aims to increase energy production in a sustainable manner because during the pandemic there was an energy shortage that "is one of the main threats to the reproduction of the industrial capitalist system, and expanding societies definitely cannot do without secure, constant, and seemingly growing energy flows" (Lezema, 2016, p. 240).

Furthermore, some of the social development policies implemented at the national level in the post-COVID era include: reforestation, scholarships to continue education, quality education, universal internet access, pensions for the elderly, housing loans, and universal access to health and public safety services, among others.

The national reforestation policy aims to foster a culture of environmental stewardship, tree planting, and the sustainable use of wood in a participatory manner, as the health crisis led to neglect in the care and conservation of forests and other green areas that now require renewed attention to mitigate potential future health problems arising from a failure to care for our environment (Vanegas and Matus, 2018).

In the field of education, the federal government has implemented a policy of quality education, which involves building a strong educational system through the collaboration of all educational stakeholders, with state support in the form of financial, human, and technological resources, to provide the educational services established in Article 3 of the Constitution (Bianchetti, 2017). A scholarship policy is also being implemented to enable students from low-income families to continue their studies, as during the pandemic many students dropped out of school because they could not afford the necessary equipment to take online classes or because they had to leave school to work full-time and bring home an income. Lik , the policy

on universal internet access was established, as distance learning revealed that many Mexican families lack internet access that would allow their children to complete school activities and assignments, communicate with other educational stakeholders such as teachers, and generally engage in self-directed learning.

Cárdenas et al., (2025) The pension policy for the elderly has seen increases following the COVID-19 pandemic, with the aim of ensuring that seniors have an income to cover basic expenses, including medications. Meanwhile, the housing loan policy can assist many families who were unable to make payments on their home loans; this initiative is intended to prevent people from losing their homes due to the economic crisis during the lockdown. Regarding the policy on universal access to health services, there is no doubt that the pandemic revealed that health services in Mexico leave much to be desired; for this reason, this post-COVID policy seeks to improve healthcare for the population so they can enjoy a better quality of life. The same applies to social security policy, as social development is impossible without the peace of mind that comes from feeling protected by the state; the population must be free from violence, and their social rights must be respected.

Involvement of various stakeholders in the development and implementation of public policies

Once the COVID-19 pandemic had ended, it was necessary to undertake a series of policies aimed at resolving issues of public interest in order to rescue the economy and promote social development, which had been in a temporary crisis. However, such actions cannot be carried out solely by decision of government authorities but must be developed through a process of citizen participation. Therefore, the design of public policies in times of social crisis must be carried out from the bottom up, because the population knows the most important needs and interests that must be addressed in order to achieve better living conditions.

In this regard, various authors have emphasized that development depends not only on economic growth but also on the ability to involve people in the decisions that determine their own future. For example, Reyes-Ortíz and Martin-Fiorino (2025) explain that the link between economic stability, growth, and social development is strengthened when there is active, free, and effective participation by individuals, social groups, and communities, as it is this participation that grants them real power to influence public decisions and ensure that their resources, identities, and aspirations are respected (p. 38). This perspective echoes what has been experienced in the post-pandemic era: without the voice of citizens, any policy runs the risk of falling short or losing social legitimacy.

It is essential that various stakeholders—such as the government, civil society organizations, parents, and business owners, among others—participate freely in the development and implementation of public policies in the post-COVID era. Currently, "citizen participation has become an essential strategy for the legitimization of public policies" (Guardamagna and Reyes, 2018, p. 1003); that is, when government actions are not designed with the voice of citizens in mind, such policies will not have the expected impact.

This is because the state cannot formulate public policies from behind a desk, attempting to decipher the situation of the health crisis to address the economic and social problems generated by the pandemic. While the state has the power and authority to make decisions

regarding public policies, "it must legitimize itself as a power so that its mandate is stable, and to do so, it must find a certain consensus" (Fernández, 2021, p. 179) with citizens.

Being a citizen is "a special legal-political status that identifies a person as an active member of the state and enables them to exercise political rights, that is, to participate in public life" (Lizcano, 2012, p. 8). Citizens have rights and responsibilities they must assume as such before the state, but part of their role in society is to collaborate in the processes of designing and implementing public policies.

Now, citizens must participate in public policy in the post-COVID-19 era, either individually or collectively on behalf of a civil association with specific objectives in a particular area; merchants who suffered greatly during the lockdown because businesses were closed to prevent infections and did not have the income they had before the crisis; parents who faced economic hardship due to increased layoffs, as well as other social actors who deserve a voice and a vote in deciding how to move forward as a society.

In this regard, the following study aims to analyze the perceptions of students in the Law program at the Autonomous University of Tamaulipas (UAT) regarding the public policies the government is implementing and which it should consider essential for improving people's quality of life in this post-COVID era. To this end, various subtopics related to the context and theoretical contributions are presented to help understand the situation society has undergone. Based on the above, the following research questions were formulated: What is the state of public policies during the pandemic and after COVID-19? What is the importance of public policies for economic development? And what is the importance of public policies for social development?

The research is approached through a case study; the chosen methodology is quantitative because information will be obtained from future legal professionals via a questionnaire that provides an appropriate overview of participants' perceptions, which is then analyzed using theoretical frameworks. The study sample consisted of 113 students from the Law ( ) program at the Autonomous University of Tamaulipas. The instrument was organized into 4 categories with a total of 25 items, and the information was collected via Google Forms. The case study refers to "a unique case of a critical nature, that is, one that allows for confirming, changing, modifying, or expanding knowledge about the object of study" (p. 141), such as public policies aimed at economic and social growth from the perspective of university students. On the other hand, according to Del Canto and Silva (2013), quantitative studies can "enable the researcher to better approach the subject of study within social reality and allow for addressing the subject of study by obtaining more concrete and reliable results that enable the achievement of the stated objectives" (p. 26).

The scope of the study is descriptive and explanatory because it details the participants' views regarding public policies appropriate for the current post-COVID context and explains the reasons why such government actions are considered indispensable for achieving economic growth and social development.

On the other hand, the research design is a non-experimental cross-sectional study, since the instrument used to collect information from the students is administered at a single point in time without the intention of altering the fieldwork conditions or the variables; rather, the aim is to obtain the data exactly as the participants respond, as this is the most important value of

the study: to consider the responses, which reflect the perceptions of the group of future legal professionals who hold a specific stance on current priority public policies.

The sampling method used is conventional non-probabilistic, that is, "it allows for the selection of accessible cases that agree to be included" (Otzen and Manterola, 2017, p. 230). In this case, the researcher assesses the possibility of applying the instrument to individuals within their reach who accept the invitation to participate in the study by sharing their perceptions regarding the research topic.

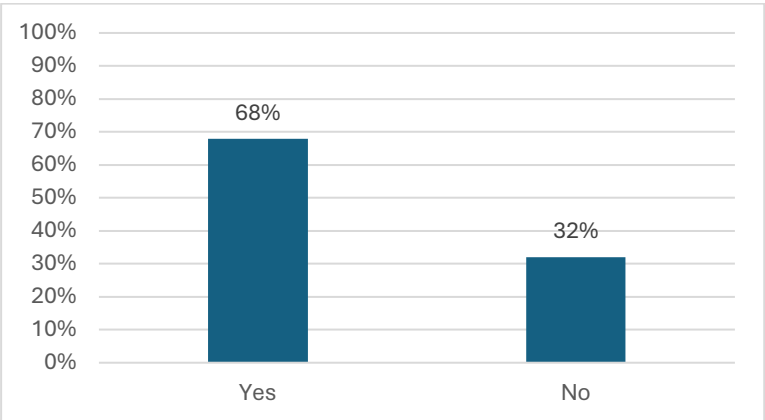
The instrument used is the questionnaire, defined as "a structured process of collecting information through the completion of a series of questions" (García, Alfaro, Hernández, and Molina, 2006, p. 3); This instrument consists of a series of questions grouped into categories of analysis: perceptions of current policies implemented by the government, policies on economic growth, social development, public safety, education, and health. The questionnaire is included in Appendix 1.

Empirical evidence on university students' perceptions of government performance

In the category *"Perceptions of Current Public Policies Implemented by the Government,"* 68% of participants believe that the public policies currently being implemented by the federal government have contributed to economic growth and social development in the post-COVID era, while 32% believe the opposite. Likewise, 56% believe that the approach to developing public policies to address the economic and social problems resulting from the pandemic in our country has been appropriate, while 44% believe it has not. Furthermore, 61% of students say they are unaware of how the government has invited various social actors to participate in the development of public policies to restore economic growth and social development during this post-COVID era, while only 31% state the opposite.

Figure 1 shows that university students believe that public policies during the pandemic and in the post-COVID-19 period have contributed to Mexico's economic growth and social development.

Figure 1. Contribution of public policies to economic growth and social development resulting from the pandemic.

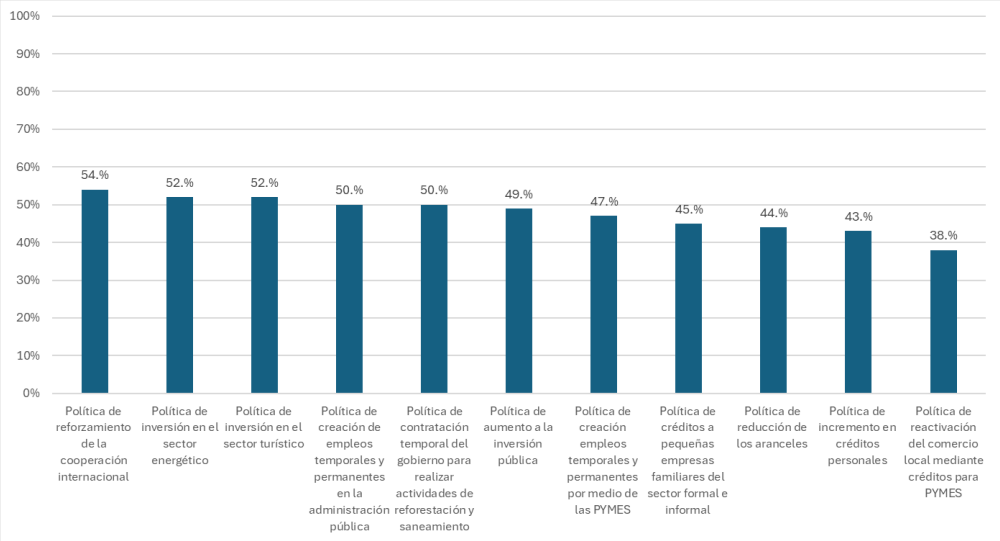


In the category of *Public Policies for Economic Growth*, 46% of students are indifferent to whether the policy of reducing public debt will contribute to economic growth in this post-COVID era, while 34% agree, 9% disagree, 7% strongly disagree, and 4% strongly agree. On another note, 49% agree that the policy of increasing public investment will contribute to economic growth in this post-COVID era, 31% are indifferent, 11% disagree, 5% strongly disagree, and 4% agree. Likewise, 41% are indifferent as to whether the Republican austerity policy regarding the use of public resources will contribute to economic growth in this post-COVID era, 40% agree, 13% disagree, 5% strongly disagree, and 1% strongly agree. On the other hand, 54% agree that the policy of strengthening international cooperation will contribute to economic growth in this post-COVID era, 33% are indifferent, 6% disagree, 4% strongly disagree, and 3% strongly agree. Furthermore, 44% agree that the policy of reducing tariffs will contribute to economic growth in this post-COVID era, 40% are indifferent, 8% agree, 4% strongly disagree, and 4% strongly agree. Also, 43% agree that the policy of increasing personal loans will contribute to economic growth in this post-COVID era, 33% are indifferent, 13% disagree, 8% strongly agree, and 3% strongly disagree.

On the other hand, 45% of participants agree that the policy of providing loans to small family businesses in the formal and informal sectors of the economy will contribute to economic growth in this post-COVID era, 35% are indifferent, 12% strongly agree, 4% disagree, and 4% strongly disagree. Similarly, 38% agree that the policy to revitalize local commerce through loans for SMEs will contribute to economic growth in this post-COVID era, 41% are indifferent, 11% strongly agree, 7% disagree, and 3% strongly disagree. Additionally, 47% agree that the policy of creating temporary and permanent jobs through SMEs will contribute to economic growth in this post-COVID era, 35% are indifferent, 9% strongly agree, 6% disagree, and 3% strongly disagree. On another note, 50% of students agree that the policy of creating temporary and permanent jobs in the public sector will contribute to economic growth in this post-COVID era, 34% are indifferent, 8% strongly agree, 5% disagree, and 3% strongly disagree. Furthermore, 50% agree that the government's policy of hiring temporary workers for reforestation, waste collection, and sanitation activities will contribute to economic growth in this post-COVID era; 24% are indifferent, 12% strongly agree, 9% disagree, and 5% strongly disagree. Meanwhile, 52% agree that the investment policy in the tourism sector will contribute to economic growth in this post-COVID era, 29% are indifferent, 12% strongly agree, 4% disagree, and 3% strongly disagree. Also, 52% of the students agree that the investment policy in the energy sector will contribute to economic growth in this post-COVID era, 27% are indifferent, 12% strongly agree, 5% disagree, and 5% strongly disagree.

Figure 2 below shows that law students consider the public policies implemented by the Federal Government for economic development following the COVID-19 pandemic to be important, as the majority agree with each of the public policies that have been implemented to revive the national economy.

Figure 2. *The majority of students agree on the importance of the public policies established by the Federal Government for economic growth in the post-COVID era.*



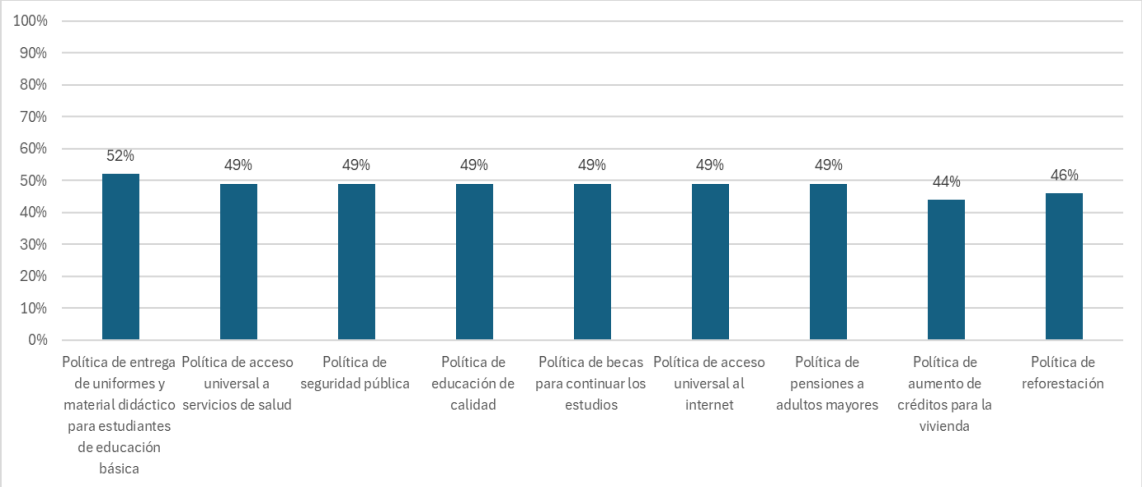
In the category of *Public Policies for Social Development*, 46% of students agree that the reforestation policy will contribute to social development in this post-COVID era, 34% are indifferent, 12% strongly agree, 5% disagree, and 3% strongly disagree. Similarly, 49% agree that the scholarship policy to continue studies will contribute to social development in this post-COVID era, 28% are indifferent, 18% strongly agree, 3% disagree, and 2% strongly disagree. Additionally, 48% agree that the pension policy for the elderly will contribute to social development in this post-COVID era, 31% are indifferent, 14% strongly agree, 4% strongly disagree, and 3% disagree.

On the other hand, 44% of university students agree that the policy to increase housing loans will contribute to social development in this post-COVID era, 31% are indifferent, 11% disagree, 12% strongly agree, and 2% strongly disagree. Likewise, 49% agree that the policy on quality education will contribute to social development in this post-COVID era, 27% are indifferent, 14% strongly agree, 6% disagree, and 4% strongly disagree. Furthermore, 52% agree that the policy of providing uniforms and educational materials to elementary school students will contribute to social development in this post-COVID era, 28% are indifferent, 10% strongly agree, 6% disagree, and 4% strongly disagree.

On another note, 49% agree that the policy of universal internet access will contribute to social development in this post-COVID era; 27% are indifferent, 15% strongly agree, 5% strongly disagree, and 4% disagree. Furthermore, 49% agree that the policy of universal access to health services will contribute to social development in this post-COVID era, 23% are indifferent, 21% strongly agree, 4% strongly disagree, and 3% disagree. Also, 49% agree that public safety policy will contribute to social development in this post-COVID era, 25% are indifferent, 20% strongly agree, 4% disagree, and 3% strongly disagree.

Figure 3 is presented below, showing that law students consider the public policies established by the Federal Government for social development in the post-COVID era to be important, as the majority agree with each of the government actions aimed at achieving the social well-being of Mexicans.

Figure 3. Students who, for the most part, agree with the importance of the public policies established by the Federal Government for social development in the post-COVID era



This section reviews some similar studies that are of interest due to the findings presented in this research. The study by Mejía, Reyes, and Vergara (2022), titled "The COVID-19 Pandemic in the Mexican Economy: Initial Conditions, Policy Strategies, and Productive Effects," analyzes the impact of the economic policy implemented during and after the COVID-19 pandemic to stimulate commercial activity and boost the country's economy. Among the findings, it is noted that during the pandemic, government actions were not sufficiently effective to counteract the market and economic downturn, while in the post-pandemic phase, economic recovery has been hindered, casting doubt on the public policies intended to boost economic activity and improve families' quality of life.

In our case, however, the majority of participants believe that the current public policies issued by the Federal Government have indeed contributed to economic growth and social development in the post-COVID phase. Given this, it is evident that there are conflicting positions among the studies: on the one hand, from the economists' perspective, no economic growth is observed following the health crisis; on the other hand, university students do perceive a positive change in the economy due to the policies implemented by the President of the Republic, which have had significant effects on the community's social development.

Another study conducted by Aguilar (2022), titled "Post-COVID-19 Economic Recovery from the Perspective of Business Leaders," analyzes the perceptions of Mexican business leaders regarding the pandemic's impact on the economy and businesses, as well as the Federal Government's approach to addressing this social crisis in order to revive the economy following the pandemic. In the findings, participants mention that the government should support economic recovery through various mechanisms that stimulate trade and the economy in general, primarily by investing in the different sectors where businesses operate. This aligns with the opinion of university students, who believe that the investment-related policies designed by government authorities are necessary and have been effectively implemented to foster economic growth, prioritizing the business sector, which, due to the pandemic, had to close its operations, resulting in many people losing their jobs. Therefore, business leaders and university students agree on post-pandemic public investment policies to revive commercial

and economic relations that lead to social development; at this point, it is necessary to sustain these policies over time until favorable signs emerge in society.

Conclusions

The perceptions of law students at the Autonomous University of Tamaulipas regarding the category *"Perception of current public policies implemented by the government* to promote economic growth and social development in the post-COVID era in *Mexico"* are optimistic that the public policies currently being implemented have been appropriate and have led to economic and social improvement. However, there are doubts regarding the manner in which public policies are being developed and the process for public participation in their formulation.

While the effectiveness of the policies is acknowledged, there is disagreement regarding the approach to engaging different sectors of society to participate, voice their opinions on the issues, and propose solutions to federal authorities to alleviate the crisis. It is suggested that the government improve transparency in the formation of the public agenda, the public policy design process, and the evaluation of government actions, and that the call for participation in these democratic processes be better publicized.

In the category of *Public Policies for Economic Growth,* there is acceptance of the federal government's economic policies, but there are also some toward which students show indifference—that is, they are not entirely convinced that these policies will yield significant results in terms of what is expected to contribute to the revival of the national economy. Among the public policies considered by university students to have the greatest impact on economic growth in the post-COVID era are: strengthening international cooperation; creating temporary and permanent jobs in the public administration; temporary government hiring for reforestation, waste collection, and sanitation activities; investment in the tourism sector; and investment in the energy sector. Meanwhile, the actions deemed to have the least impact are: reducing public debt and implementing fiscal austerity in the management of public resources.

In the category of *Public Policies for Social Development*, the results show that participants have confidence in the social policies currently being implemented by the Federal Government at the national level, as all the policies selected in this area for the study were well-rated; that is, the majority agreed that they contribute to improving people's social situation after experiencing social confinement and losing certain aspects of human interaction that contribute to a better quality of life. Of the social policies addressed in the study, students consider the following to have had positive effects: scholarships, quality education, the provision of uniforms and educational materials, universal access to the internet, universal access to health services, and public safety. Conversely, the policies that were least accepted among the students—as they were not fully convinced that they yield good results in terms of social development—were: reforestation and increased housing loans.

In general, the future lawyers in the case study have expressed their views on federal public policies from a unique perspective, as they are studying the field of public administration. Therefore, it is important that the process of constructing public agendas, designing public policies, and implementing government actions take into account the opinions of various social actors—particularly legal professionals—throughout the entire policy cycle.

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Economic-Territorial Development Planning Based on Entrepreneurship in Bolivarian Countries

Manjarrés Tete Arleth Esther
Cooperative University of Colombia, Colombia, arlet.manjarrest@campusucc.edu.co
https://orcid.org/0000-0002-7758-1646
De La Hoz Suárez Betty Auxiliadora
ECOTEC Technological University, Ecuador, bdelahozs@ecotec.edu.ec
https://orcid.org/0000-0002-5800-9775
De La Hoz Suárez Aminta Isabel
University of Cartagena, Colombia, adelahozs@unicartagena.edu.co
https://orcid.org/0000-0001-6230-8869
Luna Morán Ismael Felipe
Cooperative University of Colombia, Colombia, ismael.luna@campusucc.edu.co
https://orcid.org/0000-0002-1164-2207

Introduction

The Bolivarian countries are those nations that gained independence under Simón Bolívar as part of the Latin American independence movement, with a focus on territorial development and the resolution of social issues, based on his critique of colonial economic doctrine and the pursuit of commercial independence from European powers. A set of actions is described that highlight the symbolic nature of all Bolivarian countries, which, under economic-territorial development structures, have historically been centralized in their production and have prioritized extractive resources over productive diversification.

Entrepreneurship emerges as a key lever for linking local economies with global dynamics, fostering clusters in sectors such as agribusiness, appropriate technology, sustainable tourism, and the circular economy, aligned with the territorial strengths of each region.

This drove him to fight battles, thereby liberating five countries: Colombia, Venezuela, Ecuador, Peru, and Bolivia, as shown in Figure 1.

Figure 1. Geographic location of Bolivarian countries



The geographical position of these five countries demonstrates a significant territorial expanse; however, this was not what stood out, but rather the realities of the moment as the driving force behind the emancipatory struggle, as noted by De La Hoz, Cantillo, and Ramírez (2022), historical territorial movements sought their own sovereignty to address human inequalities through the lens of freedoms, because the natural reality is that every person possesses an egalitarian physical conception—born of dust and imbued with the breath of life that animates each body through reason—evoking cries of oppression and subjugation, devoid of human dignity.

Along these same lines, Panchi, De La Hoz, and Olivero (2021) question "superiority and inferiority"—an interesting position, given that the tendencies rooted in the biological and ideological differences between a superior race and an inferior race are what have historically shaped human behavior. This is considered utterly absurd, since the essence remains in viewing human society as a whole rather than through the disparity of stratification by power, skin color, physical traits, recognized family ties, and other exclusionary categorizations—whether dealing with so-called "blue-blooded" or "red-blooded" beings.

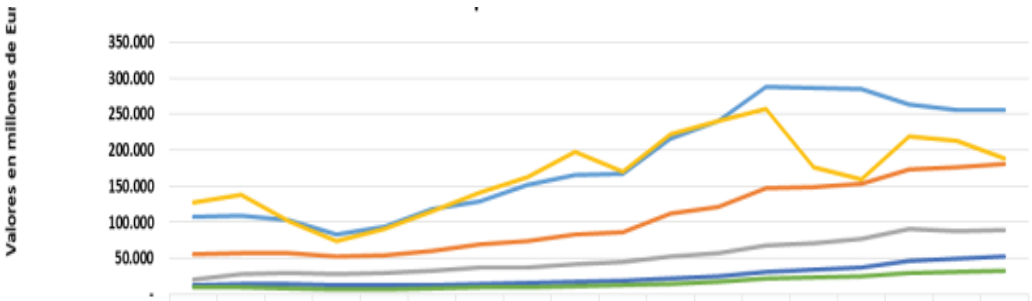
In this sense, Bolívar proposed the unification of these territories with a vision for the development of these peoples under the concept of unification to become strong and to wage the struggle for human dignity against the powers of the time that maintained subjugation. However, although that unification was not achieved, Bolivarian thought laid the groundwork for each country, in terms of governance, to address economic and social development as needs to be met for its citizens under systems of governance.

This is how the economic planning framework emerged to outline actionable steps with measurable results that would signal economic growth. And consequently, social assistance for citizens that would translate into comprehensive local development by engaging the population in the development of their own business ventures for economic openness, generating independence and, at the same time, economic freedom.

This translates into the expected economic growth, as measured by the Gross Domestic Product (GDP) indicator, which tracks monetary transactions related to the production of goods and services and has become a benchmark for international governance and a distinguishing factor between developed and developing countries, although it does not reflect a society's well-being in environmental and social terms (Quaroni, 2015). At the Latin American level, economic growth shows that results have not been significant relative to the region's vast territory, fertile land, mineral diversity, and varied climate, with the indicator declining by -6.8% in 2020 and 2021, despite the administrative measures implemented by governments to combat the COVID-19 crisis during that period (Manjarres et al., 2022).

With regard to the Bolivarian countries, scientific research indicates that historical economic growth has been characterized by stable production, with the exception of Venezuela, whose governments have implemented political-economic strategies that have caused market disruption and have not benefited its economy. For example, for the 2000–2017 period, Colombia and Peru achieved the highest GDP, and although they experienced low peaks on the timeline, they consistently stood out; in contrast, Bolivia's GDP results have always remained at a low level, as shown in Figure 2 (Caballero, 2018).

Figure 2. *GDP Performance of Bolivarian Countries, 2000–2017*



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Colombia PIB Mill. €	108.13	109.64	103.58	83.668	94.133	117.79	129.63	151.37	166.10	167.68	216.45	240.97	287.53	286.25	284.77	262.75	255.08	255.54
Perú PIB Mill. €	55.224	57.630	57.584	52.197	53.630	60.260	69.996	74.587	82.669	86.763	111.65	121.24	147.12	149.01	152.88	173.33	176.43	181.02
Ecuador PIB Mill. €	19.834	27.320	30.191	28.671	29.417	33.363	37.275	37.219	41.993	44.824	52.467	56.952	68.435	71.629	76.998	90.290	88.357	88.622
Venezuela PIB Mill. €	127.41	137.51	101.06	73.966	90.191	115.17	141.39	161.85	196.99	170.12	221.98	239.99	257.98	176.49	159.84	218.65	213.60	187.97
Panamá PIB Mill. €	13.322	13.959	13.742	12.106	12.069	13.161	14.451	15.292	16.673	19.067	21.813	24.694	31.098	33.775	37.009	46.987	49.858	52.500
Bolivia PIB Mill. €	9.079	9.106	8.372	7.153	7.062	7.695	9.175	9.643	11.417	12.521	14.925	17.338	21.234	23.254	25.018	29.960	30.542	31.977

These results highlight fluctuations in economic growth and, consequently, in territorial development, with a view to achieving Simón Bolívar's vision of independence—dedicated to the equality of nations in addressing the economic and social needs of their populations. In light of this, it is necessary to examine which government strategies regarding the production of goods and services the nations of the Bolivarian project have implemented to achieve economic and social development.

In this regard, scientific research in this field allows for reflection in the present, given the global context, which will not only address the issues highlighted in the Bolivarian nations—united by the common goal of the 2030 Agenda— but also provides a basis for reflection on the subject matter under study, drawing on criteria observed both retrospectively and prospectively regarding sensitive development issues that have not yet been adequately addressed, particularly in these Latin American countries.

In light of this, it is worth examining in this 2020s decade: what strategies are included in the economic planning agendas of the Bolivarian countries to undertake productive activities that generate territorial development? Consequently, the objective of this study is to analyze public management in Bolivarian nations based on these countries' economic-territorial development planning agendas, considering that the study aims to concretize the historical significance approach by focusing on the present and the aspirations outlined by the United Nations in the Sustainable Development Goals, thereby becoming a benchmark in political economy for future research.

Based on this narrative, the study adopts a qualitative research approach, constituting a type of applied, descriptive research grounded in a literature review that captures the realities of the environment within their historical narrative. Furthermore, the data collection technique is derived from the findings of the literature review on the categories under study and supporting documents from the governmental institutions of the Bolivarian countries as the subject of the reality addressed. In this regard, the literature considered was sourced from digital platforms corresponding to the nations of Venezuela, Peru, Ecuador, Colombia, and Bolivia; associated with territorial development plans for the 2021–2025 period; and regulations implemented in

each country related to entrepreneurship. Similarly, regulations currently in force globally to promote development were reviewed, as well as reports on global economic growth, as shown in Table 1.

Table 1. *Reference Document Collection*

Entity – Documents	Electronic Location
National Assembly of Ecuador (Official website and Development Plan)	https://www.asambleanacional.gob.ec/es/search/node/emprendimiento https://www.planificacion.gob.ec/plan-de-desarrollo-para-el-nuevo-ecuador-2024-2025/
Bolivarian Government of Venezuela (Official Website and Development Plan)	https://presidencia.gob.ve/Site/Web/Principal/paginas/classIndex.php https://observatorioplanificacion.cepal.org/es/planes/plan-de-la-patria-2019-2025-de-venezuela
Plurinational State of Bolivia (Official Website and Development Plan)	https://presidencia.gob.bo/index.php/page-builder/addons-list-3/informacion-de-planificacion https://www.planificacion.gob.bo/uploads/Presentacion_PDES_2021-2025.pdf
Government of Peru (Official Website and Development Plan)	https://www.gob.pe/ https://www.gob.pe/institucion/ceplan/campa%C3%B1as/11228-peru-plan-estrategico-de-desarrollo-nacional-al-2050
Republic of Colombia (Official Website and Development Plan)	https://www.presidencia.gov.co/ https://www.dnp.gov.co/plan-nacional-desarrollo/pnd-2022-2026
United Nations (Agenda and SDGs)	https://www.un.org/sustainabledevelopment/es/development-agenda/

Economic Planning for Territorial Development through Entrepreneurship in Bolivarian Government Agendas

Economic planning refers to the plan that compiles the economic decisions made by an authority in order to achieve specific economic and social objectives over a specific period of time (De Leuw, 1972). Economic planning refers to the forecasting and steering of economic growth in a specific territory, and responsibility for it falls directly on the State, which includes policies aimed at achieving economic goals within its government agenda.

To move closer to the proposed objectives, all economic planning must take into account the complexity of economic phenomena and the utilization of the territory's potential resources. The complexity of economic phenomena requires understanding and forecasting market behavior at the local, national, and even international levels in terms of economic indicators. On the other hand, the utilization of economic resources requires knowledge of the potential of the natural, human, cultural, and infrastructure resources available within the territory.

Therefore, economic planning requires the implementation of strategies that allow for the utilization of territorial potential and market conditions to generate economic development that can subsequently be reflected in economic growth within the territory; and it is here that we speak of Strategic Planning for Economic Development.

Strategic planning is considered a discipline that studies the forces influencing industries and markets, altering their margins and profitability (Pulla & Torres, 2022); when applied to the realm of Economic Development, it involves analyzing the behavior of the market to implement strategies that positively impact the economic growth of a locality, region, or country; and it is precisely here that the initiatives emerging within localities and the support provided by the State through government policies become highly significant.

Citing Howard Stevenson (1975), Moreno (2016) refers to entrepreneurship as the search for opportunities, regardless of the resources available at the start of the process; and Melean (2024) indicates that entrepreneurship generates progress and development on a personal, economic, and social level. In line with the text, entrepreneurship is a key aspect for generating development; and, when applied to the governmental sphere, it serves as a tool for planning economic growth and, consequently, social development; therefore, it must be included within economic planning agendas.

In this sense, entrepreneurship is one of the strategies considered in these government agendas, with the understanding that its essence is to generate economic resources that enable people's livelihoods, but with a greater expected significance, as noted by Contreras and Macías (2021); Muñoz and Martínez (2020) frame this within the context of contributing to economic and social development, since if it contributes to job creation, it begins to address the basic needs of individuals and their families.

However, this reflection leads to a need to truly determine the intent behind entrepreneurship, as it can arise from a need-based approach or, conversely, from an opportunity; it is necessary to examine its nature to determine whether the entrepreneurship aims for survival or if there is truly a vocational aspect among those who practice it.

Based on the data obtained, a comparative analysis is conducted of the strategies implemented in Bolivarian countries to enhance the productivity of goods and services, focusing on entrepreneurship as a tool within public management to drive territorial development. This study is of a qualitative nature , with the target population centered on the following nations: Venezuela, Peru, Ecuador, Colombia, and Bolivia.

Public Management with a View to Sustainable Economic and Social Progress

The literature review shows that Bolivarian countries plan territorial development in accordance with the 2030 Agenda, a global framework sponsored by the United Nations. This economic agenda seeks to ensure sustainable economic and social progress by focusing on eradicating poverty through strategies that enable its achievement, by promoting policies oriented toward the development of productive activities, entrepreneurship, and the formalization of microenterprises (United Nations, 2018). Thus, Colombia, Venezuela, Ecuador, Peru, and Bolivia plan their development based on this global agenda.

From the United Nations 2030 Agenda, three Sustainable Development Goals were identified that aim to strengthen entrepreneurship in countries: a) Goal 4: Quality Education, by including technical and entrepreneurial skills in educational programs to develop business ideas; b) Goal No. 8: Decent Work and Economic Growth, which fosters entrepreneurship by supporting policies that encourage job creation and the development of micro, small, and medium-sized enterprises; c) Goal No. 9: Industry, Innovation, and Infrastructure, by promoting a favorable

business environment through access to technology and innovation. Associated with these are specific actions through economic policy strategies that strengthen entrepreneurship as a tool for national development, as shown in Table 2.

Table 2. *Actions to strengthen entrepreneurship for national development*

SDG	ACTIONS FOR DEVELOPMENT
No. 4. Quality Education	Increase the number of young people and adults with the necessary skills—particularly technical and professional skills—to access employment, decent work, and entrepreneurship
No. 8. Decent Work and Economic Growth	Promote development-oriented policies that support productive activities, the creation of decent jobs, entrepreneurship, creativity, and innovation, and foster the formalization and growth of micro, small, and medium-sized enterprises through access to financial services
No. 9. Industry, innovation, and infrastructure	Increase access by small industries and other enterprises, particularly in developing countries, to financial services, including affordable credit, and their integration into value chains and markets. Develop reliable, sustainable, resilient, and quality infrastructure, including regional and cross-border infrastructure, to support economic development and human well-being, with an emphasis on affordable and equitable access for all

Table No. 2 shows that territorial development is partly conditioned by economic growth, which in turn aligns with economic policies related to entrepreneurship. Consequently, the entrepreneurship initiatives included in the economic agendas for the territorial development of Bolivarian countries are detailed below. A narrative is presented on entrepreneurship initiatives based on each country's territorial agendas from an economic perspective in relation to social development planning.

Venezuela

The concept of development is also viewed from a productive perspective, which is why it includes among its priorities the strengthening of entrepreneurial capacities generated within the territory. In its National Development Plan: Third Socialist Plan for the Economic and Social Development of the Nation 2019–2025, Plan for the Homeland 2025: Toward Economic Prosperity, the following are proposed (Official Gazette of the Bolivarian Republic of Venezuela, 2019):

a) The creation of a productive fabric with the People's Power (citizens) to maintain specialized corridors and components of public services in order to guarantee the system of financing, equipment, education, and training in the country.

b) Strengthening national tourism promotion through social and community tourism policies and programs, supporting agricultural and ecotourism ventures. c) Integrating training initiatives into university education to foster new productive ventures, in accordance with the

region's potential, that meet the fundamental needs of the population, for which entrepreneurial skills are taught.

Like Colombia and Ecuador, Venezuela also has regulations that support entrepreneurs, in this case the *Law for the Promotion and Development of New Enterprises* (Official Gazette of the Bolivarian Republic of Venezuela, 2021). This law aims to foster entrepreneurship nationwide, promote the development of the national economy, and drive entrepreneurial initiatives for the production of goods and services that meet the needs of the population; to this end, it identifies as a fundamental component the promotion of entrepreneurship training programs with an inclusive focus: women, youth, and people with disabilities, as well as access to credit to finance the launch of emerging productive ventures by entrepreneurs. Similarly, Venezuela has an Organic Law on Science, Technology, and Innovation (Bolivarian Government of Venezuela, 2022) whose purpose is to guide the generation of science, technology, and innovation and their applications through actors who implement them to strengthen popular power; however, this legislation makes little contribution to entrepreneurship for productive development.

In numerical terms, Venezuela has significantly increased its entrepreneurial activity rates, rising from 18.6% in 2022 to 27.6% in 2023, and its Total Early-Stage Entrepreneurial Activity (TEA) reached 22.67%, placing it among the Latin American countries with the highest rates. More than 4.5 million Venezuelans are engaged in entrepreneurship at various stages (16.5% in nascent businesses, 6.6% in new businesses, and 4.47% in established or partially consolidated businesses). Venezuela's entrepreneurship figures are comparable to those of countries with a consolidated and sophisticated entrepreneurial ecosystem. (Global Entrepreneurship Monitor, 2024*). However, 91% of people who start businesses do so to survive; and most of these ventures have little or no technological content, and nearly all fail early due to a lack of financing (El interés, 2024).

This highlights a disconnect in economic planning, as it suggests that entrepreneurs are provided with financing or access to credit, yet in reality this is uncertain; there are no resources to invest in technology and innovation because productive development is not conceived as being 100% based on strengthening innovation and technology, even though this generates added value for the product and allows for entry into markets with a differentiating effect, thereby fostering economic development.

Peru

A long-term development vision is in place; for example, the Peruvian government has approved the Strategic National Development Plan to 2050, which proposes to enhance productive and sustainable development by promoting entrepreneurship, innovation, and access to financial services—aspects related to (CEPLAN, 2023):

a) Basic and community education, by proposing to improve the skills of students in basic education through the development of curriculum guidelines to foster entrepreneurial potential.

b) Labor formalization, to promote the creation of formal jobs through incentives and the promotion of business formalization in MSMEs.

c) Productive self-employment, through the development of entrepreneurial and business skills to foster productive development.

d) Financial inclusion, aimed at micro, small, and large enterprises to ensure easy access to credit and the promotion of e-commerce.

The Peruvian government, through Supreme Decree 013-2013-Produce, approved the Law on the Promotion of Productive Development and Business Growth; whose objective is to establish a legal framework for promoting competitiveness, formalization, and the development of MSMEs, setting forth in the document general policies to incentivize private investment , production, and access to domestic and international markets, as well as other policies that promote entrepreneurship (Official Gazette of the Bicentennial El Peruano, 2013).

In addition to this, like Colombia, Ecuador, and Venezuela, Peru has established policies to promote entrepreneurship within the country, notably the *Law on the Promotion and Formalization of Micro and Small Enterprises*, which aims to boost competitiveness. It aims to formalize and develop micro and small enterprises to increase sustainable employment, their productivity, and profitability, as well as their contribution to the Gross Domestic Product, the expansion of the domestic market, and exports, with the goal of increasing tax revenue (Republic of Peru, 2003).

Regarding the *National Policy on Science, Technology, and Innovation*, the objective is to promote scientific, technological, and innovation development in support of the country's sustainable development. Regarding entrepreneurship, it proposes strategies for companies to innovate in new technologies and venture into digital commerce to maximize their revenue through exports, providing public incentives to develop business infrastructure (CONCYTEC, 2024).

The strategies implemented by the Peruvian government to promote entrepreneurship in support of territorial development have positioned the country as the third most entrepreneurial in the world, where 5.5 million people are committed to starting businesses, and there are currently around 102,000 entrepreneurs in the country who have generated approximately 340,000 direct jobs, according to Carrasco (2024) in the newsletter La Revista Digital de la Cámara de Comercio de Lima (2024), citing an Ipsos Global Advisor survey; and in 2023, the country achieved an Early Entrepreneurial Activity Rate of 22.4% (Federation of Journalists of Peru, 2024). Among the strategies implemented to achieve this objective is Startup Perú, an initiative of the Ministry of Production that provides seed capital to innovative, high-impact startups with a view to growth and targeting regional and global markets (Ministry of Production, 2024).

Ecuador

Development planning in Ecuador is based on the National Competitiveness Agenda 2030, through the "Ecuador Compite" strategy, which includes three lines of action (Ministry of Production, Foreign Trade, and Fisheries, 2024):

a) Productive Ecuador: lays the groundwork for competitiveness through cost reduction and the simplification of procedures and processes.

b) Global Ecuador: seeks to expand opportunities on a global scale by opening new markets and promoting investment.

c) Innovative Ecuador: aims to foster value addition, innovation, and entrepreneurship at every stage of the production chain; this last action is considered the most effective for encouraging the creation of businesses that drive economic development and, consequently, the country's economic growth.

Consequently, the capacity for innovation and entrepreneurship within the National Competitiveness Agenda was established as a strategic pillar, with the objective of productively enhancing startups to foster investment and job creation. Strategic actions include: 1) the internationalization of startups and best practices; and 2) the digital transformation of SMEs and connections with international buyers. However, achieving these goals requires the participation of public and private actors, academia, and society at large, working together to strengthen and generate sustainable entrepreneurship based on market opportunities. These actions are supported by regulations: the Organic Code of the Social Economy of Knowledge, Creativity, and Innovation (COESCCI) and the Organic Law on Entrepreneurship and Innovation (LOEI) (Ministry of Production, Foreign Trade, and Fisheries, 2023).

The *Organic Code of the Social Economy of Knowledge, Creativity, and Innovation* (COESCCI) establishes, in Article 76, the Innovative Entrepreneurship project, which seeks to generate processes of social innovation through new knowledge, supported by the guidance of the Secretariat of Higher Education and other local actors, creating incentives for innovative entrepreneurs (National Assembly of the Republic of Ecuador, 2016). This economic policy enables more entrepreneurs to join in the creation of innovative products, which to a certain extent aims to increase productivity within the country, seeking to foster economic development and improve the country's economic growth indicators.

Likewise, the Organic Law on Entrepreneurship and Innovation (LOEI) aims to promote an entrepreneurial culture by implementing new corporate and financing models to strengthen the entrepreneurial ecosystem (National Assembly of the Republic of Ecuador, 2020). This legislation, which provides strong support for entrepreneurs, has enabled young people to launch innovative business initiatives with tax incentives.

On the other hand, the Development Plan for the New Ecuador 2024–2025 also includes the development of entrepreneurial ventures with an emphasis on people living in poverty and extreme poverty, as a strategy to help reduce poverty indicators; to this end, policies have been formulated to develop the skills of young people aged 18 to 29; To this end, a course on entrepreneurship and management is being implemented in high school (Ministry of Education, 2015); in addition to promoting local tourism entrepreneurship and productive initiatives within communities that ensure food security in support of sustainable development (National Planning Secretariat of the Republic of Ecuador, 2024).

Consequently, all these actions have had an impact on the Early-Stage Entrepreneurial Activity Rate (TEA) indicators; for the year 2023, it stood at 32.65%, placing us at a higher level compared to other Latin American countries such as Colombia and Venezuela, which recorded rates of 23.57% and 22.67%, respectively (Global Entrepreneurship Monitor, 2024). In 2021, 934 Ecuadorian companies exported for the first time, thanks to innovation in their products: aluminum, sea bass, and electric motor propellers were the products highlighted for their innovation (Primicias, 2024). Likewise, the Gross Domestic Product (GDP) in the first quarter of

2024 grew by 1.20% compared to the immediately preceding quarter (Trading Economics, 2024).

Colombia

Currently, development planning in Colombia is structured through the 2022–2026 Development Plan "Colombia: Global Power of Life" (National Planning Department, 2023), which outlines guidelines for promoting entrepreneurship in the country:

a) Support for the solidarity economy through projects to generate inclusive and sustainable business models, leveraging the country's potential in the agricultural, aquaculture, and cultural tourism sectors.

b) Promotion of science and innovation through targeted investment in research conducted by academia but coordinated with the communities where these ventures emerge.

c) Formalization and access to credit, with support for the formalization and management of loans for entrepreneurs located in rural areas of the country.

d) Strengthening the Entrepreneurial Ecosystem, through the creation of support networks and coordination among the public sector, private sector, and academia. All these strategies outlined in the National Development Plan are aligned with the country's approved economic planning agendas, with a focus on development.

Martínez et al., (2024) Regarding the *National Entrepreneurship Policy* (National Council for Economic and Social Policy, 2020), CONPES 4011 establishes the intention to create enabling conditions for the creation, sustainability, and growth of enterprises that contribute to the generation of income, wealth, and increases in productivity and business internationalization. This policy proposes five specific objectives framed within: a) Strengthening skills development and fostering an entrepreneurial culture, b) Improving access to and the sophistication of financing mechanisms, c) Strengthening networks and marketing strategies, d) Facilitating technological development and innovation in startups, and e) Strengthening the institutio al architecture to achieve a coordinated, efficient, timely, and evidence-based public offering that provides enabling conditions for the entrepreneurial ecosystem.

Although this policy has a five-year timeframe, beginning in 2021, the national entrepreneurship rate has been increasing in percentage terms since its implementation—from 2% in 2022 to 7% in 2023. According to a recent economic study, during the 2013–2023 period, Colombian startups raised US$4.621 billion in capital, ranking Colombia third in Latin America for venture capital fundraising; this confirms that innovative entrepreneurship is a key driver of the country's economic development (La República, 2024). The results obtained are also due to the implementation of Law 2069 of 2020, which promotes entrepreneurship in Colombia and entered into force on January 1, 2021; it establishes a regulatory framework for the growth, consolidation, and sustainability of companies, including a modification to the rates of the departmental registration tax (Congress of the Republic of Colombia, 2020), benefiting nascent MSMEs and negatively impacting departmental budget revenues through this budget item—the registration tax—relative to the planning of public revenues from that source. Given this, a policy is presented that incentivizes entrepreneurship but has an impact on state finances.

On the other hand, the National Policy on Science, Technology, and Innovation seeks to make Colombia one of the three leading countries in Latin America in STI to contribute to the social, economic, environmental, and sustainable development of Colombia with a differentiated approach (National Council for Economic and Social Policy, 2021), CONPES Document 4069; proposing actions aimed at boosting the production and transfer of knowledge to Colombian society.

In this regard, economic planning focuses its efforts on small and medium-sized enterprises, implementing strategies for coordination among the government, society, and academia. Numerous efforts are being undertaken across Colombia under the economic " " agenda to achieve sustainable development goals through innovation: training entrepreneurs, preparing PhD candidates for research, among others. Despite this, Colombia ranks 66th in the Innovation Index compared to other Latin American countries; because, according to the World Intellectual Property Organization report, the country is creating fewer innovative products relative to its level of investment (La República, 2024). The initiatives included in the economic agendas regarding entrepreneurship have yielded results. Economic indicators show gradual growth in the country's economy; the Gross Domestic Product (GDP) in the second quarter of 2024 grew by 2.1% compared to 2023 (DANE, 2024).

Bolivia

Bolivia plans territorial development in four-year periods based on the strategic document Economic and Social Development Plan (PDES) developed by each government; for the 2021–2021 period, the PDES document "Rebuilding the Economy for Good Living, Toward Industrialization with Import Substitution" was drafted. It focuses entrepreneurship on the tourism sector, with a strategy to promote new ventures within the framework of the Community-Based Productive Economic and Social Model, promoting rural and ancestral tourism based on agrotourism, ecotourism, and gastronomy (Ministry of Development Planning of the Plurinational State of Bolivia, 2021).

In this way, entrepreneurship in Bolivia is driven by regulations such as the *Micro and Small Enterprises Act*, which aims to strengthen and develop MSMEs through the implementation of development policies and marketing support, as well as registration processes, consumption incentives, and the promotion of goods produced within the framework of the plural economy, where associations are prioritized (Official Gazette of the Plurinational State of Bolivia, 2017)

Likewise, the *Law on the Promotion and Development of Handicrafts,* through which the Bolivian government recognizes, protects, fosters, and promotes the sustainable development of the handicraft sector in all its forms; facilitating access to financing, training, technical assistance, market access, and the dissemination of artisanal knowledge, skills, and techniques, based on an awareness of their economic, social, and cultural importance (Official Gazette of the Plurinational State of Bolivia, 2012).

Furthermore, Bolivia has a National Plan for Science, Technology, and Innovation that aims to promote science, technology, and innovation in the ICT sector, in response to the need to coordinate the knowledge-generating sector to meet the demands of the country's social and productive sectors (Ministry of Education of the Plurinational State of Bolivia, 2013), with a view to implementing software and hardware platforms in the productive sector to generate products with higher added value.

The strategies implemented by the Bolivian government have yielded significant results; the country's economic growth reached 2.3% in the first quarter of 2023 (Ibáñez, 2023); however, there are no updated figures regarding the Total Early-Stage Entrepreneurship Rate (TEA), and the reports generated focus on the implementation of technologies in startups, highlighting Fintech—companies that have established a 30% presence in Bolivia—E-commerce/marketplace (14%), Edtech (14%), and SaaS (11%), according to Mapeo Bolivia TIC (2023). Consequently, entrepreneurship in Bolivia revolves around technology and is contributing to the country's development through the implementation of software and hardware platforms in the productive sector.

The Bolivarian countries have embraced the Sustainable Development Goals outlined in the 2030 Agenda, specifically Goals 4, 8, and 9, incorporating them into their territorial planning agendas. Based on these goals, they have formulated policies that have strengthened entrepreneurship as a strategy to generate social development and economic growth. Table 3 below summarizes the actions taken by each Bolivarian nation in line with the Sustainable Development Goals, with a focus on entrepreneurship.

Table 3. *Actions of Bolivarian countries based on SDGs regarding entrepreneurship*

Territorial Development Framework of Bolivarian Countries	Regulations that promote entrepreneurship and strengthen the SDGs of the 2030 Agenda	2023 Results
 • Promoción del turismo social apoyado en emprendimientos agro y ecoturísticos • Generación de tejido productivo con poder popular para el mantenimiento en corredores de servicios públicos	*SDG 4. Quality Education* *Entrepreneurship training programs with an inclusive approach* • Training for women, youth, and people with disabilities *SDG 8. Decent Work and Economic Growth* *Law for the Promotion and Development of New Enterprises* • Promotes entrepreneurial initiatives for the production of goods and services that meet needs *SDG 9. Industry, Innovation, and Infrastructure* *Organic Law on Science and Technology* • Guides the generation of science, technology, and innovation and their applications to strengthen popular power	Early-Stage Entrepreneurship Rate: 22.67%
	*SDG 4. Quality Education* *Curriculum guidelines to foster entrepreneurial potential* • Improves the skills of students in basic education	Early Entrepreneurial Activity

	SDG 8. Decent Work and Economic Growth *Law on the Promotion and Formalization of Micro and Small Enterprises* • Formalization and development of MSMEs, expansion of the domestic market and exports to increase tax revenue ***SDG 9. Industry, Innovation, and Infrastructure*** *National Policy on Science, Technology, and Innovation* • Innovate in new technologies and venture into e-commerce to maximize export revenue	Rate: 22.40%
	***SDG 4. Quality Education*** *Entrepreneurship and Management Curriculum in High School* • Development of entrepreneurial capacity among young people aged 18 to 29 living in poverty and extreme poverty ***SDG 8. Decent Work and Economic Growth*** *Organic Law on Entrepreneurship and Innovation (LOEI)* • Implementation of new corporate structures— —with tax incentives and financing to strengthen the entrepreneurial ecosystem ***SDG 9. Industry, Innovation, and Infrastructure*** *Organic Code of the Social Economy of Knowledge, Creativity, and Innovation (COESCCI)* • Innovative Entrepreneurship Project with a social focus through new knowledge, with incentives for innovative entrepreneurs	Early Entrepreneurial Activity Rate: 32.65%
	***SDG 4. Quality Education*** *National Entrepreneurship Policy (CONPES 4011, 2020)* • Strengthening the development of skills for an entrepreneurial culture among students. ***SDG 8. Decent Work and Economic Growth*** *Law 2069 of 2020: Promotion of Entrepreneurship in*	Early-Stage Entrepreneurship Rate: 23.57%

	Colombia • Regulatory framework for the growth, consolidation, and sustainability of businesses	
	SDG 9. Industry, Innovation, and Infrastructure *National Policy on Science, Technology, and Innovation (CONPES 4069, 2021)* • Funding for Technological Development and Innovation Projects for MSMEs	
 • Generación de nuevos emprendimientos en el marco del Modelo Económico Social Comunitario Productivo, promoviendo el turismo rural, ancestral basado en acciones de agroturismo, ecoturismo y gastronomía	***SDG 4. Quality Education*** *Law on the Promotion and Development of Handicrafts* • Protects, supports, and promotes the sustainable development of the artisan sector in all its forms through training and the dissemination of knowledge ***SDG 8. Decent Work and Economic Growth*** *Micro and Small Business Act* • Implementation of development policies and support for marketing, registration processes, and incentives for consumption and promotion of goods produced within the framework of the plural economy ***SDG 9. Industry, Innovation, and Infrastructure*** *National Plan for Science, Technology, and Innovation* • Implementation of software and hardware platforms in the productive sector to generate value-added products	Fintech 30% E-commerce 14% Edtech 14% SaaS 11%

Table No. 3 shows that Bolivia is a country that has made significant progress in electronic platforms, as 69% of its enterprises are represented by companies that base their activities on the use of hardware and software; in contrast to other Bolivarian countries where the adoption of technology within MSMEs is low, despite having established Science, Technology, and Innovation policies. Peru had the lowest early-stage entrepreneurial activity rate for the 2023 period, with an indicator of 22.40%, despite having implemented strategies to help MSMEs enter the digital world and conquer international markets.

On the other hand, Ecuador had the highest Early Entrepreneurial Activity Rate in 2023, with an indicator of 32.65%. Notably, this country has strengthened entrepreneurship in the

education sector by incorporating an Entrepreneurship and Management curriculum into high school, a key factor that set it apart from the others.

Conclusions

A country's development is guided by global regulations that seek to benefit humanity in economic, social, and even environmental terms; Based on these standards, territorial development plans are formulated that align with the vision of economic growth for nations; to be realized, they require economic policies implemented by the governments themselves; among these are policies aimed at strengthening entrepreneurship; policies for the development of Science, Technology, and Innovation; and policies aimed at strengthening entrepreneurial capacities through education.

In the case of the Bolivarian countries, they took the 2030 Agenda and Sustainable Development Goals 4, 8, and 9 as their guiding framework; considering them important for territorial development, policies were designed and implemented to generate and strengthen MSMEs, based on the concepts of entrepreneurship, innovation, science, and technology; However, when comparing them side by side—despite a common policy framework—the results achieved had a greater impact in countries that placed greater emphasis on education to foster entrepreneurship- , incorporating this component into the high school curriculum, as is the case in Ecuador.

Finally, it is noted that the implementation of policies on entrepreneurship; science, innovation, and technology is common to all Bolivarian countries, but they differ in the approach of each policy toward strengthening productive processes in the context of economic and social development. The results regarding the entrepreneurial activity rate are evident, with Ecuador standing out at 32.65% by 2023. It is concluded that the greatest impact occurred in countries that emphasized education to foster entrepreneurship, based on the strategy of incorporating the entrepreneurship component into the high school curriculum.

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Internationalization of Decentralized Autonomous Governments: Strategies for Cooperation and Attracting Local Investment

Barcia Rivera, Blanca Romina
Luis Vargas Torres Technical University of Esmeraldas, Ecuador , blanca.barcia@utelvt.edu.ec
https://orcid.org/0009-0005-4885-0615
Reina Zambrano, Jasmina Andrea
Luis Vargas Torres Technical University of Esmeraldas, Ecuador , jasmina.reina.zambrano@utelvt.edu.ec
https://orcid.org/0000-0003-2928-3705
Banguera Rojas, Dayra Elena
Luis Vargas Torres Technical University of Esmeraldas, Ecuador, dayra.banguera.rojas@utelvt.edu.ec
https://orcid.org/0009-0002-3629-5464
Renteria Valencia, Nuvia Maribel
Luis Vargas Torres Technical University of Esmeraldas, Ecuador , nuvia.renteria@utelvt.edu.ec
https://orcid.org/0000-0002-1886-1699

Introduction

Globalization has profoundly transformed the role of local governments, creating a scenario in which no territory, however small or isolated it may seem, is immune to phenomena such as migratory flows, the relocation of productive activities, or the demands of digital connectivity (Jiménez, Ochoa & Pineda, 2010). Faced with this reality, Decentralized Autonomous Governments (DAGs) are called upon to find solutions and generate strategic responses to citizen demands that transcend their administrative boundaries (Jiménez-Castillo et al., 2022). In this context, paradiplomacy emerges as the involvement of non-central governments in international relations to promote socioeconomic or political issues within their purview, acting not as a competitor to the state but as an empowerment tool to resolve internal problems (Cornago, 2010; Mesa Bedoya et al., 2023).

Territorial internationalization thus emerges as a process of local government empowerment that allows the territory to assert itself as an active actor in its own development (Jiménez, Ochoa & Pineda, 2010). This is not a passing fad, but a practical necessity: today, a local government cannot fully exercise its powers, provide quality public services, or develop the model of the city it wishes to promote without engaging in a dynamic of technical and professionalized international relations (Zapata, 2013). This vision transcends the traditional concept of welfare-based "aid" to focus on "cooperation" based on equal and horizontal partnerships (Ayllón, 2007).

Morales, (2025) in the specific case of Ecuador, the 2008 Constitution and the Organic Code on Territorial Organization, Autonomy, and Decentralization (COOTAD) laid the groundwork for decentralized governance. In 2011, the transfer of international cooperation authority to the three levels of government opened a window of opportunity for local governments to take a leading role in resource mobilization and the exchange of best practices (Mera & Papa, 2016). However, despite the enabling legal framework, evidence shows that most local governments lack systematic strategies, often acting in a reactive and disjointed manner due to a lack of specialized personnel and institutional weakness (Monje, 2014; Mera & Papa, 2016).

To overcome these limitations, it is imperative that local governments adopt decentralized cooperation as a pillar that fosters participatory development and solidarity among peers (Ponce Adame, 2018). This approach not only provides access to non-reimbursable resources but also localizes the Sustainable Development Goals (SDGs), strengthening global multilevel governance (ECLAC, 2016; Kania, 2021). Likewise, internationalization must be integrated with local economic development (LED), driving technological and management innovations in production systems to generate employment and wealth in a sustainable manner (Alburquerque, 2008).

This chapter offers a conceptual and operational framework designed to enable local governments, particularly municipal ones, to implement an effective internationalization agenda. It is based on the premise that this process must be anchored in the Territorial Development and Planning Plan (PDOT) and articulated through five strategic pillars: international cooperation, territorial marketing, diversification of value chains, participation in international networks, and attracting investment (Jiménez, Ochoa & Pineda, 2010; Ponce Adame & Sánchez Gutiérrez, 2022). Through a methodological roadmap, the aim is for local international management to become a tangible tool that improves citizens' quality of life with a global perspective (UNDP, 2012).

Internationalization and Cooperation for Local Development

International Development Cooperation (IDC) is defined as the set of relationships among international actors aimed at the mutual satisfaction of needs through coordinated and solidarity-based actions (Ayllón, 2007). Historically, this system has evolved from welfare-oriented approaches that emerged after World War II—with milestones such as the Marshall Plan—toward models centered on sustainable human development, focused on capacity building and improving quality of life (Ayllón, 2007; Smith, 2013). In this process, the concept of "aid" has been replaced by that of "cooperation," characterized by horizontal relationships, shared responsibility, and alignment with national and territorial priorities—principles enshrined in international agreements such as the Paris Declaration and the Accra Agenda (Monje, 2014).

In the context of globalization, paradiplomacy emerges as a key element for understanding the participation of subnational governments in international relations, enabling them to promote territorial interests within their areas of competence (Cornago, 2010; Zeraoui, 2016). This process does not replace state diplomacy but rather complements it, strengthening the capacity of territories to respond to global challenges (Zeraoui, 2011; Mesa Bedoya et al., 2023). Within this framework, territorial internationalization is configured as a strategic process through which local governments project themselves globally to attract investment, knowledge, and cooperation, under multilevel governance schemes that bring together public, private, academic, and social actors (Cabrera Narváez, 2023; Jiménez-Castillo et al., 2022; Wiseman, 2004; Oddone, 2023).

International cooperation takes various forms that help elucidate its technical functioning. Depending on its sources, cooperation is categorized as bilateral between states in North-South or South-South frameworks; multilateral, channeled through international organizations; decentralized, led by subnational governments; triangular, involving multiple actors with distinct roles; as well as cooperation from nongovernmental organizations and multi-donor funds (Ayllón, 2007; Ayllón, 2013; Mera & Papa, 2016; Monje, 2014; Ponce Adame, 2018;

CONGOPE, 2022). Depending on the nature of the resources, the following are identified: non-reimbursable financial cooperation, technical cooperation, and mixed modalities that combine financing with knowledge transfer to ensure the sustainability of interventions (SETECI, 2015; Monje, 2014). Likewise, implementation modalities include development programs and projects, humanitarian aid, scholarships, scientific cooperation, in-kind donations, and financial mechanisms such as debt swaps (Ayllón, 2007; SETECI, 2015; OXFAM, 2022).

In the case of Ecuador, the international cooperation system is characterized by the participation of a broad ecosystem of actors. At the bilateral level, countries such as Germany, Spain, Italy, Japan, South Korea, and China provide resources and technical assistance in strategic areas such as sustainable development, infrastructure, environmental management, and disaster prevention (Cabrera Narváez, 2023; Cobo Carpio, 2024). At the multilateral level, organizations such as the Inter-American Development Bank, the World Bank, the European Union, and CAF finance structural projects related to territorial development and climate change mitigation (Mera & Papa, 2016). Similarly, the United Nations system, through agencies such as UNDP, FAO, UN Women, UNICEF, IOM, UNHCR, UNESCO, and PAHO/WHO, plays a fundamental role in institutional strengthening and the implementation of the Sustainable Development Goals (UNDP, 2012). In this context, participation in international city networks also constitutes a key mechanism for internationalization, with initiatives such as C40 Cities (C40, 2020), United Cities and Local Governments (UCLG, 2019), and ICLEI – Local Governments for Sustainability (ICLEI, 2021), which facilitate the exchange of best practices, access to financing, and the global positioning of territories.

Access to international cooperation by Decentralized Autonomous Governments (DAGs) is primarily achieved through calls for proposals, competitive funding, and negotiation processes with donors, which requires specialized technical capacities for project formulation and management (Cabrera Narváez, 2023; ECLAC, 2014). The implementation of these resources is formalized through technical and legal instruments such as exchanges of notes, letters of acceptance, technical missions, feasibility studies, the signing of agreements, and the transfer of grants, ensuring the proper execution of development initiatives (Constitution of Ecuador, 2008; UNDP, 2012).

In regulatory terms, Ecuador has a robust legal framework that recognizes GADs as strategic actors in the management of international cooperation. The 2008 Constitution, the COOTAD, and the Organic Code of Planning and Public Finance establish that this management must align with territorial development plans and national policies (Jurado & Proaño, 2022). Resolution 0009-CNC-2011 regulates this authority, granting GADs planning, management, and oversight functions, while tools such as SIGECI enable the recording and monitoring of cooperation, promoting transparency and access to information (Mera & Papa, 2016; SETECI, 2011).

From an analytical perspective, paradiplomacy directly influences the attraction of foreign investment by enabling GADs to forge links with international actors, position their competitive advantages, and develop territorial marketing strategies (Oddone, 2023). However, this process faces significant challenges, particularly in terms of institutional capacity, intergovernmental coordination, and the sustainability of strategies over time (Mesa Bedoya et al., 2023). Furthermore, citizen participation poses a challenge in cooperation management, as

the limited inclusion of local actors can affect the legitimacy and sustainability of interventions (ECLAC, 2014).

Finally, the internationalization of GADs is established as a comprehensive strategic process that links international cooperation with other dimensions of territorial development, such as attracting investment, territorial marketing, participation in international networks, and the strengthening of value chains (Jiménez, Ochoa & Pineda, 2010). To be effective, this strategy must be integrated into the Territorial Development and Planning Plan (PDOT) through results-oriented processes of diagnosis, planning, implementation, and evaluation, thereby contributing to territorial competitiveness and sustainable development (Cabrera Narváez, 2023). Finally, this study contributes relevant information to the research projects "Institutional strengthening and advisory services for parish GADs to ensure the sustainability of their operations and administrative decisions in the province of Esmeraldas, Ecuador" as well as the "Business Strengthening Program to Support MSMEs, Startups, and Social Organizations in the Province of Esmeraldas," carried out by the Luis Vargas Torres Technical University of Esmeraldas.

Some findings on internationalization processes in decentralized autonomous governments

The evaluation of internationalization processes in the selected Decentralized Autonomous Governments (GADs) is a central element for understanding the degree of integration of Ecuadorian territories into global dynamics. In this regard, the municipal DAGs of Riobamba, Ambato, Cuenca, Manta, Santo Domingo, Loja, Tena, and Machala were analyzed, considering five strategic pillars of internationalization: international cooperation, territorial marketing, diversification and expansion of value chains, participation in international networks, and investment attraction. To this end, an ordinal scale from 1 (very low) to 5 (very high) was used, which allowed for comparisons between territories with different levels of institutional and economic development.

The development of this matrix addresses the need to operationalize the concept of territorial internationalization into observable and comparable variables, thereby facilitating the identification of behavioral patterns, structural gaps, and varying levels of performance among local governments. In this context, the assessment reflects not only the technical and institutional capacity of local governments but also their level of coordination with international actors, their strategic positioning, and their potential to attract external resources.

Table 1. *Evaluation of GADs by Dimensions*

GAD	COOPERATION	MARKETING	VALUE CHAINS	NETWORKS	INVESTMENT
Riobamba	3	3	3	2	3
Ambato	3	3	4	3	3
Cuenca	5	5	4	5	5
Manta	4	4	3	3	4
Santo Domingo	3	3	3	2	3
Loja	4	4	3	4	4
Tena	2	2	2	1	2

Machala	3	3	3	2	3

Source: Author's own work.

Analysis of the results reveals significant differences in the performance of the GADs across the evaluated dimensions. First, the case of Cuenca stands out, achieving high levels across all dimensions and establishing itself as a national benchmark in territorial internationalization processes. This performance is explained by its institutional capacity, its experience in international cooperation, and its active participation in global networks, which allows it to effectively align local development strategies with international dynamics.

In a second tier are cities such as Loja and Manta, which perform well in several dimensions, particularly in international cooperation, territorial marketing, and investment attraction. These territories show significant progress in their strategic positioning, although they still face challenges in consolidating international networks and diversifying their value chains.

Meanwhile, municipalities such as Riobamba, Ambato, Machala, and Santo Domingo show average performance across most variables, reflecting an ongoing process of internationalization. In these cases, while institutional efforts exist in international cooperation and territorial planning, limitations remain in the strategic coordination of the five analyzed pillars, particularly regarding participation in international networks and investment attraction.

Finally, the case of Tena shows the lowest levels across all dimensions, highlighting the existing territorial disparities in the country. These limitations are associated with structural factors such as lower institutional capacity, budgetary constraints, limited territorial connectivity, and scant integration into global dynamics, which hinder their access to cooperation and development opportunities.

In general terms, the evaluation matrix reveals that the internationalization of local governments in Ecuador is not a homogeneous process, but is characterized by marked territorial inequality. While some municipalities have succeeded in consolidating comprehensive strategies for international integration, others are in the early stages or lag significantly behind. This finding reinforces the need to strengthen the institutional capacities of local governments and promote differentiated policies that reduce existing gaps and foster sustainable territorial development from a global perspective.

The following section presents the PESTEL analysis applied to the municipal Decentralized Autonomous Governments (GADs) of Riobamba, Ambato, Cuenca, Manta, Santo Domingo, Loja, Tena, and Machala, as a strategic tool for understanding the external factors that influence their internationalization process.

The PESTEL model allows for the identification of opportunities and constraints in the environment across six key dimensions: political, economic, social, technological, environmental, and legal. In the Ecuadorian context, this analysis is essential for explaining the territorial disparities observed in the results, as well as the conditions that facilitate or restrict the international integration of local governments.

Table 2. *PESTEL Analysis of the Selected Municipal GADs*

DIMENSION	KEY FACTORS	IMPACT ON INTERNATIONALIZATION	EVIDENCE IN THE GADs
Political	Institutional stability, multilevel coordination, political will	Determines the capacity to manage cooperation and establish international relations	High in Cuenca and Loja; moderate in Ambato and Manta; low in Tena
Economic	Productive capacity, local investment, economic diversification	Influences the attraction of foreign investment and the generation of projects	Strong in Cuenca and Manta; moderate in Machala and Ambato; weak in Tena
Social	Citizen participation, social capital, inclusion	Promotes the legitimacy of international projects and sustainability	High in Cuenca; moderate in Riobamba and Loja; limited in Tena
Technological	Digitization, public innovation, use of ICT	Improves regional competitiveness and access to international networks	Advanced in Cuenca; intermediate in Ambato and Manta; low in Tena
Environmental	Sustainable management, climate change, land use	Determines access to international funds (SDGs, climate)	Significant in Cuenca, Loja, and Tena; nascent in other GADs
Legal	Regulatory framework (Constitution, COOTAD), GAD competencies	Enables the management of international cooperation and the formalization of agreements	Consistent across all GADs, but with variations in implementation

Source: own elaboration.

The PESTEL analysis shows that the internationalization of GADs is strongly influenced by political and economic factors. In cities like Cuenca, institutional stability and strategic planning enable efficient management of international cooperation and the attraction of investment. In contrast, territories such as Tena face structural limitations that restrict their ability to integrate into global dynamics.

In the economic dimension, it is observed that GADs with greater productive diversification, such as Manta, achieve better results in attracting investment and developing value chains. Conversely, less consolidated local economies have a lower capacity to generate internationally competitive projects.

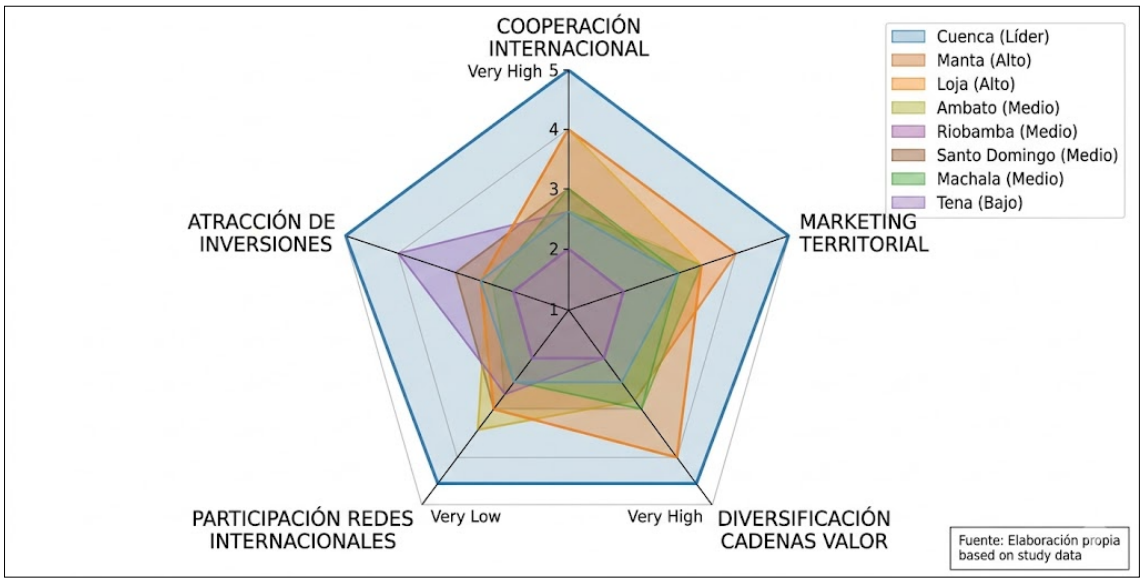
From a social perspective, citizen participation emerges as a key factor for the sustainability of internationalization processes. Municipalities with greater social coordination, such as Riobamba and Loja, are better positioned to implement projects with territorial impact, although they still face challenges in their international outreach.

In the technological sphere, the digital divide constitutes a significant limitation. While cities like Ambato have made progress in administrative modernization processes, other territories lag behind, which affects their competitiveness and access to global networks.

For its part, the environmental dimension represents both an opportunity and a challenge. GADs that incorporate sustainability criteria, such as Loja, have greater chances of accessing international financing linked to climate change and sustainable development. Finally, although the legal framework is common to all municipalities, differences lie in the institutional capacity for its effective implementation.

Overall, the PESTEL analysis confirms that the internationalization of GADs in Ecuador depends not only on internal capacities but also on structural conditions in the environment, reinforcing the need for differentiated strategies and public policies that reduce territorial gaps.

Figure 1. Assessment of Municipal GADs



Source: own elaboration.

The visual analysis through the radar chart reveals a marked stratification in the internationalization of GADs, where the shape of the polygons acts as an indicator of their institutional maturity. Cuenca is positioned with a symmetrical "expanded pentagon," demonstrating that optimal political and technological stability (PESTEL) enables comprehensive management where cooperation and investment feed back into territorial development. In contrast, cities such as Manta and Loja present asymmetric or elongated " " polygons; while the former leverages its port-based economic dynamism to attract investment, the latter compensates for its geographical limitations through active participation in networks and cooperation, demonstrating specialized internationalization processes that remain dependent on their specific comparative advantages.

On the other hand, GADs with intermediate performance, such as Ambato, Riobamba, Machala, and Santo Domingo, exhibit "network atrophy," visualized as a dip toward the center of the graph that reflects an inability to translate territorial marketing into solid global links. This morphology suggests a transactional and fragmented form of paradiplomacy that contrasts sharply with the "contracted nucleus" of Tena, whose minimal polygon indicates

structural determinism. In the latter case, the multivariate analysis confirms that the precarious technological and connectivity conditions of the environment (PESTEL) nullify any effort at international integration, underscoring that the internationalization gap in Ecuador is not merely administrative but a reflection of deep systemic and territorial inequalities.

Proposal for a systemic model of territorial internationalization (MSIT)

The following presents the comprehensive internationalization model for municipal Decentralized Autonomous Governments (GAD), which synthesizes the process of managing international cooperation from a territorial perspective in a structured and systemic manner. This model sequentially articulates the phases of diagnosis, environmental analysis, institutional strengthening, strategic planning, international management, implementation, and evaluation, integrating the main areas of intervention: international cooperation, territorial marketing, diversification of value chains, participation in international networks, and investment attraction. It also incorporates a continuous improvement approach that allows for feedback into the process and ensures its sustainability over time. Taken together, the diagram reflects a logic of inputs, processes, and outcomes that facilitates the understanding of internationalization as a comprehensive strategy aimed at strengthening the competitiveness and sustainable development of territories.

Table 3. *Process of the Comprehensive Internationalization Model for Municipal GADs*

PHASE	STAGE / COMPONENT	TECHNICAL DESCRIPTION	EXPECTED RESULTS
1. Diagnosis	, institutional, and territorial diagnosis	Assessment of the management capacities of the GAD, PDOT, and key stakeholders; identification of strategic sectors.	Baseline for decision-making.
2. Environmental Analysis	PESTEL Analysis	Analysis of political, economic, social, technological, environmental, and legal factors.	Identification of opportunities and threats.
3. Institutional Strengthening	Cooperation Unit	Creation or strengthening of technical capacities in international cooperation.	Strengthened institutional management.
4. Strategic planning	Internationalization Strategy	Strategic design based on five pillars and aligned with the PDOT and SDGs.	Plan with objectives, targets, and indicators.
5. Project Development	Project Portfolio	Development of technically and financially viable projects.	Portfolio of prioritized projects.
6. International management	Access and positioning	Management of calls for proposals, funding, and regional promotion.	Fundraising and visibility.
7. Global	Networks and	Links to international	Global

Coordination	Investment	networks and investment promotion.	integration and capital attraction.
8. Implementation	Project implementation	Formalization and execution of cooperation projects.	Projects implemented.
9. Evaluation	Monitoring and evaluation	Tracking results using indicators.	Impact measurement.
10. Feedback	Continuous improvement	Strategic adjustments based on results.	Sustainability of the model.

Source: The authors

The process of implementing international cooperation in municipal Decentralized Autonomous Governments (GADs) begins with a comprehensive assessment that identifies institutional capacities, available resources, and the territory's potential. This assessment includes a review of planning instruments such as the Territorial Development and Land Use Plan (PDOT), the organizational structure, prior experience in international cooperation, and the mapping of key stakeholders, such as cooperating agencies, the private sector, academia, and civil society. Additionally, strategic sectors with potential for international integration—such as tourism, agribusiness, or environmental sustainability—are identified, establishing a baseline for decision-making.

Subsequently, an environmental analysis is conducted using the PESTEL model, which allows for the evaluation of political, economic, social, technological, environmental, and legal factors that influence the management of internationalization. This analysis facilitates the identification of external opportunities and threats, as well as structural conditions that may enhance or limit the territory's integration into global dynamics, contributing to more strategic and context-specific planning.

In a second phase, institutional strengthening is carried out through the creation or consolidation of a technical unit for international cooperation within the GAD. This unit must have staff trained in project formulation, cooperation management, languages, and international negotiation, and its main function will be to coordinate the internationalization strategy, manage agreements, and bring together local and international actors. This step is essential to ensure the sustainability of management and prevent initiatives from being dependent on administrative changes.

Once the institutional structure is strengthened, the internationalization strategy is designed, which integrates five fundamental pillars: international cooperation, territorial marketing, diversification of value chains, participation in international networks, and attracting investment. This strategy must align with the PDOT and with global agendas such as the Sustainable Development Goals (SDGs), establishing clear objectives, performance indicators, targets, and an implementation timeline to guide institutional action.

Complementarily, a project portfolio is developed, serving as a key tool for managing external resources. This portfolio includes prioritized projects with technical profiles, feasibility studies, and defined budgets, which may be oriented toward technical cooperation, non-reimbursable financing, or investment. The existence of this portfolio facilitates the submission of proposals

to cooperating agencies and enhances the GAD's responsiveness to international opportunities.

In the external management phase, territorial marketing strategies are implemented to position the territory on the international stage. This involves building a city brand, promoting competitive advantages, and disseminating information through digital platforms and international events. At the same time, mechanisms for accessing cooperation are managed by identifying calls for proposals, competitive funds, and negotiation processes with cooperating agencies, which requires the application of methodologies such as the logical framework and results-based management.

Likewise, active participation in international networks of cities and multilateral organizations is promoted, which helps strengthen city diplomacy, exchange best practices, and access new opportunities for financing and technical assistance. Similarly, specific strategies are developed to attract investment by identifying priority sectors, creating local incentives, and promoting public-private partnerships that contribute to the region's economic development.

During the implementation phase, international cooperation is formalized through technical and legal instruments such as agreements, letters of acceptance, grants, and technical missions, which ensure the proper and effective implementation of projects in the region. This process ensures the correct use of resources and the achievement of the objectives established in the planning phase.

Finally, the process concludes with the monitoring and evaluation of results, using indicators that measure the impact of the implemented actions. This monitoring facilitates the identification of lessons learned and feedback on the strategy, promoting continuous improvement and the sustainability of internationalization. Taken together, this model constitutes a cyclical and comprehensive process that strengthens the capacity of GADs to integrate into the global context and contribute to sustainable territorial development.

Conclusions

The study shows that the internationalization of Decentralized Autonomous Governments (GADs) in Ecuador constitutes a heterogeneous process, conditioned both by internal institutional capacities and by structural factors in the environment. The application of the descriptive–analytical approach allowed for the identification of significant gaps among the municipalities analyzed, highlighting differences in the management of international cooperation, territorial positioning, and investment attraction.

In general terms, it is concluded that the DAGs with a higher level of institutional development, such as Cuenca and Loja, demonstrate more consolidated management of internationalization, evidenced by their active participation in international networks, their capacity for project formulation, and their coordination with cooperation actors. These territories effectively integrate the five strategic axes analyzed, positioning themselves as national benchmarks in paradiplomacy and territorial development.

In contrast, municipalities such as Tena exhibit structural limitations that restrict their integration into international dynamics. These constraints are associated with factors such as lower technical capacity, limited availability of resources, low levels of digitalization, and poor

institutional coordination, which directly impact their ability to access cooperation funds and attract foreign investment.

Likewise, it was found that intermediate GADs, such as Ambato, Manta, Riobamba, Machala, and Santo Domingo, are in a transitional phase, where significant progress has been made in international cooperation and territorial planning, but weaknesses still persist in the strategic coordination of elements such as territorial marketing, participation in international networks, and the diversification of value chains.

The PESTEL analysis led to the conclusion that political and economic factors are decisive for the success of internationalization. Institutional stability, political will, and investment capacity directly influence the management of cooperation and the attraction of external resources. Similarly, the technological and social dimensions emerge as critical factors, demonstrating that digitalization, public innovation, and citizen participation strengthen the sustainability of internationalization processes.

From a strategic perspective, it is concluded that the internationalization of GADs cannot be addressed in isolation but must be integrated into territorial planning instruments, particularly the Territorial Development and Planning Plan (PDOT). The articulation of the five strategic pillars—international cooperation, territorial marketing, value chains, international networks, and investment attraction—is essential for generating synergies that enhance local development with a global reach.

Finally, the study confirms that paradiplomacy is a key tool for improving territorial competitiveness, enabling local governments to access international resources, knowledge, and opportunities. However, to consolidate these processes, it is necessary to strengthen the technical capacities of GADs, promote differentiated public policies, and foster multilevel cooperation, with the aim of reducing territorial disparities and advancing toward a sustainable and inclusive development model in Ecuador.

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Impact of Corporate Social Responsibility on the competitive success of Ecuadorian companies

Mikel Ugando-Peñate
Pontificia Universidad Católica del Ecuador, Sede Santo Domingo (Ecuador), mugandop@pucesd.edu.ec ,
https://orcid.org/0000-0002-3021-0717
Ángel Ramón Sabando-García
Pontificia Universidad Católica del Ecuador, Sede Santo Domingo (Ecuador), arsabando@pucesd.edu.ec,
https://orcid.org/0000-0001-5438-9590

Introduction

CSR (corporate social responsibility) has a direct and positive influence on sustainable competitive advantages. The importance of CSR in developing sustainable competitive advantages in the construction industry is highlighted (Xuetong *et al.*, 2024). Corporate social responsibility activities (economic, social and environmental activities) have positively affected the company's performance (Jin *et al.*, 2022).

Environmental management and social management practices positively influence economic performance (Javed & Husain, 2021; Ruiz-López *et al.*, 2024; Úbeda-García *et al.*, 2021; Wei *et al.*, 2020), although there are articles that find that this relationship is not positive (Barauskaite & Streimikiene, 2021; Hu *et al.*, 2021). Corporate social responsibility practices have a significant positive effect on companies' operating results (Famiyeh *et al.*, 2018). Specifically, the economic, environmental and social dimensions of CSR have a positive and significant impact on financial results. Companies should actively carry out CSR initiatives and increase the competitiveness of the industry to improve financial results in a sustainable way (Dela *et al.*, 2024).

Innovation at the product and service level is affected by CSR in industrial companies and mediated by customers and suppliers. CSR has a greater effect on service firms than on industrial ones, even considering the role of employees and suppliers (Zhou *et al.*, 2020).

Innovation and CSR are influenced by digital transformation in significant and positive ways. Even in the case of ineffective management, companies can develop a CSR strategy and adapt to the digital environment (Sánchez, 2026) and (Tuyen *et al.*, 2023).

CSR is positively related to the environmental behaviour of employees. These findings help practitioners understand the importance of CSR and environmental behaviour in shaping and mitigating an organization's environmental footprint (Wu *et al.*, 2021). In addition, it has a significant impact on corporate reputation (CR) and brand value (BE). Trust is significant in the relationship between these variables (Zhao *et al.*, 2021). Investment decisions negatively affect the value of the company; however, CSR mitigates this effect (Suteja *et al.*, 2023).

CSR performance is positively associated with company value, as CSR reduces excessive risk-taking and risk-avoidance (Harjoto & Laksmana, 2018). There is a negative association between profit management and corporate social responsibility disclosures. In addition, family ownership reinforces the negative association between CSR and income management (Kumala

The study has a quantitative, explanatory and correlational approach, not experimental and cross-sectional. The main objective of the research was to measure the impact of corporate social responsibility on the competitive success of Ecuadorian companies, through structural

equations. Probability sampling was used to determine the sample with a confidence level of 95% and a margin of error of 5%.

The sample was 281 companies, 43.1% in the agricultural sector, 30.6% in the wholesale and retail trade sector, 24.6% in the manufacturing sector and 1.8% in other sectors. According to the size of the companies, 68.7% are microenterprises, 18.5% small enterprises, 7.8% medium-sized enterprises and 5.0% large enterprises. In addition, the number of employees working in the company was consulted. 68.7% have 1 to 10 employees, 18.5% have 11 to 50 employees, 7.8% have 51 to 250 employees, and 5% have 251 or more employees. Additionally, the questionnaire was answered in a 53.7% by operational technicians, 33.8% by managers, 8.2% by assistant managers and 4.3% by other representatives. The respondents are 62.6% male and 37.4% female.

The instrument selected to measure the effect of social responsibility on the competitive success of companies was generated by Gallardo *et al.* (2013). Social dimension of corporate social responsibility (CSR) had 15 items, innovation 13 items, performance 8 items and competitive success 10 items. These last dimensions are significantly explained by corporate social responsibility (Gallardo *et al.,* 2013; Ugando *et al.,* 2022). The instrument was made on the Google form platform and was sent from October 9 and closed on November 20, 2024. The selected population was 360 companies, of which 78.05% responded to the questionnaire.

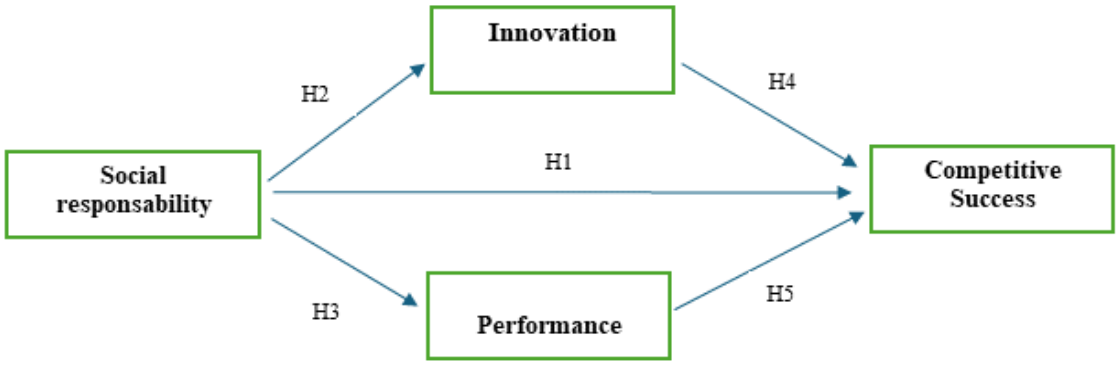
Empirical analysis of the data

In the process of empirical analysis, the proportional descriptive analysis was initially carried out for the sociodemographic and business variables. Subsequently, the veracity of the sample was performed through the Kaiser-Meyer-Olkin Measure (KMO) test and Bartlett's sphericity test complemented with Pearson's Chi-Square approximation. Simultaneously, the internal consistency reliability test was performed for the items and construct through the McDonald's Omega test (>0.70), complemented with the exploratory principal component analysis. These analyses were executed with the SPSS 25.0 software. The confirmatory, discriminant and convergent multivariate statistical analysis were validated through the goodness of fit tests of maximum likelihood and were analysed with the AMOS 24 software.

Validation of hypotheses

In the process of validating the hypotheses, structural equations-PLS were used, which allows determining the effect of the explanatory variables on the response variable (Bogaert *et al.,* 2024; Maydeu-Olivares *et al.,* 2010; Barrett, 2007). In turn, it allows the identification of standardized and non-standardized estimators, and the p-value to accept or not accept the hypotheses. Figure 1 contributes to the formulation of the hypotheses in this study.

Figure 1. Hypothetical model of corporate social responsibility on competitive success.



The hypotheses are the following: H1: The social responsibility of Ecuadorian companies contributes to competitive success. H2: Social responsibility has a significant impact on innovation strategies. H3: Social responsibility significantly influences performance strategies. H4: The innovation strategy has a positive impact on competitive success. H5: Performance strategy has a positive and significant impact on competitive success.

The Kaiser Meyer Olkin (KMO) test determined excellent adequacy in the sampling, an assessment that exceeds the established value (>0.70). These findings are confirmed with Bartlett's sphericity test using Pearson's Chi-Square test (X^2=26957.239; p<0.001), which confirms the equality of variances, and a positive confusion matrix for the items and dimensions of the social responsibility instrument. In addition, the confirmatory principal component analysis is carried out to measure the psychometric quality of the corporate social responsibility instrument and the competitive success of the companies, determining the internal consistency, convergent and discriminant validity of the constructs in the social responsibility questionnaire through the modelling of structural equations.

In this scenario, the corporate social responsibility dimension is made up of 15 items of the social dimension, 73.33% of the items presented factor loads above the established parameter (0.70), while McDonald's Omega is considered excellent (0.940), confirming high internal consistency. Pearson's correlation was high (0.723), the composite reliability was 0.943 and the mean variance extracted (AVE) had an acceptable coefficient (0.526), exceeding these coefficients the proposed thresholds.

In the case of the innovation strategies dimension, the factor loads exceeded the allowed value (>0.70), except for item 2 (EI=0.680). In addition, McDonald's reliability, Pearson's correlation, composite reliability and mean extracted variance (AVE) are excellent and have high coefficients. In the performance strategies and competitive success, the factor loads exceeded the established threshold, McDonald's Omega reliability was excellent, Pearson's correlation, composite reliability and the mean variance extracted only confirms the discriminant and convergent validity for the four dimensions of the questionnaire.

The estimated coefficients of the model present an acceptable and excellent fit according to the proposed thresholds, (X^2=3.438; CFI=0.939; SRMR=0.062; RMSEA=0.068). These coefficients guarantee the validity of the confirmatory multivariate model proposed to measure the impact of social responsibility on the competitive success of Ecuadorian companies. The Heterotrait - Monotrait Matrix (HTMT) determined that the innovation, performance and

performance factors in relation to innovation presented scores below the permitted indicator (0.85). These findings allow us to infer that the dimensions are discriminant.

However, the competitive success factor registers evaluations above the established threshold (0.90), demonstrating a high correlation between the innovation and business performance, that is, although they are different from each other. They present common elements and by default they are not discriminatory. Based on the factorial and discriminant validity of social responsibility and the competitive success of companies, the five hypotheses proposed were corroborated by the simulation of structural equations with the data observed for each construct, which are shown in Figure 2 and Table 1.

Figure 2. Unstandardized and standardized factor loadings.

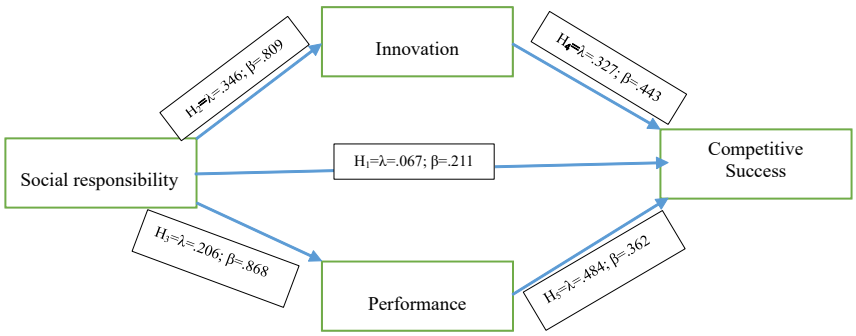


Table 1. *Validation of the hypotheses*

Hypothesis	Direct relationships	λ non-standardized	β standardized	T-Statics	p-values	Results
H1	Social Responsibility→Competitive Success	0,067	0,211	5,482	0,000	Accepted
H2	Responsabilidad social→Innovación	0,346	0,809	22,957	0,000	Accepted
H3	Social Responsibility→Performance	0,206	0,868	29,252	0,000	Accepted
H4	Innovation Strategy→Competitive Success	0,327	0,443	13,85	0,000	Accepted
H5	Performance→Competitive Success	0,484	0,362	9,551	0,000	Accepted

The H1 hypothesis was accepted by presenting the non-standardized coefficient different from 0, showing a positive degree of inclination and the beta standardized coefficient showed an impact of 21.1% with a statistical goodness of fit test T above established values (2.50) and significant p-values at 0.1% of significance ($p<0.001$), demonstrating that social responsibility significantly impacts in competitive success. In addition, the following hypotheses are accepted: H2, H3, H4 and H5. The dimension of social responsibility, innovation and business performance contributes positively and signifies the impact of competitive success on Ecuadorian companies.

Conclusions

This research carried out from the perception of Ecuadorian companies, generates relevant empirical information on the impact of corporate social responsibility on business strategies, including competitive success. It is necessary to recognize the main limitations. First, the study has only used two provinces out of a total of 24 provinces that exist in Ecuador and exclude other provinces with a lot of business activity such as Pichincha, Guayaquil and Cuenca. In this context, future research should approach the analysis of the coastal, highland, eastern and island regions and contrast the results according to the companies located in the different strategic sectors and main export products. Secondly, machine learning (AI) algorithms will be used to identify the main sociodemographic and business factors on corporate social responsibility and business strategies.

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Social inclusion from a sustainable human development perspective

Mariana Inés Tezón
Corporación Universitaria Iberoamericana (Colombia) mariana.tezon@docente.ibero.edu.co
https://orcid.org/0000-0001-9509-5353

"This article emerges from the Well-being, Clinical Practice, and Mental Health research line of the Ibero-American University Corporation, in collaboration with the University of Cartagena.".

Introduction

Amartya Sen has been the central author of the moral critique of the traditional economic development regime established at the international level, culminating in a new approach: development as freedom. Within this paradigm, the market is no longer the sole fundamental actor, and human beings are no longer viewed as mere instruments of economic growth. Instead, key components are incorporated, such as the enhancement of individuals' skills and opportunities, enabling them to meet their own needs (Sen, 2000; Singer, 1998). Thus, Human Development (HD) is not considered solely from an economic perspective but rather as: (i) multidimensional (encompassing individual, social, and environmental dimensions); (ii) integral (the elements of development are interrelated as a whole); and (iii) adaptive (preserving the historical sense of the individual while enhancing their capacity for change) (Pérez de Armiño, 2004).

In order to promote HD, society must create conditions in which individuals, both individually and collectively, can secure vital material resources, dignified cultural goods, and services of all kinds that guarantee the realization of their political and social potential, while ensuring equity of opportunities and sustainability over time (Sen, 2011; Vergara Durán, 2009).

However, Sen (2000) goes beyond the notion of basic needs by encompassing development as freedom, which rests on fundamental pillars. First, it must be considered that utility offers an incomplete account of human behavior, as it stems from a traditional economistic paradigm. This approach overlooks many crucial aspects of individual decision-making related to social concerns, the well-being of future generations, and ethical issues. Therefore, human capabilities must be expanded through the enhancement of real freedoms that individuals are able to enjoy. According to Sen (2000, 2010), these capabilities are constrained by poverty, social deprivation, the neglect of public services, and the rigidity of state intervention (Baquero & Rendón, 2009).

A key point in this theory, which serves as the axis of a critical analysis of development, is that freedom can be understood in two ways: (i) as an end, and (ii) as a means. Sen incorporates both aspects into his definition of development as freedom, assigning greater importance to the former. Freedom is, above all, the primary end of development. It is not pursued merely to achieve "something else," but rather as a constitutive component of development in its own right.

From this perspective, Sen (2000) makes clear that development is approached not only as an instrumental tool granting access to the satisfaction of diverse needs, but also as the efficacy of freedom itself in enabling individuals to enjoy and enhance their capabilities: "…if the focus is

on the individual's real opportunities to achieve their objectives, one must consider not only the primary goods possessed by individuals but also the relevant personal characteristics that determine the conversion of these primary goods" (p. 30). Thus, equality is understood not only in terms of access to goods but also in relation to how individuals empower themselves through them (UNDP, 1990, 2014; Sen, 1995). In this sense, the approach of development as freedom introduces another innovative element: the notion that individuals are "agents" rather than "patients" of development processes. For this reason, the HD approach in a society must be accompanied by a development model that not only guarantees access to rights but also grants individuals the opportunity of freedom as an end in itself.

Development Models: Which Actors for Human Development?

To engage in a deeper analysis, it is necessary to define the actors that may be involved in achieving the goals of Human Development (HD), such as freedom and social inclusion in this case.

On the one hand, the market rationality model emerged as a structural adjustment necessity following the debt crisis of the 1980s in Latin American countries. As a fundamental milestone, the Washington Consensus imposed three core principles on developing countries: price liberalization, trade liberalization, reduction of public spending, labor flexibilization, and financial liberalization. Within this framework, there was a total deconcentration and decentralization of state functions, except for those serving the primary actor: the market (Sunkel, 2007). Thus, it could be inferred that this development model, understood primarily as economic growth, would be incompatible with Human Development as an analytical framework.

However, when discussing access to public services, the question arises: What development model would be most suitable for achieving greater social inclusion? From this debate, two possible models emerge: a developmentalist model or a model of concertation among actors.

According to Sunkel (2007), in the developmentalist model the State is the key actor, as it leads a threefold function: (i) economic (through import substitution, protectionist policies, and the integration of the domestic market); (ii) social (provision of public services and redistribution of income through fiscal policy); and (iii) political (guaranteeing a balance of interests). Both in the 1970s and in contemporary times under neopopulism, this development model has sought to incorporate the so-called "marginalized" groups into the social and political dynamics of nations. Up to this point, the model appears coherent with Sen's perspective on Human Development. However, the challenge in this analysis lies in the fact that both in the 1980s and in the present, the State has become increasingly incapable of responding to the pressures and demands of various social sectors, rendering its actions narrow and unsatisfactory, and giving rise to institutional forms of protest (Spicker & Legizamón, 2009).

In response to the limitations of these approaches, the model of concertation emerges, formulated through structuralist ideas of ECLAC and critiques of neoliberalism. On the one hand, it emphasizes the need to promote modernization in Latin American and Caribbean countries without resorting to the paternalistic and welfare-oriented policies characteristic of the previous model. According to Aghón (2001), and as central to the present analysis, this model is distinguished by its orientation toward social inclusion through sound institutional

performance. In this view, social spending is not regarded as unproductive consumption but rather as an investment in human capital, seeking to eliminate all forms of exclusion within society (Farías, 2010; Putnam, 1994).

Therefore, the definition of development as freedom paves the way for redefining the conceptualization of genuine social inclusion through a comprehensive model, considering Human Development not only as a means but also as an end in itself when envisioning different cooperation strategies.

To analyze social inclusion from a comprehensive Human Development (HD) perspective, a qualitative approach was employed, allowing for the direct exploration of different cases drawn from 11 beneficiaries involved in projects aimed at fostering the development of vulnerable communities in the province of Buenos Aires, Argentina, and in the southern region of the Department of Bolívar, Colombia, over the past five years. The study adopted a qualitative and descriptive design, consisting of detailed descriptions of participants' narratives and behaviors—their experiences, attitudes, and beliefs (Taylor & Bogdan, 2002).

The purpose of this analysis was to specify the relevant properties of individuals, groups, or any other phenomenon under examination (Sampieri, Fernández Collado, & Baptista Lucio, 2014). In other words, multiple aspects, dimensions, or components of the phenomenon were evaluated. The qualitative design was grounded in the Grounded Theory of Glaser and Strauss, later expanded by Strauss and Corbin (1990), and informed by Symbolic Interactionism (Sandín, 2003). This theoretical framework involves a systematic qualitative process to generate theory that conceptually explains an action, an interaction, or a specific domain. The units of analysis considered were the following:

Health. Five cases of individuals with terminal illnesses were examined. During 2014 and early 2015, three Argentine and two Colombian cases were followed, focusing on medical treatments in vulnerable sectors under state responsibility. The analysis highlighted difficulties in maintaining continuity and ensuring the quality of public services, such as challenges in obtaining medical appointments and bureaucratic obstacles. These issues were evaluated in terms of how they undermine and condition individuals' health, dignity, and daily lives.

Education. Cases of violations of the right to education among vulnerable young adults were analyzed. In Colombia, three individuals were able to resume their studies through recognition as victims of armed conflict, thereby gaining access to public university enrollment. In Argentina, three cases involved individuals who were incorporated into the education system to complete secondary school and pursue higher education at a public institution in Buenos Aires. In both contexts, the analysis examined the processes of accessing such state benefits, as well as the causes of dropout, often linked to difficulties in leveling or adapting to the group.

The process of generating theoretical categories followed a deductive–inductive logic: it began with a theoretical framework and prior studies on HD to define macro-categories or dimensions to be explored (top-down). Subsequently, a list of codes was elaborated and extracted from the natural research context (bottom-up) (Osses Bustingorry, Sánchez Tapia, & Ibáñez Mansilla, 2006; Muñoz, 2006).

For the analysis of cases, the Constant Comparative Method was applied (Sirvent, 2007; Valles, 1997), based on the central premise that theory or conceptual networks emerge from

interaction with the data obtained in the field. Through this method, the components constituting HD in each case were analyzed and coded, generating categories related to: (i) "means" of access, and (ii) "as an end of development" (Osses Bustingorry, Sánchez Tapia, & Ibáñez Mansilla, 2006; Muñoz, 2006).

Public Health in Argentina and Colombia

Regarding the health case, multiple experiences illustrate the challenges faced by vulnerable populations in Latin American and global contexts with respect to access to, and benefits from, public health services. For this study, cases were selected in which Human Development (HD) opportunities were undermined due to inadequate institutional responses to health issues in each country. The first category was labeled "Access to Public Health: A Means for Development." This category refers to the conditions of public access to healthcare for individuals with terminal illnesses in Argentina. The evidence reflects inclusion within the health system and free access to treatment, as expressed by several patients with terminal conditions treated in the public system: "*We have a place in hospitals…when I was told I had AIDS, they also told me that treatment here must be free. So I presented my documents, and they accepted me at Hospital D.*" This testimony highlights a positive (+) dimension of freedom, as it shows the direct implementation of a basic health need for vulnerable individuals.

However, from another excerpt, the category "Negative Experience of Treatment as an Obstacle to Development as an End" begins to emerge. This category reveals how the treatment process is experienced, the representations it generates, and its impact on the illness of those involved. Narratives of the process often conveyed worry and uncertainty, as expressed by another patient undergoing treatment: *"It is agony in this city to be treated as we deserve, we are sick people."* This illustrates the negative (–) aspects of freedom, as patients reported pessimism and low self-esteem, often preferring not to be seen by others in their condition. Additionally, inequalities in treatment were noted: "…*sometimes I arrive first, but I am treated last, because some health insurance plans are given priority." In this case, patient J faced the treatment with significant demotivation: "I don't want to come anymore… I feel like crying and staying home."*

In sum, the comprehensive analysis of HD suggests that the dimension of development "as an end in itself" is not fully realized in the realm of public health. Nevertheless, regarding development models, this case may be inferred to align more closely with a developmentalist model, which seeks to provide popular access to services but demonstrates institutional weaknesses in enabling individuals to live freely in relation to their illness.

Public Education in Argentina and Colombia

The final unit of analysis refers to cases of academic dropout among victims of the Colombian armed conflict in southern Bolívar, as well as among individuals living and studying under conditions of socio-economic vulnerability in the city of Buenos Aires. In this case, the category "Access to Education: A Means for Human Development (HD)" refers to the conditions of public access to university education with priority given to individuals in situations of forced displacement in Colombia. The evidence for this category highlights inclusion in the public education system: *"I had to complete several documents…finally I was able to be admitted because I was the daughter of a displaced family…in Córdoba, about 10 years ago."; "Through a list published by the university, I was granted a benefit that covered my tuition*

fees." These excerpts reflect a positive (+) aspect of freedom, as they demonstrate the direct implementation of a basic educational need for young adults who are victims of the Colombian armed conflict or living in socio-economic vulnerability in Argentina.

However, as in previous cases, the outcomes were not what these individuals expected: "*I started out well, happy, it was something new…months went by and I didn't feel like the others…they knew more than I did…I felt ashamed…I failed several courses.*" From this, the category "Prior Education vs. University: An Obstacle to Development as an End" emerges, showing how many participants in this analysis experienced shame from not feeling equal to their peers regarding their previous educational background. Gradually, this process reactivated a self-perception of social inequality they believed had been overcome upon entering university: "*I wanted to leave all the time…I sweated during every class, clenched my teeth, I didn't want the professor to ask me anything…I didn't know anything.*"

Ultimately, in all cases, and on average between six months and one year, five out of the six participants decided to abandon their university studies. Accounts revealed feelings of guilt for not taking advantage of the opportunity, accompanied by the belief that they would never "be someone" in society. This demonstrates the emergence of negative (–) aspects of freedom, as participants expressed feelings of loneliness and discrimination, with no perceived possibility of change. Thus, the third category, "Comprehensive Analysis of HD in Popular Higher Education," highlights how daily life in these cases was pervaded by sentiments that undermined personal identity.

Conclusions

The analysis of the two categories found across the different cases underscores the need for a comprehensive approach to Human Development (HD). That is, if development is addressed only in terms of instrumental means, situations may be interpreted as positive in terms of increased freedom merely by virtue of accessing public services. However, to fully account for HD, these aspects must be articulated with subjective dimensions (what Sen refers to as "an end in itself"), since in many cases access to services does not necessarily entail genuine satisfaction for the individuals involved (Bangher, 2002).

Following this line of thought, the selected cases provide a clear example of the neglect of fundamental features that development must fulfill in order to generate freedom as an end in itself: achieving equity, fostering individual capabilities, and empowering individuals to manage processes that promote social inclusion (Baquero & Rendón, 2009; Sen, 2000).

Therefore, when evaluating human development, it is essential to consider whether individuals are accessing their rights, and how they are doing so, in order to understand the perceptions, feelings, and representations that such situations generate. This requires adopting a stance on which development model could more inclusively address the issues identified in social diagnoses when planning development projects. In this regard, HD is not only about living with rights formally satisfied, but also about ensuring that those rights reflect quality and dignity for each member of a community (Bangher, 2002).

As the different examples demonstrate, it is necessary to move beyond the sole protagonism of either the State or the Market, toward a concerted model that fosters dialogue among diverse actors in pursuit of expanded freedoms. Thus, as international cooperation actors for development, there is a need to act by seeking new perspectives that increasingly approach

those freedoms, questioning—through dialogue—the notion of a single, established "truth" about development.

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Implementation of quality management standards: experiences in accounting firms in Facatativá and Fusagasugá, Colombia

Andres David Serrato Guana
Universidad de Cundinamarca (Colombia), adserrato@ucundinamarca.edu.co, https://orcid.org/0000-0001-9021-0869
Jhonathan David Rincón Martínez
Universidad de Cundinamarca (Colombia), jhonathandrincon@ucundinamarca.edu.co, https://orcid.org/0000-0001-7114-5926
Edgar Enrique Aguas Guerrero
Universidad de Cundinamarca (Colombia), eaguas@ucundinamarca.edu.co, https://orcid.org/0009-0006-3477-4866

This text arises from the project "Challenges and opportunities in the application of NIGC1 and NIGC2 in accounting and auditing firms in the municipalities of Facatativá and Fusagasugá Cundinamarca" code 385 of the University of Cundinamarca, Colombia.

Introduction

Quality in auditing and accounting services is essential to ensure the transparency and reliability of financial information presented to regulators, investors, and society in general. The International Quality Management Standards (IQAS 1 and IQAS 2), issued by the International Auditing and Assurance Standards Board (IAASB), seek to ensure that accounting firms implement effective quality control systems that mitigate risks in the audit process and increase confidence in financial reporting.

In Colombia, the implementation of these standards presents both challenges and opportunities, especially in territories such as Facatativá and Fusagasugá, where infrastructure, access to resources and technical training are limited compared to large urban centers. Accounting firms in these regions face difficulties in adopting the requirements of IQAS1 and IQAS2, which can compromise the quality of financial reporting and the confidence of local and regional investors.

In addition to financial aspects, there is a growing demand for accounting and auditing firms to include environmental risk assessment and sustainability in their processes. Companies are increasingly required to account for their environmental impact and comply with regulations that promote sustainability. The correct application of IQAS1 and IQAS2 in this context enables accounting firms not only to improve their internal quality control processes, but also to ensure that environmental audits and sustainability reports meet international standards, providing an accurate assessment of the environmental performance of local companies.

In the first version of the standards, responsibility for the quality rested largely with the individual partners in charge of the audit engagements. However, the IQAS place more emphasis on the firm's collective responsibility for ensuring that the entire quality system functions properly. The standards require firms to design and implement quality control systems that are regularly reviewed and cover all aspects of audit work, from the hiring of personnel to the review of results. In the Colombian context, since 2022, the Technical Council of Public Accounting - CTCP recommended incorporating this standard for quality management in firms, projecting its application since January 2024. In this way, accounting firms and companies need to apply this standard because they issue audit reports that are used to support audit reports of economic groups, where the financial statements are already subject to these standards.

Thus, the objective of our study is to identify the challenges and opportunities in the application of international quality management standards 1 and 2 in the firms located in Facatativá and Fusagasugá, Colombia. It is necessary to know the appropriation of these standards, the degree of importance they give to them in the provision of their services and the common and/or differential factors of the firms.

Conceptual, Theoretical and Normative References

According to the International Standardization Organization - ISO (2021), quality is described as the adaptation and conformity to the requirements that the standard itself and the customers establish. From another perspective, quality is the ideal scenario or perhaps perfection in processes, services, and products. This same institution has developed three fundamental concepts of quality, which are listed below.

1. Quality assurance: Seeks to ensure the standard aspects and requirements of quality in the areas of the organization.
2. Quality control: It is carried out through inspections to verify compliance with quality standards and requirements.
3. Quality management: It demands a commitment and coordination of activities so that the processes, areas, and services of the organization perform with quality. It is the permanent search for excellence, for greater reliability and perception of the organization.

From these concepts, some theories revolve around that reinforce their relevance in the organizational context. Mentioning again W. Edwards Deming, who was one of the pioneers in quality management quoted by Noguchi (1995), his approach is based on the PDCA Cycle, a continuous improvement process: plan, do, check, and act.

According to the International Federation of Accountants - IFAC (2020), quality is a "set of internal mechanisms that a firm has to verify that its professional work complies with the established standards, both in technical and ethical aspects, ensuring confidence in the reports issued".

In that sense, the IFAC through the International Auditing and Assurance Standards Board - IAASB have designed and issued the IQAS1 and IQAS2 that replace the previous international standards of quality control. The new standards are created to guide accounting firms in the implementation of quality control policies and procedures.

However, in Colombia, one of the key factors for the effective implementation of IQAS1 and IQAS2 has been the training of accounting and auditing professionals. National bodies, such as the CTCP and the National Institute of Public Accountants - INCP, have organized workshops, seminars, and training to raise awareness among firms about the importance of these standards and their practical implications.

Previous research

The quality of financial information is essential to generate trust among stakeholders and facilitate informed strategic decisions. According to Rodríguez and Ríos (2024), the implementation of tools such as the valuation matrix can help define criteria that ensure the usefulness of financial information for external users, thus strengthening corporate credibility. In addition, it is emphasized that auditing processes should follow international standards, such as the International Standards on Auditing (ISA), to ensure effectiveness in detecting and preventing errors that affect the quality of financial information.

On the other hand, Elsayed *et al*. (2023) indicate that the audit firm has the responsibility to establish defined policies and procedures for the assessment of audit risk, evaluating its level of quality. Syam *et al*. (2021) highlight the importance of auditors having an in-depth knowledge of the organization to manage these risks effectively.

Therefore, financial auditing is seen as a comprehensive process that not only verifies the accuracy of financial information, but also seeks to improve systems and processes within the organization, thus ensuring the quality and reliability of the information presented. It is a key instrument for the control, inspection and monitoring of the organization, and its quality is essential for users to formulate conclusions about the performance of the entity (Laverde Molina & Vera Álvarez, 2017).

Additionally, it mentions that the International Quality Management Standards (IQMS) and other revised standards are constantly evolving, reflecting the need to adapt to a changing and complex environment. This implies that audit firms must be attentive to new expectations and quality requirements (Eyzaguirre Quispe, 2022). It is also worth mentioning the work entitled *Quality management and its impact on the financial audit performed by auditing firms in Manabí,* carried out in Ecuador and where they identify that there is a high number of firms that do not apply quality management procedures in financial auditing. The IASG1 responds to this issue by demanding several procedures that must be managed for their process to achieve an optimal and competitive level of service provision (Achundia *et al*., 2021).

Research in Colombia has focused on the role of accountants and auditors, as well as the design of quality management systems. One such challenge is that it requires a strategic approach and a commitment from audit firms to ensure the effective implementation of international standards.

In relation to the proposal of designs for quality management, there is the proposal developed by Lozano Caicedo and Oyola (2023), where they conclude that "the basis of this implementation lies in the deep understanding of the NIGC requirements and the internal evaluation of the firm" (p.35). In addition, they emphasize the scope of continuous updating and training, as well as transparent communication with key clients and regulators supports the strengthening of confidence in the firms.

The research is qualitative. The scope is descriptive, which allows relating the characteristics, barriers, and specific opportunities of the implementation of the standards in the regional context of Facatativá and Fusagasugá.

The population and sample were the accounting firms located in the two territories where the study was conducted. A non-probabilistic sample was made by convenience, with a total participation of 20, mostly represented by independent accounting firms and professionals. Complementary sources of information were used, such as the international quality management standards and the follow-up reports prepared by the Central Board of Accountants of Colombia, the latter were downloaded from the web page of said institution, and the documentary analysis technique was used. The main instrument was a semi-structured interview made up of five questions and was applied to the firms and independent accounting professionals in the months of March, April, May, and June using the Microsoft Teams tool using the institutional account.

Finally, for the respective analysis of the information obtained, three categories and nine subcategories were defined with their respective codification, using artificial intelligence prompts, thus allowing to achieve the results and from them the conclusions of the study.

The results are presented in three sections: the first section is related to the monitoring of the Central Board of Accountants to accounting and auditing service providers; the second explains the data obtained from the interviews in Facatativá; and the third the data obtained from the interviews in Fusagasugá.

Reports of the Central Board of Accountants

For 2022, 649 accounting firms were inspected throughout the country, of which 30.6% had not implemented the quality control standard and 50.2% had partially implemented the standard. In the case of the year 2021 the sample was 1336 companies, which in relation to the non-implementation of the quality control standard the percentage was 23.5% and partial implementation was 51.4%.

Interviews in Facatativá

Table 1 below presents the findings derived from the interviews in Facatativá.

Table 1. *Interview analysis in Facatativá.*

Analysis Category	Subcategory	Code	Analytical Observations (Summarized)
Conceptual Understanding of Quality in Auditing	Conceptions of Quality Control	Traditional Reactive Control	A structured quality assurance system exists, but continuous improvement through adaptive internal controls is still needed.

	Quality Management according to IQAS	Proactive Risk-Based Management	IQAS fosters strategic planning, adaptability, and value creation; it supports sustainability and competitiveness.
	Level of Standard Adoption	Partial Knowledge of IQAS	Limited access to training affects effective adoption, though there is willingness to improve if proper support is provided.
Challenges in IQAS Implementation	Technical and Operational Barriers	Lack of Technology	Lack of adequate accounting systems and digital tools limits IQAS integration; investment in infrastructure is required.
	Team Training and Competencies	Training Deficit	Training gaps hinder proper implementation; structured and continuous education is essential for standard compliance.
	Organizational Culture and Resistance to Change	Resistance to Change	[No explicit observation provided in source text – presumed resistance as ongoing challenge.]
Opportunities and Projections	Improvements in Service Quality	Institutional Strengthening	Continuous training strengthens quality and enhances competitiveness in audit and accounting services.
	Good Practices and Recommendations	Training Recommendation	Structured, accessible training aligned with market needs promotes a culture of learning and continuous improvement.
	Future Vision of Quality Management	Potential Competitive Advantage	Creating support networks enables adaptation and implementation of IQAS as a strategic advantage, if actively sustained.

The analysis table of the interviews in Facatativá reveals a more structured understanding of quality in auditing, highlighting the progress towards proactive risk-based control models, in

line with the IAGAS. However, a partial knowledge of the standard persists, conditioned by barriers such as lack of technology and poor training. Despite these challenges, clear opportunities are identified to strengthen the quality of service through continuous training strategies and inter-institutional collaboration.

Interviews in Fusagasugá

Table 2 below shows the main results in Fusagasugá.

Table 2. *Interview analysis in Fusagasugá*.

Analysis Category	Subcategory	Code	Analytical Observations (Summarized)
Conceptual Understanding of Quality in Auditing	Conceptions of Quality Control	Traditional Reactive Control	Seen as procedures to ensure compliance with firm standards, differing from team-focused quality management.
	Quality Management according to ISQM	Proactive Risk-Based Management	Linked to team responsibilities and competence; recognized as necessary but not always applied systematically.
	Level of Standard Adoption	Partial Knowledge of IQAS	General awareness of IQAS benefits exists, but full understanding and implementation are lacking.
Challenges in IQAS Implementation	Technical and Operational Barriers	Lack of Technology	Limited resources, outdated practices, and informal hiring hinder IQAS implementation.
	Team Training and Competencies	Training Deficit	Training is vital but costly, often left to individual responsibility.
	Organizational Culture and Resistance to Change	Resistance to Change	Lack of quality-oriented culture and perceived need prevents adoption in small firms.

Opportunities and Projections	Improvements in Service Quality	Institutional Strengthening	IQAS helps define responsibilities and improves audit service quality.
	Good Practices and Recommendations	Training Recommendation	Staying updated on standards is seen as an ethical and professional duty.
	Future Vision of Quality Management	Potential Competitive Advantage	No clear long-term vision expressed; focus remains on present-day needs.

The table of analysis of interviews conducted in the municipality of Fusagasugá shows a basic but differentiated understanding between traditional quality control and the quality management proposed by the IQAS, highlighting a conceptual transition towards a proactive risk-based approach. However, a partial knowledge of the standards is identified, which limits their effective implementation. Among the main challenges are operational barriers, such as lack of technological and financial resources, informality in contracting, and the absence of a quality-oriented organizational culture, reflecting a resistance to change in many local firms.

Conclusions

The interviews show that while firms have traditional quality control systems in place based on compliance and internal reviews, there is a growing awareness of the need to evolve to a more proactive approach. The risk-based quality management proposed by the NIGC promotes continuous improvement, strategic planning and strengthening of the organizational culture, which is perceived as crucial to achieve more efficient, adaptive, and value-added oriented audits.

Significant barriers are identified as lack of adequate technological infrastructure, training deficits and resistance to organizational change. However, clear opportunities also emerge continuous training, the development of specialized accounting tools and the creation of professional support networks. These actions would not only facilitate the adoption of the standards but would also strengthen the competitiveness and sustainability of the firms in the long term.

There is evidence of a necessary transition from traditional quality control models to proactive risk-based approaches, strengthening continuous improvement and organizational culture. Gaps persist such as deficient infrastructure, lack of training and resistance to change, but opportunities are opening in continuous training, accounting innovation and professional support networks to enhance the competitiveness and sustainability of the firms.

The main obstacles in implementing the ISQMs within small firms such as limited resources, insufficient specialized training, and cultural resistance to change contrast with the opportunities the standards themselves offer reputational enhancement, continuous

improvement, and internal capacity building. Interviewees agree that effective adoption demands strategic leadership, ongoing monitoring, and interfirm collaboration, thereby opening a window to redesign local accounting practices under international quality benchmarks.

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Equality and Non-Discrimination in Algorithmic Systems: Reinterpreting Article 7 of the UDHR

Yaritza Pérez-Pacheco
Universidad Internacional de La Rioja en México (México),
yaritzadelcarmen.perez@unir.net, https://orcid.org/0000-0003-1435-1517

This text is developed within the framework of an Universidad Internacional de La Rioja in México project, "UNIRME: Strategic litigation clinic in human rights and sustainable development".

Introduction

The 75th anniversary of the UDHR coincides with an era of accelerated technological transformation, marked by the expansion of Artificial Intelligence (AI) and automated decision-making in justice, health, education, and employment (UNESCO, 2022; La Spina, 2024). This temporal convergence reveals the urgency of reexamining the foundational principles of the international human rights system considering contemporary challenges posed by algorithmic automation. Article 7 of the UDHR proclaims that: "All are equal before the law and are entitled without any discrimination to equal protection of the law. All are entitled to equal protection against any discrimination in violation of this Declaration and against any incitement to such discrimination" (United Nations, 1948, p. 3). However, recent scientific literature has evidenced a fundamental paradox: algorithmic decision-making systems, designed to enhance objectivity and procedural efficiency in administrative and judicial processes, can reproduce, amplify, and standardize sophisticated forms of systemic discrimination (Barocas *et al.*, 2023; Coitinho & Da Silva, 2024; Obermeyer *et al.*, 2019).

In this context, the present study calls into question: How can Article 7 of the UDHR be reinterpreted from a substantive equality perspective to address algorithmic discrimination in 21st-century digital human rights? The main objective consists of proposing a comprehensive normative framework that recognizes algorithmic discrimination as a contemporary form of structural inequality requiring transformative legal responses based on positive state obligations and principles of human rights-centered algorithmic governance. The underlying hypothesis of this research posits that the traditional application of the principle of formal equality is insufficient to address the complexity of algorithmic discrimination, requiring a substantive reinterpretation that considers both the design and implementation processes of AI systems and their differentiated material effects on historically marginalized groups.

This article aims to contribute to legal science by integrating Sandra Fredman's theory of substantive equality with contemporary technical challenges of algorithmic discrimination, offering an innovative conceptual framework for updating international human rights law in the digital era.

Contemporary Manifestations of Algorithmic Discrimination

Algorithmic discrimination constitutes a multifaceted phenomenon that operates through various technical and social mechanisms, manifesting from the initial stages of AI system design to the implementation of automated decisions in specific social contexts (Barocas *et al.*, 2023; Gerards & Zuiderveen, 2022). Such a complexity transcends traditional categories of

anti-discrimination law, requiring analytical frameworks that can address both technical sophistication and systemic social effects of intelligent automation.

This intricate scenario has been recently conceptualized by Roberts (2025) through a tripartite framework that understands digital rights as legal entitlements, evaluative frameworks, and forms of class action against technology injustices. Particularly relevant is Roberts' analysis of how algorithmic bias systematically affects groups based on gender, ethnicity, and social class, confirming that AI risks automation inequality and that such systems are increasingly prone to determine access to welfare, employment opportunities, and judicial decisions.

Algorithmic mechanisms perpetuate and amplify biases in training data, derived from historical patterns of discrimination in automated decisions. For example, if the historical data used to train hiring algorithms reflect past discriminatory practices, the system may reproduce these patterns based on false correlations between demographic characteristics and biased performance measures (Obermeyer et al., 2019; Capasso et al., 2024). Capasso et al. (2024) note that algorithmic management of human resources can increase recruitment efficiency but also generate discriminatory outcomes and systematic disadvantages for marginalized groups, affecting their rights to equality, equity, non-discrimination, privacy, and work.

In algorithmic contexts, discrimination may be direct or indirect. Direct discrimination occurs when systems explicitly use protected characteristics such as race, gender, religion, or nationality to make automated decisions; while relatively easy to prohibit, its detection is complicated by the opacity of proprietary models and limited access to relevant variables (Wachter *et al.*, 2021). Indirect discrimination is more complex, arising when apparently neutral variables function as proxies for protected characteristics, thus producing disproportionate disadvantages for protected groups (Capasso *et al.*, 2024). For instance, postal codes can reflect racial segregation; the type of educational institution may indicate socioeconomic class, and consumption patterns can reveal gender or sexual orientation. As Capasso *et al.* (2024) emphasize, such proxy discrimination encodes group membership indirectly, posing significant challenges to legal frameworks originally designed to address more evident forms of unequal treatment.

International and comparative jurisprudence has begun to develop normative responses to these challenges, although in a fragmentary and inconsistent manner. The case State v. Loomis (Supreme Court of Wisconsin, 2016) constituted a fundamental precedent by specifically addressing the use of the Correctional Offender Management Profiling for Alternative Sanctions (COMPAS) algorithmic process in the criminal justice system. The Wisconsin Supreme Court recognized the risks associated with the use of opaque algorithms and established specific safeguards that include transparency about system limitations, access to information about its functioning, prohibition of basing decisions solely on algorithmic scores, and effective judicial review.

In the European context, the SyRI case (Rechtbank Den Haag, 2020) represents a more decisive milestone in the development of jurisprudential standards for the evaluation of governmental algorithmic procedures. The District Court of The Hague annulled the Risk Indication System used by the Dutch government to detect social benefit fraud, determining that the system's opacity, the breadth of processed data, and the absence of effective safeguards generated disproportionate risks of indirect discrimination and stigmatization of vulnerable groups, particularly in migrant and low-income communities (Zuiderveen, 2020).

The Inter-American Human Rights System has emerged as a particularly innovative framework for addressing technological challenges to human dignity. As noted by Piovesan & Morales (2024), the system's emphasis on extraterritorial responsibility and corporate accountability provides crucial mechanisms for tackling global technological challenges that transcend borders. This approach becomes essential when considering that AI programs that were developed in one jurisdiction can affect human rights across multiple territories, requiring coordinated international responses that go beyond traditional state-centric models.

Chan & Lo (2025) demonstrate how AI-powered surveillance can create dystopian futures where individuality, freedom of choice, and opposition are illusions under oppressive regimes. Algorithmic discrimination is not only an individual harm but a structural threat to democratic governance, requiring responses to both immediate effects and long-term risks to human agency and cohesion.

The principle of formal equality, expressed in Article 7 of the UDHR and developed in multiple human rights instruments, is based on the premise that equal treatment is achieved through the application of identical norms to all people, without considering differences in circumstances, capacities, or needs (Fredman, 2019). This approach, although historically important for combating explicit forms of discrimination, presents significant limitations when addressing the technical sophistication and systemic nature of contemporary algorithmic discrimination.

A fundamental shortcoming of the formal equality framework lies in its inability to address discriminatory effects that emerge from apparently neutral processes (Xenidis, 2020). Algorithmic systems can generate discriminatory results without explicitly using protected variables, operating through complex statistical correlations which are difficult to detect through traditional legal analysis. The technical opacity, inherent in many AI systems, complicates the application of traditional legal scrutiny standards (La Spina, 2024).

Furthermore, the approaches on formal equality traditionally focus on the identification and correction of discrimination after it has already occurred,, through reactive mechanisms of individual complaint and ex post facto reparation. This strategy is inadequate for addressing automated protocols that can process millions of decisions daily, generating discriminatory effects on a massive scale before they can be detected and corrected (Coitinho & Da Silva, 2024).

The probabilistic nature of many AI systems presents additional challenges for legal frameworks designed to evaluate discrete individual decisions. Machine learning algorithms typically operate by assigning risk scores or probabilities, creating gradations of treatment that do not easily align with binary categories of discrimination/non-discrimination used in traditional legal frameworks (Gerards & Zuiderveen, 2022).

This conceptual transformation must be based on the recognition that equality before the law cannot be limited to the mechanical application of identical norms, but must be evaluated based on its material effects on people's capacity to access opportunities, their participation in social life, and the observance of their fundamental rights under conditions of dignity.

The theory of substantive equality, developed by Sandra Fredman and other critical theorists of anti-discrimination law, provides a robust conceptual framework for addressing the challenges of algorithmic discrimination by establishing four interconnected dimensions that must be

considered in the evaluation of policies and practices (Fredman, 2016). First, the redistributive dimension requires examining how automated decisions affect the distribution of resources, opportunities, and burdens among different social groups. Secondly, the recognition dimension entails addressing stereotypes, prejudices, and stigmas that can be incorporated and amplified by algorithmic systems. In the third place, participatory dimension demands ensuring that potentially affected groups have meaningful opportunities to participate in the design, implementation, and oversight of AI resources that affect their rights and interests. Finally, the transformative dimension focuses on dealing with the structural causes of inequality rather than merely correcting individual discriminatory decisions, recognizing that true equality may require fundamental changes in the design and governance of algorithmic programs (Fredman, 2019).

Zuiderveen (2020) identifies essencial challenges in strengthening legal protection against algorithmic discrimination, noting that current legal frameworks struggle to handle the opacity and complexity of automated decision-making systems. The author emphasizes that traditional anti-discrimination law assumes transparency in decision-making processes, which is often absent in algorithmic systems that operate as "black boxes" (p. 1577).

Limitations of the Current International Normative Framework

The international human rights apparatus faces significant structural limitations when addressing the specific challenges of algorithmic discrimination, evidencing the need for substantial normative adaptations that go beyond traditional interpretations of existing instruments (Nourooz Pour et al., 2025; Risse, 2019). Although Article 7 of the UDHR establishes the fundamental principle of equality before the law, its original formulation, developed in 1948, does not contemplate present-day challenges such as algorithmic opacity, the impossibility of traceability in automated decisions, the differentiated effects of automation on vulnerable groups, or the difficulty of establishing institutional responsibilities in contexts of distributed decision-making among multiple technological actors (Coitinho & Da Silva, 2024; La Spina, 2024; Wachter et al., 2021).

The systemic nature of surveillance technologies gives rise to these challenges. Recent scholarship by Chan & Lo (2025) demonstrates how AI vigilance systems can create new forms of structural discrimination that operate through the continuous monitoring and categorization of individuals based on behavioral patterns, social networks, and predicted risks (Bartoletti & Xenidis, 2023). These mechanisms, often disproportionately, have an impact on marginalized communities while remaining invisible to traditional legal frameworks designed to address explicit forms of discrimination.

A significant limitation of current human rights frameworks lies in the procedural gap faced by victims of algorithmic discrimination. As Kinchin (2024) observes, the opacity of the opacity of automation and the difficulty of accessing effective remedies hinder individuals from asserting their rights. This challenge underscores the inadequacy of legal structures that presuppose transparent and accessible decision-making processes, which are often absent in algorithmic systems.

The traditional approach to equality in Article 7 assumes the possibility of understanding and challenging legal decisions. However, algorithmic decision-making programs often operate as "black boxes" where the underlying logic of specific decisions remains opaque even to their

designers and operators (Wachter et al., 2021). This opacity creates fundamental complications for the exercise of procedural rights and the possibility of effective legal remedy.

Furthermore, the globalized nature of algorithmic resources creates jurisdictional complexities that defy traditional approaches to human rights enforcement. AI systems developed in one jurisdiction can impact individuals in multiple countries, creating gaps in regulatory oversight and accountability mechanisms that current international human rights frameworks are ill-equipped to deal with

Contemporary Normative Responses and Their Limitation

UNESCO's Recommendation on the Ethics of AI (UNESCO, 2022) represents the first global normative framework that specifically addresses AI pitfalls from a human rights perspective, establishing principles such as human dignity, justice, non-discrimination, explainability, and meaningful human supervision. However, its non-binding character limits its effectiveness, depending on the political will and institutional capacity of states for its implementation.

The European Union's AI Act (European Commission, 2024) constitutes the world's first binding regulatory framework for automated decision-making tools and sets an important precedent for the development of more robust normative responses. This instrument adopts a risk-based approach, categorizing AI systems by their impact on fundamental rights and imposing obligations on high-risk mechanisms, including conformity assessments, risk management, and human oversight.

However, the AI Act presents significant limitations from a substantive equality perspective. Its focus on individual harm prevention does not adequately address the systemic nature of algorithmic discrimination or the need for transformative measures to correct structural inequalities. The regulation's emphasis on technical compliance may inadvertently legitimize discriminatory procedures that meet formal requirements while perpetuating substantive inequalities (Xenidis, 2020).

Xenidis (2020) proposes three pathways to enhance the resilience of EU equality law against algorithmic discrimination: (1) expanding the conceptual understanding of discrimination to encompass predictive analytics and intersectional forms of segregation; (2) tackling procedural challenges in proving algorithmic discrimination; and (3) developing new remedial procedures that account for the systemic nature of algorithmic bias. This analysis reveals that existing legal frameworks require fundamental reconceptualization rather than merely technical adjustments.

Regional developments in Latin America present mixed advances in algorithmic governance. Brazil's National AI Strategy (Ministério da Ciência, 2021) emphasizes innovation and economic development with limited considerations on human rights. Argentina's National Comprehensive Program for AI in Justice (Ministerio de Justicia de la Nación, 2024) focuses on efficiency improvements in judicial processes without adequate safeguards against discriminatory outcomes. Colombia's Ethical Framework for AI (Colombia, 2021) provides more comprehensive human rights protections but lacks binding enforcement mechanisms.

Toward a Substantive Reinterpretation of Article 7: Applying Fredman's Four-Dimensional Framework

The proposed reinterpretation of Article 7 from a substantive equality perspective requires recognizing algorithmic discrimination as a multidimensional phenomenon that demands comprehensive legal responses that deal with the redistributive, recognition, participatory, and transformative dimensions identified by Fredman. This systematic application provides the analytical structure necessary for developing effective legal frameworks that concentrates on both procedural and substantive dimensions of equality in algorithmic systems.

Table 1. *Application of Substantive Equality Dimensions to Algorithmic Governance*

Fredman Dimension	Algorithmic Challenge	Article 7 Reinterpretation
Redistributive	Unequal access to opportunities	Mandatory distributive audits
Recognition	Bias in data/algorithms	Prohibition of discriminatory proxies
Participatory	Opacity in design	Obligatory public consultation
Transformative	Perpetuation of inequalities	Positive preventive obligations

Redistributive Dimension in Algorithmic Systems

The redistributive dimension requires examining how automated decisions affect the distribution of resources, opportunities, and burdens among different social groups, moving beyond formal equality to assess material outcomes. Algorithmic systems in critical areas such as employment, credit, housing, and social services fundamentally alter access patterns to essential resources, often replicating and amplifying existing socioeconomic disparities.

The reinterpretation of Article 7 from this perspective demands that states implement mandatory distributive impact assessments for algorithmic systems that significantly affect resource allocation. These appraisals must evaluate not only immediate distributional effects but also cumulative impacts over time, recognizing that algorithmic decisions create feedback loops that bring about disadvantage. For example, algorithms used in social benefit allocation must be designed and monitored to ensure they do not systematically exclude or disadvantage historically marginalized communities, requiring proactive measures to correct distributive inequalities rather than merely avoiding explicit discrimination.

Recognition Dimension: Combating Algorithmic Stereotypes

The recognition dimension addresses how algorithmic systems can incorporate, amplify, and systematize stereotypes, prejudices, and stigmas that undermine the dignity and social standing of protected groups. Algorithmic discrimination often operates with proxies that correlate with protected characteristics, effectively encoding social biases into automated decision-making processes.

The reinterpretation of Article 7 requires recognizing that equality before the law encompasses protection against algorithmic systems that perpetuate stigmatizing representations or decisions based on stereotypical assumptions about group characteristics. This demands legal frameworks that prohibit the use of variables or correlations that, while not explicitly referencing protected characteristics, systematically inflict a handicap on groups based on prejudicial assumptions. States must ensure that algorithmic systems are designed with explicit consideration of how they represent and classify individuals, requiring techniques that identify

and mitigate bias embedded in training data, algorithmic architecture, and implementation processes.

Participatory Dimension: Democratizing Algorithmic Governance

The participatory dimension requires ensuring that potentially affected groups have meaningful opportunities to get involved in the design, implementation, and oversight of AI systems that affect their rights and interests. The opacity characteristic of many algorithmic tools creates fundamental challenges for democratic participation and accountability, as affected communities often lack both access to information about how instruments operate and meaningful channels for influencing their development.

The reinterpretation of Article 7 must include procedural rights that guarantee transparency, explainability, and meaningful participation in algorithmic governance. This requires establishing obligatory public consultation mechanisms that enable affected communities to meaningfully engange in the design and evaluation of algorithmic resources, particularly those deployed in public administration or with significant social impact. Such participation must extend beyond token consultation to include substantive influence over system design, ongoing monitoring, and modification processes.

Transformative Dimension: Structural Change in Human Rights Law

The transformative dimension addresses the structural causes of inequality rather than merely correcting individual discriminatory decisions, recognizing that genuine equality may require fundamental changes in how algorithmic systems are conceived, designed, and governed. This dimension moves beyond negative obligations to avoid discrimination toward positive obligations to actively promote substantive equality through algorithmic governance frameworks.

The reinterpretation of Article 7 from this perspective demands states to implement proactive measures that ensure that the algorithmic systems contribute to reducing rather than perpetuating structural inequalities. This includes developing legal frameworks that mandate human rights impact assessments, establish independent oversight mechanisms with enforcement powers, and create accountability tools that hold both public and private actors responsible for the equality effects of their algorithmic systems. The transformative approach recognizes that achieving substantive equality requires not just technical fixes but fundamental changes in power relations and institutional structures governing technological development.

Conclusions

This research demonstrates that formal equality is insufficient to address discrimination produced by AI systems, requiring a substantive reinterpretation of Article 7 of the UDHR that considers both algorithmic processes and their differentiated effects.

From this perspective, substantive equality entails a paradigmatic transformation, calling for normative frameworks that incorporate binding legal principles, adaptive technical standards, independent supervision, and democratic participation in order to legitimize algorithmic governance. These findings bear direct implications for states, which must urgently adopt robust legal mechanisms; for international organizations, which should promote global minimum standards to prevent a regulatory race; and for the private sector, which must

integrate human rights at the earliest stages of AI development.

Moving forwards within the governance of human rights-centered algorithms will be complex and contested, demanding negotiation between efficiency and equity, innovation and precaution, privacy and transparency. Yet, the risks posed by algorithmic discrimination demand that these negotiations be transparent, participatory, and grounded in human dignity. Equality and non-discrimination in the algorithmic era are not an end in itself, but a continuous process of social construction that calls for vigilance, institutional adaptation, and sustained commitment to the values that constitute the underpinning underpinning of the human rights human rights project.

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ISO 9001 Quality Management System as a driver of Process Innovation

Yenith Cristina Ortiz González
Corporación Universitaria de Asturias- Bogotá (Colombia), Yenith.ortiz@uniasturias.edu.co, https://orcid.org/0000-0003-3601-6517

This text is a chapter of the doctoral thesis project in Management Sciences, which focuses on the impact of the Quality Management System (QMS) on process maturity and business performance.

Introduction

In the current context of organizational transformation, success is no longer determined solely by economic capacity, but by the ability of organizations to learn, adapt, and innovate continuously. In this regard, Quality Management Systems (QMS) aligned with the ISO 9001 standard have emerged as strategic tools, enabling process monitoring focused on continuous improvement and innovation (Fonseca, 2021; Fonseca & Domingues, 2018).

This chapter examines the evolution and effects of QMS in certified service companies in Colombia, emphasizing their role in fostering improvement, learning, and innovation in organizational processes. It is grounded on the seven universal principles of quality, which aim to achieve satisfaction among customers and all stakeholders. The central research question is: How does the implementation of the ISO 9001 QMS contribute to process innovation in certified companies in the service sector in Colombia?

Evolution of ISO 9001

In 1987, the ISO 9000 standards were published for the first time, aimed at design, production, installation, and inspection processes, and differentiated by requirements and demands according to the type of organization(López, 2016). In 1994, it was updated and a second edition was launched without significant changes in its structure, in order to support QMS certification by company management.

The third version, published in 2000, introduced major modifications, such as customer focus, process orientation, and continuous improvement. The fourth version was updated in 2008, with changes in wording, explanatory notes, and some numerals, although without substantial changes compared to the previous version (Claver & Tarí, 2010; López, 2016).

The fifth edition, which replaced the 2008 version of the ISO 9001 standard, is considered an enhanced version and was published both as an International Standard (IS) and as a Colombian Technical Standard (NTC) in 2015 (ICONTEC, 2015b). ISO 9001:2015 takes into account operational performance, process and risk management, and employs the continuous improvement cycle aligned with organizational processes (Dentch, 2017). It also emphasizes how employees' skills generate added value to internal activities (Zayas-Mateo & Martínez-Lorente, 2021). The standard was consolidated under the High-Level Structure (HS), which is aligned with other international standards in the ISO series (Dentch, 2017; Lizarzaburu, 2016; Marimon, Melão, et al., 2019; Zayas-Mateo & Martínez-Lorente, 2021).

The standard has evolved to adapt to a dynamic environment, with a focus on stakeholder-

centered improvement. A systematic literature review (SLR) from all stakeholders, confirmed that the ISO 9001:2015 version will remain in force for an additional five to seven years without major revisions. However, recommendations such as the inclusion of new terms like financial performance and circular economy will be considered in future updates (International Organization for Standardization, 2021).

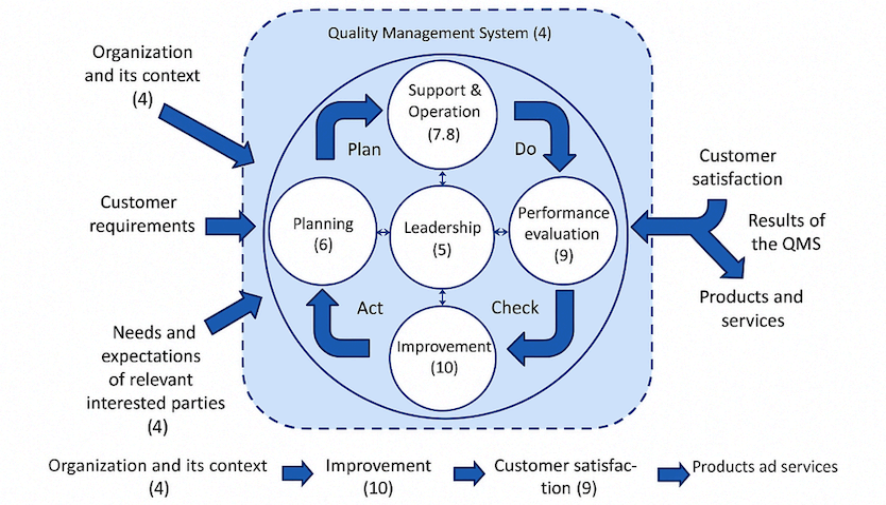
ISO 9001 Process Innovation

One of the principles of the ISO 9001 QMS is the process approach, which is based on the circle of continuous improvement Plan–Do–Check–Act (PDCA) continuous improvement circle, created in 1930 to demonstrate how variability can become a cycle that improves production processes (Shewhart, 2012). In the 1950s, this tool was considered the circle of continuous improvement for the entire organization, involving people and management processes. The PDCA seeks to identify and eliminate the causes that do not allow the improvement of QMS processes (Deming, 1989). This makes it possible to verify the relationships between the processes that make up the QMS to achieve an effective implementation of the requirements aligned with the quality strategy and policy (Rajagopalan, 2020).

The circle of continuous improvement PDCA is implemented in four moments that are executed throughout the cycle: 1) Plan, which consists of projecting objectives, processes, resources and identifying risks; 2) To do, which consists of executing what is planned; 3) Verify, which implies checking through measurements that what is planned is being fulfilled; and 4) Acting, which requires implementing actions to improve performance (Aguiar & Loos, 2017; Lodgaard et al., 2013; Rajagopalan, 2020). Likewise, the process approach helps the organization to achieve planning by implementing prevention mechanisms that minimize negative results and make the most of the opportunities that arise (Garengo & Biazzo, 2013).

Figure 1 graphically represents the ISO 9001:2015 QMS model through the PHVA continuous improvement circle. This circle identifies the sections of the standard from 4 to 10, since these contemplate the requirements of the QMS, thus, section 4 addresses the requirements of the QMS related to the organization and its context, followed by section 5 that addresses leadership, then section 6 corresponds to the planning stage (P), sections 7 and 8 address the execution (H) of the plan and the implementation of new processes, in section 9 there is verification (V) through the presentation of the results and evaluation and, finally, section 10 corresponds to improvement and is represented by action (A), which identifies the causes that prevent a process from achieving the goals (ICONTEC, 2015b). It is important to note that this circle of continuous improvement has no end and is based on a constant search for problem prevention. Therefore, the PDCA allows processes to achieve effectiveness and efficiency (Wilson & Campbell, 2018).

Figure 1. PDCA - NTC-ISO-9001.



The PDCA is the basis of to constantly improve according to the ISO 9001 standard, which allows to guarantee satisfied customers and the reduction of internal costs to maximize the company's performance (Cronemyr & Danielsson, 2013). Therefore, process management is considered to be more effective than the traditional management model (Bawden & Zuber-Skerritt, 2002). A process is defined as a series of interactions that generate value (Barros-Bastidas and Gebera, 2020) and (Terziovski & Guerrero, 2014). As for the types of processes, the following can be mentioned: a) strategic, also known as management, b) missional or realization, which aim to comply with what is projected in the mission and reason for being, c) support, the transversal in the organization and are interrelated with all processes, and d) measurement, analysis and improvement, also known as (MAM), which are created in favor of continuous improvement

Maturity Levels

The ISO 9004 standard has been considered as a floor for the development of models of excellence such as those of EFQM, or the Baldrige, due to its systemic nature and its attention to sustainability and the creation of value for each stakeholder (Boys et al., 2004). Organizational maturity in improvement, learning, and innovation is defined in five levels. It evolves from informal and unstructured practices (Level 1) to partially documented and reactive approaches (Level 2), structured and consistent processes (Level 3), strategic and performance-driven management (Level 4), and finally, full integration where innovation and continuous improvement are part of the organizational culture (Level 5)

The study adopted a quantitative, descriptive and cross-sectional approach, aimed at characterizing the implementation of practices related to continuous improvement, organizational learning and innovation in 131 Colombian companies in the service sector that have ISO 9001:2015 certification.

For data collection, a structured instrument was designed composed of 20 items organized into four key dimensions: D1-General, D2-Improvement, D3-Learning and D4-Innovation, based on the guidelines of the ISO 9004:2018 standard. Each dimension was evaluated through five levels of maturity, using a Likert-type scale with values from 1 to 5, where level 1

represents an informal or incipient practice, and level 5 reflects a full integration into the organizational culture and management strategy.

The questions allowed us to assess from reactive and non-systematic approaches (level 1) to the existence of consolidated structures, committed leaderships and formal mechanisms that promote continuous improvement, shared learning and transversal innovation (level 5).

Subsequently, descriptive statistical analyses were applied for each dimension, including measures of central tendency (mean and median), dispersion (standard deviation) and extreme values (minimum and maximum). These analyses facilitated the identification of general patterns of behavior in the responses, as well as the level of development achieved by the organizations in each of the practices evaluated.

To ensure comparability of the results, the scores were maintained on a scale of 1 to 5, consistent with the design of the instrument and the maturity logic set out in ISO 9004.

Improvement, Learning and Innovation, which encompasses dimensions D1 to D4, illustrates the organization's ability to reflect on its activities, foster organizational learning, integrate innovation mechanisms and maintain continuous improvement cycles. This factor illustrates the ability to change and evolve proactively.

Overall Improvement, Learning and Innovation Outcomes

The Improvement, Learning and Innovation factor, composed of dimensions D1 to D4, evaluates the organization's capacities to self-evaluate its activities, promote organizational learning, incorporate innovation systems and sustain continuous improvement. This set of dimensions helps to determine the NM achieved by companies in relation to their ability to adapt to change and evolve proactively.

The results indicate that companies certified to ISO 9001:2015 have reached maturity levels. This finding suggests that QMS not only reinforces process standardization, but also adapts with the organizational environment that supports systematic innovation, sustained organizational learning, and continuous improvement.

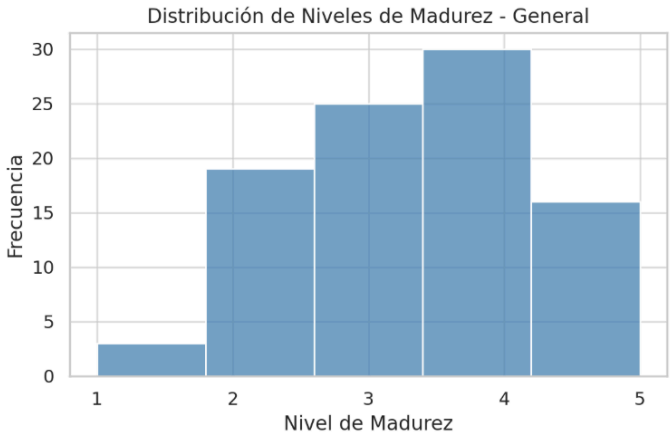
Notably, dimension 4 (Innovation) received the highest score among all certified companies. This finding indicates that companies with QMS seem to have practices that favor creative thinking, the adoption of emerging technologies, and the generation of value-added solutions. This behavioral pattern could be associated with an organizational culture of active change, motivated by leadership that encourages responsible experimentation, joint learning, and the adequate dissemination of knowledge.

Dimension 1: General

The results of the General dimension, which assesses the degree of strategic alignment of improvement, learning and innovation in the organization, show a mean maturity of 3.51, with a standard deviation of 1.13. This score reflects that ISO 9001:2015 certified organizations are at a moderate level of maturity, characterized by the existence of partially structured practices that, although documented and in execution, still present opportunities for strengthening in their full integration with the organizational strategy. The minimum value recorded was 1 and the maximum 5, which indicates heterogeneity in the degree of maturity reached among the participating companies.

The corresponding graph shows a distribution centered on levels 3 and 4, which suggests that most organizations have overcome incipient stages and are in the process of consolidating these practices as part of their organizational routine. However, there is still a considerable percentage of companies with low levels (1 and 2), indicating the need for specific interventions to strengthen these strategic foundations.

Figure 2. General Maturity Level.

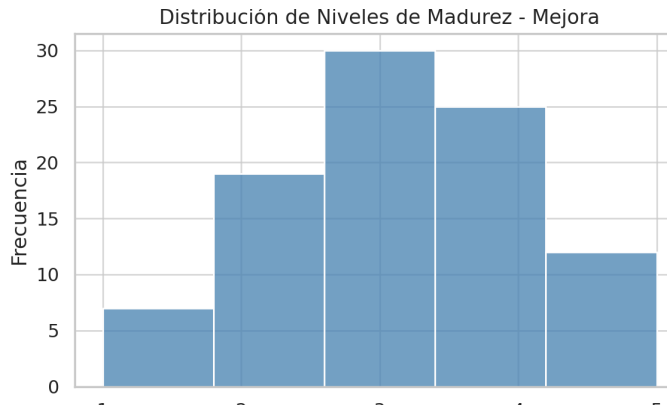


Dimension 2: Improvement

In the Improvement dimension, which includes the development of systematic processes to optimize products, services and internal procedures, the mean obtained was 3.32 with a standard deviation of 1.17. This score represents an intermediate level of maturity, where more structured improvement efforts are evident, although not necessarily constant or strategically managed. The range observed was from 1 to 5, which reaffirms the variability between organizations with respect to the commitment to continuous improvement.

The graph reveals a concentration of responses at levels 3 and 4, with less participation at the extremes. This reflects a general trend towards the institutionalization of continuous improvement practices, although gaps are still perceived in the articulation of these actions with the organizational culture and with the performance evaluation mechanisms.

Figure 3. Maturity Levels-Improvement

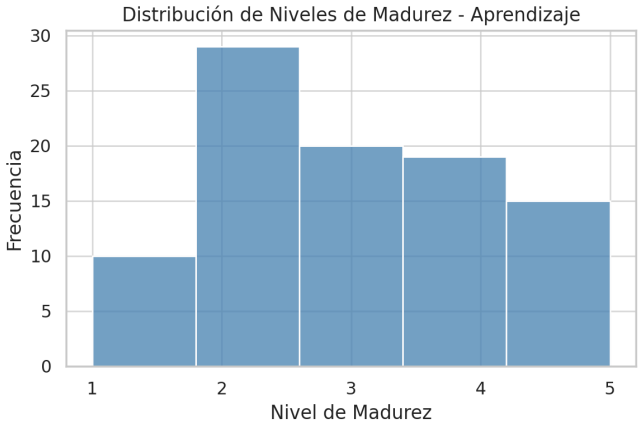


Dimension 3: Learning

Regarding the "Learning" dimension, a mean of 3.28 and a standard deviation of 1.12 were observed, with a minimum of 1 and a maximum of 5. These results show that organizational learning in the evaluated companies is in a transition stage, with the existence of collaborative practices and exchange forums, but with little systematization in some cases.

The graphical analysis shows a more homogeneous dispersion, although with a slight concentration on levels 3 and 4, which suggests that learning is present as a relevant organizational element but has not yet been fully recognized as a strategic pillar. It is still necessary to strengthen a culture that fosters learning from error, knowledge management and collaborative innovation.

Figure 4. Maturity Levels-Learning

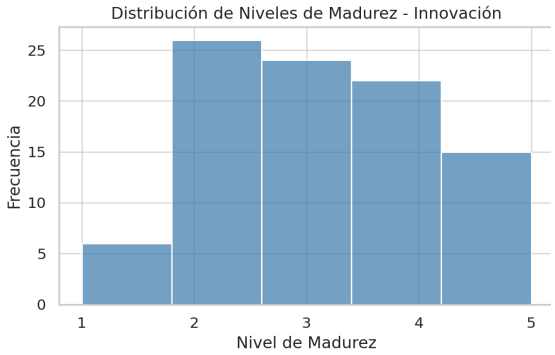


Dimension 4: Innovation

The "Innovation" dimension was the one that obtained the highest mean of the study (3.51), with a standard deviation of 1.16, and a range between 1 and 5. This score shows that certified organizations show greater maturity in innovation management, which may be due to the incorporation of emerging technologies, as well as the promotion of strategic leadership that promotes creativity and disruptive thinking.

The graph reflects a clear trend towards levels 4 and 5, indicating that a significant number of organizations have integrated innovation practices in a more systematic and cross-cutting way. Despite this, there are still companies at the lower levels, which highlights the need to extend these practices in a homogeneous way throughout the sector.

Figure 5. Maturity Levels-Innovation



Conclusions

The results of this study show that the implementation of the Quality Management System based on the ISO 9001:2015 standard significantly favors organizational maturity in key dimensions such as continuous improvement, organizational learning and innovation.

The integration of the process-based approach, results-oriented and evidence-based management, characteristics of QMS, allows the creation of structures that not only standardize and control processes, but also promote environments conducive to constant improvement, collaborative learning and the generation of value through innovation.

A higher level of maturity in the innovation dimension was identified within the certified organizations, which suggests that ISO 9001:2015 certification can act as a catalyst for organizational transformation, by strengthening an adaptive, change-oriented culture based on quality principles.

This finding reaffirms the strategic role of QMS as a driver for business evolution, not only in terms of operational efficiency, but also as a platform that drives dynamic capabilities essential for competitiveness in changing and demanding contexts.

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Chinatization: A Neo-Modernization theory driven by China´s financial and economic expansion– Case Latin American countries

Alfonso Omaña-Guerrero
ULA (Venezuela), alfonsomana@ula.edu.ve, https://orcid.org/0000-0001-5773-0301
Giuseppe Vanoni-Martínez
Politécnico Grancolombiano (Colombia), gvanoni@poligran.edu.co, https://orcid.org/0000-0002-9884-066X
Alison Dengler
NewGate School (USA), alisondengler@newgate.edu, https://orcid.org/0000-0211-2088-9939

Introduction

The research introduces Chinatization as an emerging theory of economic and social development for Latin American and Caribbean countries. It is based on the Action Plan for China-Community of Latin American and Caribbean States (CELAC) Cooperation 2025-2027, announced at the China-CELAC Forum (CCF) (China CELAC Forum, 2025). The theoretical foundation draws on similarities with modernization theory (Americanization and Europeanization), which emerged in the 1950s due to the Marshall Plan and the Alliance for Progress (AP) proposed by Kennedy in 1961, along with the Americas Partnership for Economic Prosperity (APEP) introduced by Biden in 2022 (US Department of State, 2022). The study reviews Latin American development plans across political, economic, and social areas, using qualitative analysis and stages like rupture and construction. In summary, the US promotes development through political, economic, and social interests, focusing on defense, economic growth via foreign investment, and social programs supported by international funding. China's approach centers on public investment driven by the state, emphasizing energy, mining, agriculture, and infrastructure. Both aim to enhance citizens' quality of life through sustainable development, focusing on education, employment, health, and welfare.

Theory of modernization (1950)

This theory, rooted in social science, traces back to the Marshall Plan, which was launched in the 1950s to help Europe recover after World War II. This led to the creation of economic and social programs to rebuild infrastructure in Allied nations and other developing countries. The IMF and World Bank were established to provide funding, and FDI from mainly the U.S. played a key role (Daniels et al., 2019; Reyes, 2009).

This theory outlines four perspectives based on political, economic, and social views. Alvin (1953) highlights three key events: the US leading the First World with the Marshall Plan; Eastern Europe's inclusion in the Second World under Soviet communism, including China and Korea; and the emergence of the Third World from colonial fragmentation in Asia, Africa, and Latin America, pursuing democratic development. Similarly, from a socio-political perspective (Smelser, 1963), modern societies rely on specialized institutions based on their roles to enhance productivity and assist those in need. However, coordination issues among these new institutions pose significant challenges.

Almond and Coleman (1960) and Coleman (1990) highlight the differences between modern and traditional societies from a political perspective. They compare public systems based on

citizen participation and state institutions, describing the structure, authority functions, cultural integration, and scope of modern political systems.

Rostow (1960) describes modernization as a transition from traditional to modern society. It follows a linear process with five stages: traditional society, preconditions for takeoff, takeoff, technological maturity, and high mass consumption. The process involves social, economic, and political changes aimed at reaching mass consumption and societal integration. Regarding modernization, Huntington (1966) introduced the terms Americanization and Europeanization as models of political, economic, and social expansion in Latin America after World War II. Based on these definitions, Omaña-Guerrero and Vanoni-Martínez (2023) introduce Chinatization as a form of Neo-modernization.

The anti-communist view sees the Alliance as a capitalist hub that promotes economic growth and social reforms to help Latin American countries build democracy and strengthen US ties. It is based on military support to fight communism, with the US training Latin American military personnel at the School of the Americas. The Peace Corps was also established to send young Americans to foster economic and social progress. (Gill, 2004; US Department of State, 2022).

Wiarda (1986), Martínez et al., (2024) and Tulchin (1988), and Rabe (1989) stated that the Alliance prioritizes a political approach focused on defense and security interests over economic and social concerns, even though they believe the anti-communist stance is the catalyst for recognizing shared responsibility. for the development of the region and led to the creation of the Inter-American Development Bank (IDB) and the Social Progress Fund, approved by Congress. This decision resulted in a distancing from military dictatorships and support for moderate reformers in the late 1970s and early 1980s. According to LaFeber (1986), the revisionist view has two main parts: one emphasizes economic growth and democratic reforms to improve citizens' lives and prevent far-left revolutions. The other focuses on stability through social and political frameworks that reduce threats from local business elites.

Finally, the ideological vision based on modernization theory aims to identify regional dangers, legitimize risk-reduction strategies, and shape national identity (Latham, 2000). Politicians rely on sociologists to understand citizen behavior and counter discontent with Western imperialism, stop Soviet expansion, and support national revolutions.

Based on the approaches of Rostow (1960), Latin American countries are considered traditional societies facing issues related to poverty, such as limited access to education, a small labor supply that hinders social development, low political participation, an industry heavily focused on the primary sector, and limited access to technology. Given the post-war situation, the State Department should support programs that promote self-sustaining growth to reduce poverty, social tensions, and political instability, which could lead to revolutions backed by the Soviet Union and Cuba.

This is how modernization theory, from Rostow's perspective, plays a leading role in transforming Latin America, characterizing the current society as traditional and promoting political, economic, and social changes that enable accelerated development through the transfer of technology, knowledge, and financial resources necessary to become a modern society.

China-CELAC Cooperation (2018)

Relations between China and Latin American countries began in the early 2000s, growing through cooperation. The establishment of CELAC in 2011 and Xi Jinping's 2014 visit to Latin America strengthened these ties, leading to the launch of the CCF in 2015. (Ministry of Foreign Affairs of China, 2025). The CCF promotes China-LAC cooperation based on equality and mutual benefit. It involves dialogue and collaboration between China, CELAC members, and regional organizations to build a balanced partnership.

This background on China's 21st-century economic expansion, as discussed in CCF (Omaña-Guerrero & Vanoni-Martínez, 2023), highlights two main phases: from 2000 to 2008, focusing on trade with Latin America, and from 2008 to 2016, emphasizing foreign direct investment in sectors like energy, agribusiness, and infrastructure. The first phase focused on trading raw materials from Latin America and exporting machinery from China. The second phase involved Chinese investments in energy, construction, and port improvements to support infrastructure development.

According to the Ministry of Foreign Affairs of China (2025), bilateral trade between China and Latin America and the Caribbean (LAC) has grown twenty-six times from 2000 to 2016, with 65% of investments directed toward raw materials. Its main trading partners are Argentina, Brazil, Chile, Peru, Uruguay, and Mexico, with a particular emphasis on Brazil, which has been a member of BRICS since 2006.

Recently, China's Ministry of Foreign Affairs (2025) emphasized the country's support for win-win cooperation, which contrasts with U.S. tariffs that strain regional economies and challenge countries maintaining good relations with China. At the May 13, 2025, CCF Ministerial Meeting, China highlighted the importance of people-to-people ties and coordinated development, focusing on mutual understanding, equity, and openness.

This framework states that Chinese investment focuses on infrastructure to boost economic growth, with FDI supporting technology transfer, productivity, jobs, and income (Ministry of Foreign Affairs of China, 2025). The CCF 2025 details the CELAC-China Joint Action Plan 2025-2027, which includes thirteen agreements on social, economic, and sustainability policies.

The agreements include strengthening economic, infrastructure, environmental, scientific, space, digital, health, educational, cultural, youth, knowledge, security, and diplomatic cooperation. These agreements are based on four main principles, summarized below: i) equality and mutual trust; ii) synergy between development strategies; iii) friendship among nations and mutual learning among civilizations; iv) unity among people and tackling global challenges.

Americas Partnership for Economic Prosperity (APEP 2022)

At the opening ceremony of the Ninth Summit of the Americas, President Biden announced the Alliance (APEP) to strengthen economic integration, tackle economic inequality, and rebuild trust in democracy (US Department of State, 2022). The member countries of this alliance account for 90% of the Western Hemisphere's GDP and nearly two-thirds of its population.

During the meeting, leaders from the United States, Barbados, Canada, Chile, Costa Rica,

Colombia, the Dominican Republic, Ecuador, Mexico, Panama, Peru, and Uruguay committed to strengthening the region's potential to promote inclusive, sustainable, and shared prosperity. To enhance regional competitiveness and achieve results, the alliance highlights sustainability through a collaborative plan to address emerging challenges. The coalition involves revitalizing regional institutions, attracting investments, strengthening supply chains, updating negotiation strategies, creating clean energy jobs for decarbonization and biodiversity, and promoting sustainable, inclusive trade.

This meeting discusses the International Technology and Innovation Security Facility (ITSI), created through the CHIPS initiative. ITSI aims to support secure telecom networks, ensure access to essential minerals for semiconductor production, coordinate international supply chain policies, expand manufacturing capabilities, and reduce cyberattack risks through international collaboration.

In November 2023, during the APEP Leaders' Summit, participants announced plans to launch an investment platform for sustainable infrastructure, startups, digital workforce training, and climate solutions. Leaders also emphasized providing grants to expand social infrastructure for migrants and hosts. This meeting launched the Symposium on Semiconductor Workers and the Fund for Nature, which partners with the IDB to combat climate change, enhance resilience, and protect biodiversity. (US Department of State, 2023)

In July 2024, the APEP high-level meeting was held in Washington, DC, led by Secretary Blinken. It aims to promote business, innovation, clean energy, and food security.

This study compiles the fundamental pillars of development plans aimed at Latin American countries, considering modernization theory and the AP (1961), the CCF (2018), and the APEP (2022). The research is conducted using a qualitative approach based on documentary analysis, with a design framed in the social research method (Quivy & Van Carnphood, 1995) through the stages of rupture, construction, and testing.

The modernization theory, based on Rostow, seeks to turn traditional societies into modern ones with high consumption. The U.S. uses the Marshall Plan to develop the AP, combating Soviet communism by promoting democratization and strong institutions. The alliance boosts economic growth through funding from the IMF, World Bank, and FDI, focusing on infrastructure, energy, and social programs, supporting stability and modernization.

The People's Republic of China's economic growth relies on social strategies promoting people-to-people connections and cultural exchange. The government funds projects in mining, energy, communications, and infrastructure, including railway and port enhancements.

In 2022, the U.S. State Department is developing APEP, a new plan for Latin America and the Caribbean, focusing on sustainability, biodiversity, and clean energy. It aims to decarbonize the economy, enhance cybersecurity for critical minerals, and promote semiconductor manufacturing and technology transformation.

Conclusions

The modernization reflects a shift from traditional to modern society. Americanization and Europeanization, linked to the AP (1961), are financed by institutions like the IMF, World Bank, or U.S. Department of State, which are also connected to the APEP. Chinatization, introduced by Omaña-Guerrero and Vanoni-Martínez (2023), describes China's economic growth. For FDI,

Americanization and Europeanization involve private investments, while the Chinese government directly oversees Chinatization.

Expansion models differ: Americanization and Europeanization target defense and politics to enhance democracy and economic growth by improving citizen security, healthcare, employment, and education. Chinatization, on the other hand, emphasizes social cohesion, blending cultures, and sharing traditional knowledge to navigate global economic and trade challenges.

Both Americanization, Europeanization, and Chinatization aim to support social progress by focusing on the transfer of knowledge through education and training, along with the transfer of technology needed to help citizens develop toward a higher quality of life.

Based on the similarity in the economic and social development goals of both models, differentiated by political purpose and funding sources, Chinatization can be defined as the process of economic expansion by the government of the People's Republic of China in Latin American and Caribbean countries.

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Export Boom of Colombian Coffee to China, Exchange Rate, and International Price of the Bean 2017–2024

William Moreno López
Universitaria de Asturias (Colombia), William.moreno@asturias.edu.co, https://orcid.org/0000-002-0156-7127
Laura Valentina Ramírez Faura
Pontificia Universidad Javeriana, lvramirez@javeriana.edu.co

Introduction

Within the framework of their bilateral relations, characterised by a discreet dynamic, there has been a significant boom in Colombian coffee exports to China over the past eight years. This phenomenon constitutes the core subject of the present research, the results of which are presented here with the aim of addressing the following problem question: What is the relationship between the boom in Colombian coffee exports to China and the exchange rate, along with the macroeconomic variables associated with this binational trade activity?

The objective is to understand the relationship between the growing export activity that has occurred between 2017 and 2024 and the behaviour of the exchange rate, along with other determining variables such as the inflation rate and its corollary, the interest rate. From this point, the study addresses the aforementioned export boom, paving the way towards achieving this purpose.

This work examines the export boom considering its interplay with relevant variables, including the exchange rate, inflation, interest rate, and the international price of coffee. For the purposes of this analysis and using the COVID-19 pandemic as a chronological reference, three periods are distinguished: pre-pandemic (2017–2019), pandemic (2020 2021), and post-pandemic (2022–2024). The study concludes with a brief discussion of the prospects that this research presents for Colombian coffee exporters to China.

The present study is of a correlational nature, illustrating the relationship between the unusual growth in Colombian coffee exports to China and the monetary variables referenced in its title. The research methodology is based on an exhaustive literature review, including the consultation of up-to-date and relevant documents in the fields of economics and trade. In this regard, studies, data, figures, and statistics provided by the National Association of Foreign Trade – Analdex – have been particularly valuable. Likewise, with specific reference to coffee, the research, data series, and outstanding support from the National Federation of Coffee Growers have been essential.

Regarding conceptual and theoretical aspects, the analysis relies on the most representative authors in the field of exchange rates, such as Krugman and Kozikowski, as well as the explanations provided by Moreno.

How is the international price of coffee determined?

According to Germán Bahamón, General Manager of the National Federation of Coffee Growers of Colombia (FNC), "The price of coffee depends on variables beyond supply control, such as the stock exchange quotation, which is subject to speculation and controlled by a few actors who are concentrating coffee purchases globally." (Más Colombia, 2023). Based on this premise, several factors influencing the determination of coffee prices are explained.

According to the FNC, the price of a load of dry parchment coffee, equivalent to 125 kilograms of beans obtained after removing the husk and mucilage, washing, and drying them to a humidity level of 12%, is established by the behaviour of three variables: Quotations on the New York Stock Exchange, Recognition of a premium for the high quality of Colombian coffee, Exchange rate fluctuations between the Colombian peso and the US dollar.

Between 2019 and 2022, the international price of coffee increased due to the COVID-19 health emergency. During this period, it increased on average by 89.7%, according to Más Colombia (2023). Thus, the quotation for Colombian mild coffee on the New York Stock Exchange rose from $137.07 per pound in 2019 to $294.63 in 2022. Once the pandemic subsided, the price for this same category dropped by 20.2%, closing at USD 236.00 per pound in june of 2023.

Evidently, coffee prices are heavily influenced by speculative activity on the New York Stock Exchange, the exchange rate, and the quality premium. According to the FNC, by the end of 2023, these elements displayed exaggerated variation:

"The pound on the Stock Exchange dropped from USD 2.36 to USD 1.50; at the same time, the exchange rate fell from 4,900 Colombian pesos per US dollar to 3,900, and the premium decreased from USD 0.80 to USD 0.25 in just three months." (Más Colombia, 2023).

Theorisation on the Exchange Rate and Its Dynamics

The capitalist economic system has established that the production of modern, industrial, and technological goods holds greater value and determines the level of development. In contrast, agricultural, mineral, and primary goods are considered to have lower value and thereby hinder development. In the absence of monetary exchange, if a direct barter were to be conducted between a developing country whose economy is based on coffee and a developed country producing computers, the coffee-exporting country would have to provide many sacks of coffee in exchange for each computer. In nominal terms (in terms of money), this implies that for each monetary unit of the developed country, many units of the developing country's currency would be required.

Following the ideas of Moreno (2024), equating the value between two currencies establishes what is known as the exchange rate, namely, the value of one currency in terms of another. The amount of the weaker currency required to purchase one unit of the stronger currency represents its price. Thus, the exchange rate is defined as the price, in a country's own currency, that must be paid for one unit of a stronger currency. In the specific case of Colombia, considering the reference currency, it is reasonable to state that the exchange rate is the price in Colombian pesos that must be paid for one US dollar. For further details, see Sánchez, (2026) and Krugman (2019).

The foreign exchange market constitutes the arena in which currencies are bought and sold (Kozikowski, 2000). As in any market, prices—in this case, exchange rates—are determined by the balance of supply and demand. When the supply of US dollars is lower than the demand, the price of the dollar tends to rise due to its scarcity. Conversely, when supply exceeds demand, the price falls due to an abundance of goods.

How Are the Interest Rate and the Exchange Rate Interrelated?

Both the interest rate and the exchange rate are indicators belonging to the nominal sector of the economy. The interest rate is managed domestically by each country's central bank and varies according to inflation trends. If inflationary pressures rise, interest rates are increased to counteract them by inducing a reduction in investment, which consequently decreases production and employment. This contraction in demand leads to lower prices, thereby helping to control inflation. Conversely, in the absence of inflationary threats, interest rates may be reduced to stimulate the economy, as lower rates encourage investment, which in turn drives greater production and job creation.

The exchange rate, in turn, is a key indicator in international finance and trade. Its fluctuations are determined by supply and demand conditions in the foreign exchange market.

The dynamics of the interest rate exert a significant influence on the exchange rate. As Moreno explains, many investors closely monitor interest rate returns to determine where to allocate their dollars. This behaviour affects the inflow and outflow of foreign currency between countries and, as a result, its availability, which in turn influences the price (i.e., the exchange rate). Ultimately, a rise in a country's interest rate attracts dollars, while a decrease prompts their outflow. Naturally, as he himself notes, this dynamic has notable consequences.

Colombian Coffee Exports to China During the Pre-Pandemic Period (2017–2019) in Relation to Monetary Variables

The year 2016 marked the beginning of a steadily growing export activity, which, although progressing at an irregular pace, gradually gained momentum amidst the various circumstances shaped by the COVID-19 health emergency. This pandemic is taken here as a reference point, enabling the distinction of three analytical periods: pre-pandemic (2017–2019), pandemic (2020–2021), and post-pandemic (2022–2024).

According to ProColombia (2018), 2015 registered the last decline in Colombian coffee exports to China, with a value of just USD 2.30 million. From 2016 onwards, however, a consistently upward trend was observed, beginning with USD 5.45 million. The pre-pandemic period under review here begins in 2017 with an increase of USD 2.82 million, equivalent to a 51.75% rise compared to the previous year, reaching USD 8.227 million. In 2018, exports grew even more significantly, totalling USD 16.513 million, a 100.7% increase over 2017. The growth rate slowed in 2019, with exports totalling USD 17.162 million, representing a modest 3.93% increase over the preceding year (see Table 1).

Table 1. *Colombian Coffee Exports to China (Pre-Pandemic 2017–2019)*

Year	Coffee sacks	Revenue (USD)
2017	39,017	8,227,599
2018	84,984	16,512,995
2019	87,642	17,162,104

Source: National Federation of Coffee Growers of Colombia

During this period, Colombian coffee exports to China saw a 108.59% increase in revenue and a 124.62% increase in the number of coffee sacks exported. This difference is explained by the declining international coffee price year after year (see Table 2). Regarding Colombia's monetary variables, this trend occurred within a context of controlled inflation, which has remained below 4% over the last two years. Consequently, the interest rate was reduced by five basis points in 2018 and held at 4.25% throughout 2019. This relatively stable environment was also reflected in the exchange rate, which rose by 9.23%, from COP 3,000.17 to COP 3,277.14—partially offsetting the drop in international coffee prices during the same period.

Table 2. *Monetary Variables in Colombia (2017–2019)*

Year	Coffee Price (US cents/lb)	Exchange Rate (TRM COP/USD)	Inflation (%)	Interest Rate (%)
2017	152.68	3,000.17	4.09	4.75
2018	137.15	3,249.75	3.18	4.25
2019	133.19	3,277.14	3.80	4.25

Source: National Federation of Coffee Growers and Banco de la República

For exporters, the situation created by the monetary variables could be seen as favourable, except for the downward trend in the international price of coffee, which declined year after year: from USD 1.52 per pound in 2017 to USD 1.37 in 2018, and a slight further drop to USD 1.33 in 2019. Overall, the price fell by 12.76% over the period. Nevertheless, it is essential to note that this decline was largely offset by the rising value of the US dollar and, additionally, by the increase in export volume.

Colombian Coffee Exports to China During the Pandemic (2020–2021) in Relation to Monetary Variables

Before the end of the third quarter of 2020, the COVID-19 health emergency emerged, leading to the imposition of lockdowns worldwide. Unsurprisingly, this new and dramatic scenario had serious repercussions on the global economy: lockdowns immediately and drastically reduced demand, disrupted production, increased unemployment, slowed trade, strained the financial system, and halted investment. In short, the measures aimed at mitigating the spread of the pandemic inevitably led to a public health crisis transforming into an economic.

Table 3. *Colombian Coffee Exports to China During the Pandemic (2020–2021)*

Year	Coffee sacks	Revenue (USD)
2020	108,471	22,299,643
2021	164,316	41,506,506

Source: National Federation of Coffee Growers of Colombia

The sharp contraction in demand was reflected in the very low inflation rate of 1.61% in 2020, which resulted in similarly low interest rates of 1.75%. Under "normal" conditions, such figures might suggest a healthy economy. However, it must be acknowledged that the pandemic imposed its own logic upon global economies, and that stagnation became the common denominator. These seemingly positive indicators offered no real advantage, as they mirrored the broader dynamics of a world economy in crisis.

Table 4. *Monetary Variables in Colombia (2020–2021)*

Year	Coffee Price (US cents/lb)	Exchange Rate	Inflation (%)	Interest Rate (%)
2020	158.25	3,432.50	1,61	1,75
2021	218.17	3,981.16	5,62	3,00

Source: National Federation of Coffee Growers and Banco de la República

Crisis conditions also spurred increased demand for US dollars as a safe-haven asset amid uncertainty. This put upward pressure on the exchange rate, which rose more rapidly than it had during the pre-pandemic period, particularly in 2021, as further detailed below. In 2020, the exchange rate reached COP 3,432.50, a COP 155.36 increase over 2019, representing a 4.74% rise. In 2021, the rate climbed to COP 3,981.16 an increase of 15.98% compared to 2020 (Table 4): "This was explained mainly by two factors: capital flight seeking refuge in dollars, and rising uncertainty in financial markets over the possible economic impacts of the virus." (Acosta, 2020)

In 2021, the exchange rate situation in Colombia became even more complex. As previously mentioned, the price of the dollar rose significantly. In addition to the pandemic, the country experienced a series of events that exacerbated social, economic, and political instability. For instance, at the end of April, the Minister of Finance proposed a fiscal reform that was met with widespread public opposition, triggering massive protests and social unrest.

This eventually led to the resignation of the Minister and his economic team. One serious consequence followed shortly thereafter: the credit rating agency S&P Global Ratings downgraded Colombia's creditworthiness, prompting some media outlets to declare the peso a severely devalued currency: "This year, the Colombian peso is one of the most devalued currencies in the world." (Portafolio, 2021)

Paradoxically, for Colombian coffee exporters to China, this adverse macroeconomic environment proved beneficial. They not only received more pesos for the dollars paid for their growing exports to China, but also benefited from a substantial rise in the international price of coffee. The price per pound increased from USD 1.33 in 2019 to USD 1.58 in 2020 and then

further rose to USD 2.18 in 2021. Over the past two years, the international price of coffee increased by 63.8%—a highly favourable outcome for exporters, as higher volumes of coffee were sold at better prices, resulting in more dollars per pound exported and more Colombian pesos per dollar earned (Tables 3 and 4).

Colombian Coffee Exports to China During the Post-Pandemic Period (2022–2024) in Relation to Monetary Variables

The return to "normality" after the end of lockdowns posed a challenge for countries to reactivate their economies. There was an urgent global need to boost production and employment in a context marked by scarcity of goods, which had led to soaring prices. In this scenario, Colombia experienced a sharp rise in inflation, from 5.62% in 2021 to 13.12% in 2022—an increase of 133.45%. This situation posed a dilemma: whether to reduce interest rates to encourage investment, production, and employment, or to raise them in order to curb inflation and create a climate of confidence for foreign investment. The latter option was chosen, and interest rates, already on an upward trend of 71.42% between 2020 and 2021, were raised to 12% in 2022, representing a 400% increase, as shown in Table 5.

Despite extremely high interest rates, the supply of US dollars remained constrained. To the uncertainty already present in 2021, an additional factor was added: the 2022 presidential election, which resulted in the historic election of Colombia's first left-wing president. This political shift caused further unrest in the foreign exchange market. Within this volatile context, the price of the dollar rose by 20.82% in 2022, reaching COP 4,810.20—a figure that significantly surpassed the psychological threshold of COP 4,000 and nearly touched the COP 5,000 mark (Table 5).

Table 5. *Monetary Variables (2022–2024)*

Year	Coffee Price (US cents/lb)	Exchange Rate (COP/USD)	Inflation (%)	Interest Rate (%)
2022	279.92	4,810.20	13.12	12.00
2023	209.12	3,822.05	9.28	13.00
2024 (July)	236.52	3,932.49	6.86	11.25

Source: National Federation of Coffee Growers and Banco de la República

However, what clearly represents a bleak economic outlook did not necessarily spell bad news for Colombian coffee exporters to China. For them, the year 2022 was especially favourable: the international price of coffee reached USD 2.79 per pound, an increase of USD 0.6175—equivalent to 28.30%—continuing the upward trend observed since 2020. If 2021 was considered an ideal year for exporters, 2022 could be described as truly paradisiacal: a high dollar exchange rate, record coffee prices, and strong demand for their product (Table 6).

In 2023, a further adjustment to the interest rate was made. Meanwhile, both inflation and the exchange rate began to show signs of easing, albeit only slightly. The interest rate was raised by one basis point, reaching 13%. Coffee prices also fell, though not to 2020 levels. The payment per pound of coffee remained attractive at USD 2.09—still above the two-dollar mark. The most significant development, however, was a 156% increase in sales volume, which rose

from 206,312 sacks of 60 kg to 529,994 sacks. As a result, exporter revenue increased from USD 64,251,269 to USD 124,664,348—a rise of 94.02%. Although each dollar earned was worth fewer pesos, this was more than offset by the massive growth in the quantity of coffee exported, which reached an unprecedented level.

Table 6. *Colombian Coffee Exports to China (Post-Pandemic 2022–2024)*

Year	Coffee sacks	Revenue (USD)
2022	206,312	64,251,269
2023	529,994	124,664,348
2024 (July)	323,507	69,340,107

Source: National Federation of Coffee Growers of Colombia

From January to July 2024, the price of coffee rose to USD 2.36 per pound—a notable increase. The exchange rate fluctuated between COP 3,950 and COP 4,180, remaining above the rate at the end of 2023. This occurred despite lower interest rates, prompted by the declining trend in inflation, which stood at 6.86% as of July. Under these conditions, Colombian coffee exports to China showed a strong performance in the first seven months of 2024, reaching 323,507 sacks and generating USD 69.34 million—almost double the USD 35.92 million received during the same period in 2023.

Conclusions

The export boom of Colombian coffee to China gained particular strength during the period 2020–2021, the years of the Covid-19 pandemic. This global crisis led to an increased demand for US dollars as a safe-haven asset, which in turn triggered significant devaluation, despite the high interest rates implemented to curb inflation in local economies. In Colombia, this scenario was compounded by a context of domestic uncertainty, which—paradoxically—benefited coffee exporters. These exporters also took advantage of growing demand from China and rising international coffee prices.

Altogether, these factors created a promising environment that offered highly favourable prospects for Colombian coffee exports to China. As demonstrated through the analysis presented herein, this situation paves the way for further academic work aimed at exploring this compelling topic in greater depth.

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Validation of an Instrument to Measure the Dimensions of Corporate Social Responsibility in Purchase Decision and Repurchase Intention

Flor Miranda Pablos
Instituto Tecnológico de Sonora (México) flor.miranda@itson.edu.m
https://orcid.org/ 0009-0000-6115-8854
Elba Navarro Arvizu
Instituto Tecnológico de Sonora (México) elba.navarro@itson.edu.mx
https://orcid.org/0000-0003-2695-0883
Teodoro Wendlandt Amezaga
Instituto Tecnológico de Sonora (México) teodoro.wendlandt@itson.edu.mx
https://orcid.org/0000-0003-0244 4062

Introduction

In all scientific research, data collection is crucial for ensuring the validity of the anticipated results. This task requires the design and application of appropriate instruments that allow for the accurate and clear gathering of necessary information, aligned with the study's objectives and hypotheses. Therefore, data collection instruments must meet criteria of validity, reliability, and contextual adequacy, ensuring that the data reflect the reality under study (Hernández *et al.*, 2014). In recent years, the importance of developing and validating instruments has increased, both due to technological advancements and the growing demand for solid empirical evidence in multiple disciplines. In this context, the validation of instruments is not only methodologically necessary but also essential for generating useful and applicable knowledge, especially in the business field, where data-driven decisions have a direct impact on the competitiveness and sustainability of organizations. As Nunnally and Bernstein (1994) state, the quality of a study largely depends on the robustness of the instrument used to collect information, as it constitutes the empirical foundation of the analysis.

The contemporary business environment is characterized by increased competitiveness and greater awareness of responsible resource use. For this reason, Corporate Social Responsibility (CSR) has become a determining factor in consumer perception, influencing not only purchasing decisions but also customer loyalty. Companies are no longer evaluated solely by the quality of their products or services but also by their commitment to the economic, social, and environmental context. In response to this, the present research aims to validate an instrument that measures the influence of CSR on customer purchasing decisions and repurchase intentions in a company that provides maintenance services. This instrument was developed through the adaptation and combination of six tools previously validated in the specialized literature and was subsequently subjected to expert judgment review, a pilot test, and statistical validation using Cronbach's Alpha coefficient and factor analysis through IBM SPSS (Statistical Package for the Social Sciences), to ensure its reliability and relevance.

Through this validation, the goal is to generate a methodologically robust instrument and provide empirical evidence that enables companies to better understand the strategic role of CSR as a generator of value, competitive advantage, and customer loyalty.

Data Collection Instruments: Characteristics and Application

Below are some commonly used instruments in research, along with their main characteristics, validity, reliability, and the type of research in which they are used:

Table 1. *Data Collection Instruments.*

Instrument	Main Characteristics	Validity	Reliability	Type of Research
Survey (Torres *et al.*, 2019)	Standardized procedure to obtain quantitative measurements of objective and subjective characteristics of a population.	High, if questions are representative and applied in a standardized manner.	High, if consistently applied to a representative sample.	Quantitative
Likert Scale Questionnaire (Matas, 2018)	Instrument with statements and response options that measure attitudes or perceptions on a 5-point ordinal scale.	High construct and content validity, if statements are relevant and adequately represent the study topic.	High, with Cronbach's alpha reliability coefficients above 0.70, if properly designed.	Quantitative
Psychometric Tests (Catino, 2016)	Standardized tools to measure skills, knowledge, and psychological traits of participants.	High construct and criterion validity; widely validated for different contexts and populations.	High, with Cronbach's alpha coefficients above 0.80 in most cases.	Quantitative
Direct Observation (Torres *et al.*, 2019)	Qualitative technique where the researcher observes participants' behavior without intervening in their natural setting.	High internal validity, if the observation protocol is well-defined and the observer is trained.	May be low to moderate due to potential observer bias, though it can be improved with a structured protocol.	Qualitative
Focus Groups (Hernández Sampieri & Fernández Collado, 2014)	Qualitative method involving a small group of participants who discuss specific topics guided by a moderator.	High, if a representative sample is selected and an open, natural discussion of topics is allowed.	Moderate, as it may vary depending on the group, the moderator, and group dynamics.	Qualitative
Online Community (López & Gómez, 2006)	Tool that gathers data through interactions and discussions on	Depends on the type of community and the degree of representation of the	Moderate, since online participation may be influenced by various external	Qualitative or Mixed

Instrument	Main Characteristics	Validity	Reliability	Type of Research
	digital platforms, such as forums or social networks.	study group; may be influenced by factors such as anonymity.	variables such as participant availability.	
Field Diaries (Luna-Gijón *et al.*, 2022)	Instrument that enables data collection through the researcher's personal observation and reflection.	High internal validity, as diaries provide a detailed view of the research process.	May be low due to the researcher's subjectivity, although it can be improved through a reflective approach.	Qualitative

Understanding the characteristics, advantages, limitations, and psychometric requirements of data collection instruments is one of the fundamental steps in adapting, designing, and validating research tools that meet scientific standards. This understanding ensures that the instruments employed genuinely measure what they are intended to measure, providing reliable and useful results for decision-making in both academic and business contexts.

This research adopted a quantitative approach, focusing on the collection and analysis of numerical data in order to validate a measurement instrument and establish relationships between variables. A non-experimental, cross-sectional, and correlational design was used. A custom instrument, in the form of a questionnaire, was developed based on five previously validated instruments applied in the following research studies. First and foremost, it seeks to comply with some of the national CSR guidelines established by the ESR distinction from the Mexican Center for Philanthropy (CEMEFI); the questionnaire was based on the instrument used to measure corporate social responsibility among Mexican consumers by Wendlandt *et al.* (2016) and on the content of the instrument by Alvarado (2008) concerning CSR dimensions and future purchase intention. In addition, it drew from Pérez and Topa (2018), who demonstrated the relationship between the perception of corporate social responsibility and customer attitudes and behaviors; the instrument by Vales (2017) was also included, which assessed basic responsibilities as predictors of purchase intention among consumers in Ciudad Obregón, specifically regarding purchase decision items. Lastly, it incorporated Hurtado and Izquierdo (2021) and the instrument applied in their study on the relationship between logistics, corporate image, product reliability, customer service satisfaction, and repurchase intention. These questionnaires were analyzed to design a new, tailored instrument suited to the research needs of this study.

The instrument was structured into two sections: the first covered the sociodemographic data of the clients, and the second aimed to assess the degree of agreement or disagreement that clients assigned to each of the three CSR dimensions, the purchase decision, and repurchase intention. It consisted of 35 items, seven for each variable, using a five-point Likert scale ranging from "strongly disagree" to "strongly agree," and it was divided into three CSR dimensions (economic, environmental, social), purchase decision, and repurchase intention.

Procedure

To validate the content of each dimension of the instrument, a review of the instruments developed by the aforementioned authors (Wendlandt *et al.*, 2016; Arias, 2008; Beltrán Virgüez & Sanes Orrego, 2024; Vales, 2017; Carrillo Barbosa, 2025) was conducted, in alignment with the variables of Corporate Social Responsibility, purchase decision, and repurchase intention, which have already been applied and validated in previous studies. A prototype questionnaire was designed, ensuring item clarity and alignment with the research objectives. Once the first version of this hybrid questionnaire was developed, it was submitted for expert validation by five Ph.D. professionals specializing in CSR, marketing, and management, affiliated with Instituto Tecnológico de Sonora, Universidad La Salle Noroeste, and Instituto Tecnológico Superior de Cajeme. These experts reviewed and assessed each question for congruence with the research objectives and clarity of wording.

The feedback from all five experts was received via email and proved highly valuable for improving the instrument. All suggestions and proposed improvements were implemented, enhancing the instrument's quality. Initially composed of 25 items divided into four sections using Likert-type and numeric response scales, the instrument underwent several modifications. The main adjustments recommended by the experts included standardizing the Likert scale response format for all items and eliminating the numeric scales from the final sections. Additionally, important demographic questions were added to the beginning of the instrument to provide sufficient data for comparing results. The items related to purchase decision and repurchase intention were developed in detail, following examples from existing validated instruments. The final version of the instrument is presented in Annex 1. Finally, the instrument was administered in a pilot test involving 36% of the companies from the target population. The results showed no issues with question comprehension. The clients' responses were then entered into IBM SPSS (Statistical Package for the Social Sciences), which was used to evaluate the reliability of the data collection instrument and conduct preliminary analyses.

The results were entered into SPSS (Statistical Package for the Social Sciences), a statistical program used to assess the instrument's reliability through Cronbach's Alpha coefficient and inter-item correlations. The following result was obtained, as shown in table 2.

Table 2. *Reliability of the Variables.*

	N	Percentage
Valid Cases	88	100
Excluded	0	0
Total	88	100

Cronbach's Alpha	Number of Items
.949	35

Cronbach's Alpha was .949, a value well above the commonly accepted threshold of .70. This suggests that the instrument has excellent reliability, very close to 1.0, which means that the questions consistently measure the intended objective.

Additionally, an analysis was conducted on each of the 35 items of the instrument, as presented in table 2, to determine whether any should be removed. The results showed that all items exhibit good overall reliability, with a stable and high Cronbach's Alpha ranging from .947 to .949. Therefore, none of the items were removed. Table 3 shows that the items used have adequate correlations, indicating that they are measuring the same construct, with values ranging from .427 to .755. Although correlations below .5 may be considered for review, reformulation, or removal, these particular items did not present significant variance in the results when tested for modification.

Table 3. *Variance and Correlation Results.*

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Item 1	138.66	379.332	.602	.948
Item 2	139.06	374.956	.626	.948
Item 3	138.96	379.275	.483	.949
Item 4	139.01	378.750	.524	.948
Item 5	138.97	377.078	.590	.948
Item 6	138.97	377.894	.565	.948
Item 7	138.66	379.463	.597	.948
Item 8	138.74	374.853	.656	.948
Item 9	138.51	379.885	.585	.948
Item 10	138.66	374.937	.755	.947
Item 11	138.79	374.588	.704	.947
Item 12	139.34	370.727	.669	.947
Item 13	139.04	371.459	.645	.948
Item 14	138.92	375.652	.556	.948
Item 15	138.62	375.475	.642	.948
Item 16	138.83	379.800	.504	.948
Item 17	138.52	373.911	.712	.947
Item 18	138.91	368.847	.728	.947
Item 19	138.91	367.268	.760	.947
Item 20	139.58	369.299	.654	.947
Item 21	139.51	372.674	.583	.948
Item 22	139.52	366.463	.715	.947
Item 23	139.10	372.621	.596	.948
Item 24	138.84	371.660	.555	.948
Item 25	139.44	369.750	.569	.948
Item 26	139.27	375.648	.524	.949
Item 27	139.47	341.463	.585	.948

Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Item 28	139.14	378.545	.427	.949
Item 29	138.62	383.422	.445	.949
Item 30	138.51	383.622	.444	.949
Item 31	138.73	379.754	.434	.949
Item 32	138.57	382.432	.475	.949
Item 33	138.96	378.064	.465	.949
Item 34	138.58	380.720	.479	.949
Item 35	134.48	382.858	.482	.949

Outer loadings, according to Cervero *et al*. (2024), represent the values of correlation between each indicator and its associated construct in structural equation models based on PLS. These loadings indicate how well each indicator measures the latent construct to which it is linked. These are presented in Table 4.

Table 4. *Factor Loadings of the Model*.

Items	Outer Loadings
Item 1	0.858
Item 2	0.806
Item 3	0.830
Item 4	0.898
Item 5	0.850
Item 6	0.871
Item 7	0.862
Item 8	0.775
Item 9	0.747
Item 10	0.889
Item 11	0.781
Item 12	0.780
Item 13	0.774
Item 14	0.740
Item 15	0.902
Item 16	0.871
Item 17	0.752
Item 18	0.736
Item 19	0.820
Item 20	0.807
Item 21	0.785

Items	Outer Loadings
Item 22	0.819
Item 23	0.761
Item 24	0.762
Item 25	0.716
Item 26	0.683
Item 27	0.782
Item 28	0.810
Item 29	0.752
Item 30	0.900
Item 31	0.813
Item 32	0.773
Item 33	0.839
Item 34	0.869
Item 35	0.834

Ideally, loadings should be ≥ 0.7, indicating a strong correlation and a significant contribution of the indicator to the construct. Loadings < 0.4 are generally removed as they provide little information to the construct—however, none of the items in this study showed such low values. It is worth noting that all items contribute significantly to the overall construct, and thus, none were eliminated.

Conclusions

This research successfully validated a reliable and relevant instrument to measure the influence of Corporate Social Responsibility (CSR) on customers' purchase decision and repurchase intention in a company that provides maintenance services. Through a methodological process that included the adaptation of six previously validated instruments, expert review, a pilot test, and statistical analysis using IBM SPSS Statistics, a solid questionnaire was developed—both in terms of validity and reliability. The results confirmed that the instrument demonstrates excellent reliability, as evidenced by a Cronbach's Alpha coefficient of .949, indicating high internal consistency among the questionnaire items. Furthermore, the factor loadings obtained in the confirmatory analysis were mostly above the recommended threshold of 0.7, reinforcing the validity of the evaluated constructs.

All items were found to contribute significantly to the general construct, so there was no need to eliminate any of them. This outcome supports the quality of the instrument's design and its alignment with the variables of interest in the study. It can therefore be affirmed that this instrument is a useful tool for service-oriented companies to assess the effectiveness of their CSR policies and their real impact on customer relations. In doing so, it contributes to strengthening the value proposition, increasing competitive advantage, and promoting sustainable customer loyalty.

Based on the above, it is concluded that the instrument is suitable for capturing clearly and accurately the customer perception of a company's CSR actions across its economic, social,

and environmental dimensions, and their relationship to purchase decisions and repurchase intention. This finding is highly relevant in today's business environment, where consumers are increasingly informed—thanks to technology and social media—and are therefore more demanding and sensitive to the ethical and sustainable behavior of organizations. This study highlights the importance of using valid and reliable instruments in organizational and marketing research, especially when analyzing intangible variables such as the perception of CSR. It enhances methodological rigor and generates knowledge applicable to strategic decision-making.

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Corporate Social Responsibility: An Influential Factor in Sonoran Commercial SMEs in Mexico

Nora Edith Meza Ramírez
Technological University of Southern Sonora (Mexico)
Beatriz Alicia Leyva Osuna
Sonora Technological Institute (Mexico)
Carlos Armando Jacobo Hernández
Sonora Technological Institute (Mexico)

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Introduction

Over time, corporations have engaged with society in diverse ways. Initially, actions were limited to goodwill-based donations starting in the 1950s (Garrida & Melé, 2004). Robert Bowen en 1953 laid the groundwork for what is now known as Corporate Social Responsibility (CSR), highlighting its early societal influence (Rodríguez et al., 2023). In the 1970s, Friedman (2007) critiqued CSR from an economic standpoint, asserting that a firm's sole responsibility was profit maximization. By the 1980s, business ethics and legal compliance gained prominence, emphasizing obligations toward employees, consumers, and regulatory frameworks (Carroll, 1991). The 1990s introduced stakeholder theory and social legitimacy (Freeman & McVea, 2001). Between 2000 and 2010, ISO 26000 emerged as a guideline for CSR strategy and sustainability (Porter & Kramer, 2006), while later, CSR became linked to innovation, competitive advantage, reputation, and shared value creation (Porter & Kramer, 2011).

CSR is recognized for enhancing social, economic, and environmental outcomes while bolstering corporate competitiveness and added value (Secretaría de Economía, 2016). It serves as a tool to benefit organizational stakeholders and society, aligning profitability with strategic initiatives such as value-driven partnerships, brand image improvement, consumer engagement, and fostering stable, high-quality work environments (Lara & Sánchez, 2020). In Mexico, consumers increasingly prioritize CSR-aligned practices, including eco-friendly production and fair employee treatment (Paredes, 2024).

This study examines how CSR influences human capital development and organizational performance in small and medium-sized retail enterprises (SMEs) in Sonora, Mexico. A quantitative approach was employed, using partial least squares structural equation modeling (PLS-SEM) to measure CSR's effect on human capital and organizational performance. The analysis identifies the significance and directionality of these relationships within real-world organizational contexts.

Corporate Social Responsibility and Human Capital

Within an organization, employees recognize that the implementation of Corporate Social Responsibility (CSR) contributes to enhancing their quality of life, primarily through the reinforcement of a sustainable economy. This perception fosters greater commitment and active participation among staff in institutional strategies, thereby facilitating their adoption and execution. Such strategies not only add value to organizational development and

environmental stewardship but also promote the growth and well-being of human capital. In this regard, it can be asserted that a relationship exists between CSR and human capital within enterprises.

According to Gaete et al. (2022), the contributions of human capital—specifically in relation to CSR strategies—include generating plans, identifying stakeholder groups, aligning processes, determining requirements, considering environmental factors, and positively impacting consumers. Collectively, these efforts result in higher-quality work and improved employee health, thereby enhancing overall behavior and performance.

Based on these arguments, the first hypothesis (H^1) is formulated: Corporate Social Responsibility has a direct and positive impact on Human Capital.

Corporate Social Responsibility and Organizational Performance

Statistical evidence supports a relationship between Corporate Social Responsibility (CSR) and Organizational Performance, particularly through the hypotheses of *Workplace Quality, Community Engagement, Professional Ethics*, and *Environmental Stewardship*. These variables exert a direct and positive influence on Organizational Performance. Such practices not only aim to uphold ethical standards but also seek to generate societal value, preserve natural resources, and enhance competitiveness. Furthermore, they enable firms to access new opportunities and markets (Arias et al., 2023).

In a study conducted by Mayorga (2023) on manufacturing firms in Guadalajara, statistical evidence confirmed a direct and positive relationship between CSR and Organizational Performance. Using structural equation modeling (SEM), the study evaluated multiple factors associated with this relationship, including value creation, philanthropic initiatives, organizational identity, market participation, corporate image, product quality and branding, as well as employee and customer satisfaction. Key performance indicators such as productivity and profitability were also analyzed, demonstrating that CSR can serve as a strategic driver with tangible effects on organizational outcomes.

Based on these findings, the second hypothesis (H^2) is proposed: Corporate Social Responsibility has a direct and positive impact on Organizational Performance.

This study adopted a quantitative approach with a descriptive scope. According to Hernández & Mendoza (2018), this approach enables the objective and precise measurement of variables and hypothesis testing, which is essential for evaluating the influence of CSR on the aforementioned variables. The descriptive scope, in turn, specifies the characteristics of the variables, providing a comprehensive understanding of the research problem.

The research design was non-experimental, as independent variables were not manipulated. Instead, CSR and its effects on human capital and organizational performance were observed in their natural state, facilitating the identification of relationships and patterns without direct intervention. Additionally, the study employed a cross-sectional design, with data collected at a single point in time. This approach proved useful for describing the current state of SMEs and their CSR practices in Cajeme, Sonora (Kerlinger, 2001).

To examine the significance of the relationships under study, small and medium-sized enterprises (SMEs) in the retail sector of Sonora, Mexico were selected from the National Statistical Directory of Economic Units (DENUE) maintained by the National Institute of

Statistics and Geography (INEGI, 2024). The total population consisted of 298 SMEs distributed across various commercial categories, including grocery stores, supermarkets, department stores, textiles, jewelry, apparel, footwear, healthcare products, stationery, household goods, hardware stores, motor vehicle sales, spare parts, and fuel and lubricant retailers. A probabilistic convenience sampling method was employed, wherein firms were selected based on geographic location, availability, and accessibility for data collection during the study period. The sample size was determined to be 168 SMEs, calculated using the finite population formula (Hernández et al., 2014) with a 95% confidence level and 5% margin of error.

To measure the variables under investigation, a 33-item questionnaire employing a five-point Likert scale was developed. The instrument was structured into four distinct sections: 1) Respondent demographics, including age, gender, position, and job tenure; 2) Corporate Social Responsibility, grounded in the six dimensions of ISO 26000 (Cruz et al., 2013) and comprising 18 items; 3) Human Capital, which assessed workforce impact on dependent variables using a validated instrument by Flores et al. (2019) containing 7 items; and 4) Organizational Performance, measured through an 8-item scale developed by Gallardo et al. (2013).

Following data collection, IBM SPSS Statistics version 2021 was used for the statistical analysis of the data, and to identify the relationships and significance between the variables, a Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis was conducted using SmartPLS 4 software; this analytical method allows for examining complex relationships among unobservable variables while accounting for the observed data and incorporating predictive analysis as a relevant component in scientific research (Martínez & Fierro, 2018). Based on the theoretical model developed at the outset of the investigation, the testing of the two proposed hypotheses was conducted through structural model evaluation. For this purpose, the path coefficients, coefficient of determination (R^2), predictive relevance (Q^2), effect sizes (f^2), and statistical significance through bootstrapping were analyzed, with t-values and p-values being evaluated to determine the robustness of the relationships between variables.

The analysis of the research was divided into three sections: the first section corresponds to the description of the sociodemographic data of the study sample; the second section presents the assessment of the measurement model; and the third section details the evaluation of the structural model, following the methodology established by Hair et al. (2019).

Sociodemographic Analysis

Of the 168 surveyed SMEs, 82% were small enterprises, while 18% were medium-sized. This predominance of smaller businesses may reflect a local market trend toward more compact operations. Regarding organizational maturity, the majority of participating firms (34%) reported 4–7 years of operation, followed by established enterprises with over 16 years of activity (32%). In contrast, only 6% represented early-stage ventures (<3 years), suggesting that while most surveyed SMEs have achieved operational stability, a noteworthy subset remains in relatively nascent phases of development.

Concerning respondent demographics, 62% of data providers identified as male versus 38% female. This distribution mirrors the persistent gender asymmetry in decision-making roles within the regional SME commercial sector. Nevertheless, the substantial female participation

rate indicates progressive, though incomplete, gender inclusion in organizational leadership—demonstrating women's growing presence in strategic positions despite continued male dominance in sectoral governance.

Measurement Model Assessment

Internal validity and reliability are fundamental to ensure that measurement instruments in research are appropriate and consistent. According to Hair et al., (2019), the assessment of reliability and validity is conducted by examining indicators of internal consistency, convergent validity, and discriminant validity. Below, Table 1 presents the internal consistency and convergent validity criteria.

Table 1. *Internal Reliability and Convergent Validity Indicators*

Variable	Cronbach's Alpha	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Corporate Social Responsibility	0.889	0.909	.502
Human Capital	0.804	0.863	.559
Organizational Performance	0.828	0.874	.539

Regarding the assessment of construct reliability, the values presented in Table 1 demonstrate full compliance with the thresholds established by Hair et al., (2019). The Cronbach's alpha coefficients exceed 0.8, while composite reliability (**ρ**_c) values surpass 0.7, confirming high internal consistency for the measurement instruments assessing Corporate Social Responsibility (CSR), Human Capital, and Organizational Performance. Furthermore, the **ρ**_c values for each construct indicate robust internal consistency among their respective indicators.

Concerning convergent validity, the Average Variance Extracted (AVE) for all constructs exceeds the 0.5 benchmark, suggesting that each latent variable explains over 50% of the variance in its indicators. This confirms that the measurement items exhibit strong explanatory power for their underlying theoretical dimensions.

Discriminant validity was evaluated using cross-loadings and the Heterotrait-Monotrait (HTMT) ratio to verify the absence of substantial inter-construct correlations (Martínez-Ávila & Fierro-Moreno, 2018). The first criterion examines how items correlate with non-target constructs. As shown in Table 2, all items demonstrate appropriate cross-loadings, loading more strongly on their theoretically assigned constructs than on others, thereby confirming their distinctiveness.

Table 2. *Cross-Loadings matrix*

ÍTEMS	HC	OP	CSR
HR1	0.555	0.491	**0.662**
HR2	0.662	0.571	**0.795**
LP4	0.528	0.266	**0.626**
LP5	0.628	0.578	**0.755**
LP6	0.473	0.500	**0.748**
EN8	0.396	0.436	**0.649**
FLP10	0.493	0.435	**0.760**
FLP11	0.652	0.623	**0.751**
CI13	0.415	0.396	**0.647**
CI15	0.404	0.370	**0.665**
HC19	**0.753**	0.539	0.538
HC20	**0.685**	0.412	0.445
HC21	**0.788**	0.552	0.598
HC22	**0.720**	0.429	0.484
HC23	**0.785**	0.597	0.693
OP26	0.363	**0.634**	0.405
OP27	0.563	**0.771**	0.511
OP28	0.360	**0.660**	0.325
OP29	0.479	**0.681**	0.423
OP31	0.576	**0.756**	0.615
OP33	0.610	**0.878**	0.609

The Heterotrait-Monotrait (HTMT) ratio criterion displayed in Table 3 evaluates the proportion of between-construct correlations to within-construct correlations, with values required to remain below the 0.90 threshold as per Hair et al. (2019). Table 3 confirms adequate discriminant validity, as all observed correlations between study variables demonstrate values strictly below .90.

Table 3. *Heterotrait-Monotrait (HTMT) Criterion*

	CH	DO
HC		
OP	0.808	
CSR	0.851	0.743

Evaluation of the measurement model confirms that the instrument used to measure CSR, HC, and OP in the studied enterprises is both reliable and valid. This ensures that the results for each construct are well-defined, and the observed relationships are consistent for understanding the impact of CSR on human capital and organizational performance in retail SMEs in Sonora, Mexico.

Structural Model Evaluation

Following the assessment of the measurement model, it was necessary to evaluate the structural model to analyze the relationships between latent variables. According to Feitó Madrigal & Moreno Ortega (2023), this analysis reflects the strength of the relationships between constructs. This figure presents the proposed structural model, illustrating the relationships between Corporate Social Responsibility (CSR) and the two dependent variables: Human Capital (HC) and Organizational Performance (OP).

The path coefficients show the magnitude and direction of CSR's direct influences on HC and OP, being 0.752 for the CSR-HC relationship and 0.678 for the CSR-OP relationship. These values indicate that CSR has a stronger effect on Human Capital than on the Organizational Performance of retail SMEs.

The coefficient of determination (R^2) for HC is 0.565, suggesting that CSR explains 56.5% of the variability in HC. For OP, the R^2 is 0.459, indicating that CSR explains 45.9% of the variability in OP. These R^2 values reflect the model's explanatory capacity and effectiveness in predicting both dependent variables.

Regarding predictive relevance (Q^2), the values obtained for Human Capital (Q^2 = 0.538) and Organizational Performance (Q^2 = 0.417) are positive, indicating the model has good predictive capability. These results suggest the model can adequately predict variations in both dependent variables. Concerning effect size (f^2), the relationship between CSR and Human Capital shows a large effect of 1.301, indicating CSR has a significant impact on human capital. On the other hand, the relationship between CSR and Organizational Performance shows a moderate effect of 0.849, suggesting CSR's impact on organizational performance is important but relatively smaller than on human capital.

The results from the bootstrapping analysis confirm the statistical significance of all model relationships, with t-values above 1.96 and p-values below 0.001, validating the proposed relationships between CSR, Human Capital, and Organizational Performance. The structural model evaluation, supported by the Bootstrap method through the generation of 5,000 replicated samples from the original data, has confirmed the validity of the proposed hypotheses described in Table 4. The results obtained for the **β** coefficient, t-value and p-value for both relationships demonstrate that CSR has a significant impact on the dependent variables.

Table 4. *Hypothesis testing*

	β	t-value	p-value	Conclusion
H^1. Corporate Social Responsibility (CSR) exerts a direct and positive impact on Human Capital (HC).	0.752	14.405	0.000	Supported
H^2. CSR has a direct and positive impact on Organizational Performance.	0.678	10.602	0.000	Supported

Note: According to Chin (1998), for the t-statistic value in a two-tailed test: $t > 1.96$ ($p < 0.05$) indicates a significant relationship at the 95% level, $t > 2.58$ ($p < 0.01$) denotes a significant

relationship at the 99% level, and $t > 3.29$ ($p < 0.001$) represents a highly significant relationship at the 99.9% level.

For Hypothesis 1, which posits that CSR has a direct and positive impact on Human Capital, the values ($\beta = 0.752$, t-value = 14.405, p-value = 0.000) lead to the acceptance of the hypothesis. Similarly, for Hypothesis 2, which states that CSR directly impacts Organizational Performance, the values ($\beta = 0.678$, t-value = 10.602, p-value = 0.000) also result in the acceptance of this hypothesis, in accordance with the standards established by Hair et al., (2019). These findings validate the proposed structural model, demonstrating that CSR has a significant impact on both human capital and organizational performance in commercial SMEs.

Research Findings and Contributions

The results of this study confirm the proposed hypotheses and achieve the research objective of examining the influence of Corporate Social Responsibility (CSR) on Human Capital (HC) and Organizational Performance (OP) in retail SMEs. The analysis demonstrates that CSR exerts a direct and positive impact on HC, improving employee well-being, quality of life, and engagement, which contributes to creating a more productive organizational environment, as evidenced in prior research by Gaete et al., (2022). Furthermore, the results support Hypothesis 2, showing that CSR significantly influences, consistent with previous studies (Mayorga, 2023) that have established connections between CSR and productivity, profitability, and corporate image.

These findings provide empirical evidence that CSR practices contribute to employee welfare and drive organizational success, while deepening the understanding of CSR as a strategic element for enhancing the competitiveness and sustainability of retail SMEs in Sonora, Mexico. The study offers valuable insights for human resource management, CSR implementation in retail sectors, and regional business strategies in emerging markets.

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Proposals for a Latin American legal framework for micro-credentials in sustainability

Laura Magalhães de Andrade
Universidad Internacional de La Rioja (España),
laura.magalhaes@unir.net, https://orcid.org/0000-0002-3083-4343

Introduction

The global challenges of the 21st century - climate change, digital transformation, inequality, and youth unemployment - demand profound reforms in educational systems, particularly in Latin America. In this transitional context, it is necessary to rethink the connection between education, work, and sustainable development. One emerging response is the use of micro-credentials: short, stackable certifications of specific competencies aligned with labor-market needs and transferable across educational and productive sectors (Shanahan & Organ, 2022).

Despite their growing recognition as flexible tools for validating professional skills, micro-credentials in Latin America still face legal and institutional barriers. This is especially relevant in sustainability-related fields, where the continuous renewal of competencies is essential to address complex challenges (Mulder et al., 2017; UNESCO, 2024). The study therefore hypothesizes that the lack of legal institutionalization of micro-credentials limits their integration into education systems and weakens their potential contribution to the green transition and youth employability. It asks: To what extent have Latin American regulatory frameworks evolved toward the legal recognition of micro-credentials in sustainability?

The research follows a qualitative–comparative design based on documentary analysis. It examines higher-education and sustainability frameworks in Mexico, Colombia, Peru, Ecuador, and Brazil, drawing on national legislation and policy instruments, complemented by reports from UNESCO, UNESCO IESALC (2022 - 2025), and the OECD. Data was coded around three analytical categories: qualification frameworks, sustainability, and micro-credentials, to identify regulatory patterns, institutional gaps, and regional opportunities.

The study pursues two objectives: (1) to identify the main obstacles to the legal institutionalization of micro-credentials, and (2) to propose a regional roadmap toward a shared regulatory architecture aligned with digital certification technologies and supported by public–private quality-assurance networks. In doing so, it contributes to the literature on educational innovation and comparative education law, highlighting the potential of micro-credentials to democratize access to green-skills training, foster inclusion, and strengthen regional integration through interoperable and technology-based legal frameworks.

Micro-credentials and sustainability : theoretical foundations and state of the art

As economies digitalize and shift toward sustainability, micro-credentials provide rapid, modular certification of specific competencies, aligning education with labor-market needs and the green transition (Shanahan & Organ, 2022; OECD, 2023b).

Guided by SDG 4, education systems increasingly seek tools to align learning with sustainability goals. Micro-credentials foster competencies in green innovation and social

responsibility while connecting education to labor-market transformation (Carretero et al., 2017; De Rosa et al., 2024).

A major challenge remains the absence of shared standards for their design and recognition. As Zain (2023) emphasizes, credibility depends on linking micro-credentials to formal qualification levels and transparent evaluation criteria. Existing regional frameworks - MRC-AP and MERCOSUR - illustrate progress toward harmonization but still lack modular and digital interoperability. The UNESCO IESALC (2025) report further identifies quality assurance and equity as the pillars of any regional system.

Hence, micro-credentials can connect sustainability, learning, and employability, provided they gain consistent legal and institutional recognition across Latin America.

Regulatory developments and institutional challenges: a comparative analysis in Latin America

This section presents an initial diagnostic comparative analysis of five Latin American countries - Mexico, Colombia, Peru, Ecuador, and Brazil, with the aim of identifying the degree of legal and institutional consolidation of micro-credentials related to sustainability competencies. The analysis considers aspects such as formal recognition, alignment with national qualification frameworks, connection with the Sustainable Development Goals (SDGs), and interaction with the productive sector.

México

Mexico has advanced toward a National Qualifications Framework (NQF) under the Ministry of Public Education, though micro-credentials are not yet formally included (UNESCO IESALC, 2022a). The National Education Strategy for Sustainability calls for more flexible learning pathways but lacks specific legal instruments for credential recognition. Meanwhile, the National Competency System (CONOCER) provides a foundation for certifying occupational skills and could support sustainability-oriented micro-credentials (Global Institute for Sustainability, 2023). However, coordination among education, industry, and accreditation bodies remains limited, and programs are still weakly aligned with the SDGs (OECD, 2023a).

Colombia

Colombia has advanced competency-based training through SENA, which has introduced modular learning pathways and partial certifications (SENA, 2022). While universities and training centers offer short sustainability programs, the Ministry of Education has yet to legally incorporate micro-credentials into the national qualification's framework (UNESCO IESALC, 2022b). The 2022 Roadmap for Education for Sustainable Development, aligned with the SDGs, provides a potential bridge, though fragmentation among higher, technical, and vocational sectors still limits certificate interoperability (Presidential Agency for International Cooperation of Colombia, 2022).

Peru

Peru has modernized its vocational system by promoting competency-based, sustainability-oriented training. The MINEM has launched renewable-energy programs, and the National

Qualifications Framework includes modular certification, though micro-credentials lack formal status (UNESCO IESALC, 2022a; MINEM, 2023). Persistent policy fragmentation continues to limit effective certification of green skills (OECD, 2019).

Ecuador

Ecuador has advanced sustainability-focused qualifications but lacks a legal framework for modular micro-credentials (UNESCO IESALC, 2022b). The CES encourages continuing education in technical and environmental areas, and participation in the Pacific Alliance could support SDG-linked validation. However, without a national digital registry of learning achievements, reliable credential verification remains limited (UNESCO, 2024).

Brazil

Brazil's vocational network - SENAI, SENAC, and the Federal Institutes - offers short green and tech courses but lacks a national micro-credential policy (GOPA Group, 2023). The evolving Brazilian Qualifications Framework and the National Education Plan align with the SDGs, yet no operational regulations currently support credential issuance or recognition (UNESCO UNEVOC, 2018).

In summary, the analysis reveals an uneven landscape in which some countries have begun to explore institutional frameworks for sustainability-focused micro-credentials, while others are advancing in a more limited or uncoordinated manner. Although there is a shared discourse around the SDGs and the need for flexible educational pathways, the lack of specific legal frameworks, interoperability mechanisms, and common validation platforms limits the systematic development of these credentials (UNESCO IESALC, 2023). This highlights the need for a coordinated regional strategy to advance their institutionalization.

Multilevel governance and subnational initiatives

Across Latin America, local and institutional initiatives are advancing micro-credentials ahead of national regulation. In Mexico, the Guanajuato State Law and CIEES proposals address modular validation and digital credentialing (SEP, 2021; CIEES, 2024). Brazil's SENAI and Federal Institutes test applications in renewable and circular industries, while Colombian universities explore partial sustainability certifications (GOPA Group, 2023). These experiences demonstrate emerging multilevel governance, requiring national frameworks to connect with MERCOSUR and Pacific Alliance qualification systems (OIT/Cinterfor, 2023; MERCOSUR Educativo, 2021).

Initial guidelines for a regional legal roadmap

The analysis shows a persistent gap between SDG rhetoric and the policies needed to accredit flexible learning. A regional legal roadmap is essential to promote regulatory alignment and cross-country interoperability. The next section presents five key guidelines.

Establishment of a supranational legal framework

The first condition for progress is the design of a common legal framework for Latin America that recognizes micro-credentials as valid, portable, and stackable learning units. This proposal can be grounded in previous regional experiences, such as the Regional Qualifications

Frameworks (RQFs) promoted by UNESCO IESALC (2022a), and the recent initiative to develop reference frameworks (UNESCO IESALC, 2025), which establish shared minimum standards for quality assurance. Legal harmonization would enable the creation of standards, prevent duplication, and promote cross-institutional recognition.

Integration of micro-credentials into National Qualifications Frameworks (NQFs)

Qualifications frameworks should explicitly incorporate micro-credentials as modular components linked to actual occupational profiles and sector-specific competency standards. In countries such as Peru and Brazil, where NQFs are under development or revision, there is a strategic opportunity to integrate this category as a structural part of the system. Such integration would facilitate validation by educational authorities and support their use in processes of job placement, academic mobility, or professional reskilling (UNESCO IESALC, 2025).

Development of regional digital platforms for credential traceability

An effective roadmap also requires a shared technological infrastructure. It is proposed to design regionally interoperable platforms that can securely and verifiably record, validate, and issue micro-credentials.

These platforms should allow students, employers, and universities to access records of achievements and acquired competencies, as discussed by De Rosa et al. (2024) and Zain (2023). The use of blockchain and decentralized technologies can enhance trust and portability, while also facilitating lifelong learning tracking.

Effective alignment with the SDGs and strategic sectors

Micro-credentials should be thematically aligned with the SDGs, particularly in areas such as energy transition, climate education, waste management, circular economy, and sustainable agriculture. This alignment not only enhances the relevance of educational programs but also enables the mobilization of international cooperation funding and the alignment of educational policies with multilateral commitments (Carretero et al., 2020). Furthermore, micro-credentials should be co-developed with the productive sector to ensure they respond to real labor market needs.

Quality assurance and teacher training

Finally, a robust quality evaluation system for micro-credentials is required, both pedagogically and institutionally. It is essential to establish clear criteria regarding workload, level of complexity, learning outcomes, and assessment mechanisms. Evidence from recent reviews and empirical studies indicates that educators generally show positive attitudes toward micro-credentials but need clearer standards, institutional support, and alignment with green-skills agendas to implement them effectively (Varadarajan et al., 2023; Ahsan et al., 2023; OECD, 2023c).

In summary, this foundational roadmap is not intended to be uniform or centralized but rather to offer a flexible legal basis that can guide States toward a shared goal: the consolidation of

modular, accreditable learning pathways with recognized professional value. Minimal regional standardization will make it possible to align diverse systems, facilitate educational mobility, and strengthen educational responses to the climate crisis, digital labor transformation, and the demands of the twenty-first century.

Conclusions

This study identifies a crucial dimension in Latin America's educational response to sustainability, digital transformation, and employability: the absence of a consolidated legal framework formally recognizing micro-credentials as part of national and professional structures. Although countries have promoted competency-based training and SDG-related initiatives, regulatory instruments ensuring institutional validation, portability, and integration into qualification systems remain scarce.

Weak coordination among governments, universities, employers, and accrediting agencies continues to fragment the educational ecosystem. The lack of interoperable digital platforms limited legal recognition, and the persistent gap between curricular intentions and implementation hinder the democratization of lifelong learning and the employability of both emerging and transitioning workers.

The research therefore proposes guidelines for a regional legal roadmap—not as a prescriptive model, but as a cooperative framework enabling states to advance sovereign yet convergent approaches. It calls for integrating micro-credentials into national qualification frameworks, aligning them with SDGs and labor-market needs, building reliable digital verification systems, and ensuring quality in both content and certification processes.

Beyond their technical function, micro-credentials constitute a strategic opportunity to redefine the nexus between education, work, and sustainability. Their regulation is not merely administrative but a political commitment to inclusion, educational justice, and transformative capacity.

The findings confirm that fragmentation extends beyond institutional dispersion to a structural gap between governance levels—national, subnational, and institutional. While local actors experiment with modular certifications, national policies lack articulation and mutual recognition, and linkages with regional frameworks such as MERCOSUR and the Pacific Alliance MRC-AP remain limited.

Building a Latin American framework for micro-credentials thus requires overcoming technical and legal barriers through multilevel governance that aligns national policies, local innovation, and evaluation systems under shared principles of quality assurance and equity, as underscored by UNESCO IESALC (2025). Only through such coordination can the region achieve a recognition architecture combining legal legitimacy, technological interoperability, and social commitment to sustainability and educational justice.

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Sustainable management in tourism enterprises in Los Cabos, México

Claudia Carolina Lacruhy Enríquez
Tecnológico Nacional de México- Instituto Tecnológico de Estudios Superiores de Los Cabos (México)

Introduction

The 2030 Agenda and the 17 Sustainable Development Goals (SDGs) in the tourism sector are specifically impacted in three goals: SDG 8 decent work and economic growth, SDG 12 Responsible Production and Consumption and SDG 14 Underwater Life; these in turn are transversal in the creation of tourism plans and programs as a sector of intervention (Puig & Foronda, 2018). The SDGs recognize the preponderant role of the private sector, without discriminating by size and activity of the organization. The contribution of economic growth and job creation is a key mechanism in its productivity role (Sanabria, 2018). The coexistence of the generation of value for society and companies (Melamed, Blanco and Calderón, 2018), as well as tourism companies, manages good practices from their daily operation (Leyva & Ochoa, 2020). The search for a sustainable economy for the harmony of the three economic, social and environmental axes, with indicators as a measurement tool for decision making (Vidal & Asuga, 2021).

Los Cabos, Mexico, is the third most visited destination in the country, with a sun and beach tourism model, in transition towards a sustainable and regenerative tourism model. Tourism competitiveness based on public and private collaboration, with public policies aligned to the SDGs in the Municipal Development Plan of Los Cabos, 2025 of the (H. XV Municipality of Los Cabos), actions of stakeholders for sustainability, for example, of the main cluster the hotel sector (Lacruhy, 2025).

Therefore, a roadmap is required for tourism business management towards sustainability in Los Cabos, considering it is the third most important international destination in Mexico according to the Government of the State of Baja California Sur (2021), stakeholders are joining efforts for sustainable tourism. The objective of the chapter is to evaluate the progress of management of Development Goals of tourism companies from 2022 to 2024 by means of an annual diagnosis.

Agenda 2030 and tourism enterprises

The 193 members state of The United Nations adopted in 2015 the Agenda 2030 with 17 goals, 169 specific targets and 231 global indicators. Bonilla, (2024, p. 3), explains "its influence extended beyond those mentioned, proving to be an effective tool to promote economic prosperity, social inclusion, and environmental sustainability".

For their part, companies have an interest in sustainability compliance (Ormaza, Ochoa, Ramirez & Quevedo, 2020), cluster actions, such as sustainability committee formations and sustainability reporting (Bandeira, Albuquerque and Villagelín, 2022). The detection and analysis of effects produced by the tourism sector has been intensified (Badano, Gallucci & Rodríguez, 2022).

Tourism requires the promotion of sustainable practices to ensure the preservation of cultural

and natural capital, in a more collaborative, equitable and inclusive tourism model (Molina *et al.*,2022), as well as business models with value propositions that consolidate sustainability in the value chain and with the capabilities and resources to create shared value in the destination they are located.

In such sustainability reporting, according to Ramanathan and Isaksson (2022) 21 existing CSR measurement frameworks are limited. They are neither aligned nor appropriate–for currently measuring a company's ecological footprint to mitigate climate change. When reporting, pre-diagnosis is critical.

Therefore, Jones & Comfort (2019, p.8), in his study of hoteliers' groups identified "sets of issues that merit reflection and discussion, namely:1. interpretation and terminology, 2. business priorities for the SDGs, 3. metrics and measurement, 4. business reporting and communication, and 5. the relationships and tensions between business imperatives and sustainability".

SDG management requires the design of methodologies for the business system and each organization to adopt indicators for monitoring according to its capabilities and competencies.

To evaluate the progress of SDG management in tourism enterprises in Los Cabos between 2022 and 2024. (2) To identify the strategic SDGs prioritized by tourism enterprises. (3) To analyse trends in the five strategic axes of the 2030 Agenda (People, Planet, Prosperity, Peace and Partnerships). An intrinsic case study (Creswell, 2016), using a mixed descriptive using mixed-methods descriptive study with repeated annual measurements between 2022 and 2024 (Hernández and Mendoa, 2018), with a three-year longitudinal approach.

The sample was selected in a simple random manner, with a confidence level of 95% and a margin of error of 5%, with the following selection criteria: 1. Tourism companies, 2. They are part of the National Statistical Directory of Economic Units of the National Institute of Statistics and Geography, and 3. Interest in participating in the study. The final sample by year was: 2022 (n= 108), 2023 (n=81) and 2024 (n=178).

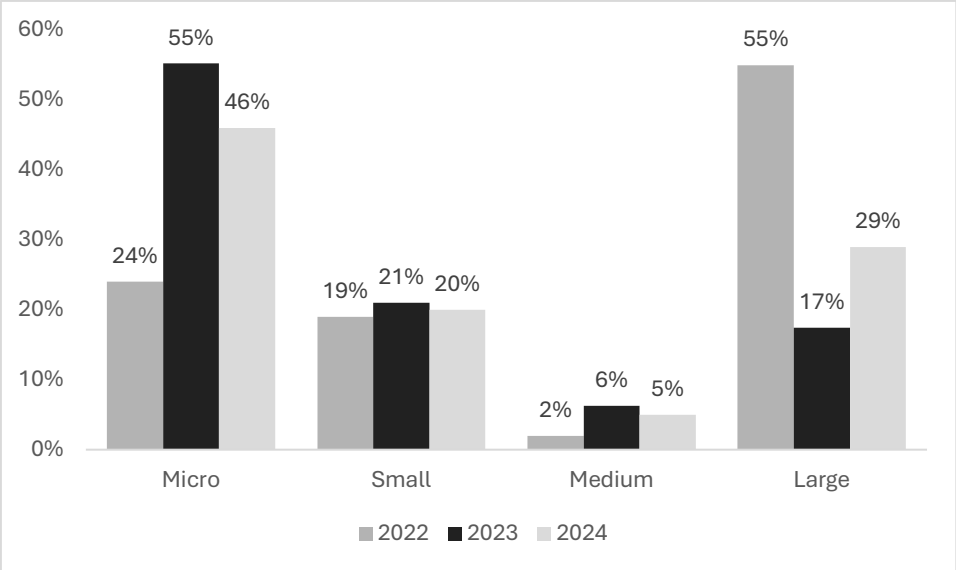
b) Instrument design

A data collection questionnaire was designed with the five strategic axes of the 2030 Agenda (people, prosperity, planet, peace and partnerships) in 45 items and with 85 sustainability indicators. It was validated with a Cronbach's Alpha of 0.894 by tourism experts. The instrument was applied electronically through Google Forms for three consecutive years. The data were analysed with descriptive statistics and subsequently, an annual comparative was performed to integrate the final reflections.

Profile companies' analysis

The profile of the companies by size in 2022, the majority were large companies, in 2023 and 2024, microenterprises. The capabilities and competencies for sustainability management influence the material, human and financial resources that each organization possesses. In 2022, the level of knowledge was intermediate, while in 2023 and 2024, the majority of microenterprises assumed representativeness.

Figure 1. Size of companies



Source: by author

Diagnosis of the strategic axes of the 5Ps of the SDGs

The annual diagnosis conducted between 2020 and 2024 revealed that, in 2022, the priorities were: SDG 3 (48%), SDG 5 (40%), SDG 8 (57%). 2023: SDG 8 (37%), SDG 3 (26%), SDG 5 (21%) and in 2024 SDG 8 (56%), SDG 3 (46%) and SDG 5 (37%).

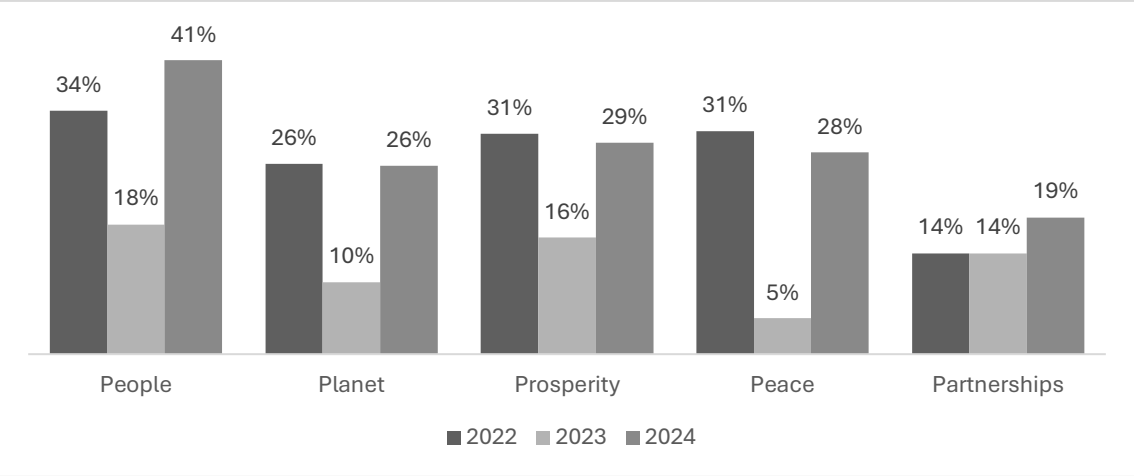
A greater participation of companies in the study was observed in relation to the SDGs, i.e., there is greater interest and awareness. The main challenges are the SDGs related to the planet axis (6, 12, 13, 14 and 15). The increased interest in the SDGs in 2024, especially those related to health, gender equality and decent work, shows a positive change in the approach to social and economic issues.

A decrease was observed, but by 2024 it recovered significantly to 41%, reflecting the revaluation of well-being and the inclusion of equity in public policies and company actions in the post-pandemic context. In the planet axis, a drop is observed in 2023, due to the prioritization of other strategic axes. The prosperity axis reflected a short-term reduction due to the pandemic crisis and economic recovery, but the trend is increasing, suggesting that it is a strategic axis to improve quality of life and the creation of shared value.

In relation to the peace axis, a significant decrease was observed in 2023, and increased again in 2024, possibly due to the change in priorities of the companies that participated in the study.

Regarding partnerships to achieve the objectives, an increase was observed in the collaboration of public, private and academic sectors to achieve the SDGs, as a key factor in the sustainability of sustainable development in all areas. Figure 2 shows the axes of the 2030 Agenda in three consecutive years.

Figure 2. The strategic axes of the 5Ps of SDGs for the periods 2022, 2023, and 2024



Source: by author

Progressive progress in SDG management was identified in large tourism companies in Los Cabos, Mexico, as well as good sustainable tourism practices, 25 beaches with Blue flag, as a result of the collaboration of the hotel sector and the Federal Maritime Terrestrial Zone, the Sea Turtle Protection Program, foundations and public policy advocacy in the Municipal Development Plan of Los Cabos 2024- 2027. The initiative to generate an annual report of the hotel sector was included (Lacruhy, 2025).

Tourism companies carry out sustainability actions in their value chain without identifying them as SDGs. In relation to the 5 Ps, it was determined that people, prosperity and partnerships have a positive trend, while the SDGs of the planet axis are a challenge particularly in water management, energy management and responsible production and consumption.

In the annual diagnosis, changes in priorities influenced by the context were identified, for example the pandemic. For this reason, SDG 3 on health and well- being showed a high priority due to the emergency health crisis. When interest recovered, it shifted to SDG 8 on decent work and economic growth, as they seek economic recovery.

Conclusions

This article examines how tourism companies carry out actions in their value chain that contribute to sustainability; however, they do not explicitly identify them with the SDGs. The 5Ps analysis identified that the axes of people, prosperity and partnerships show a positive trend; the SDGs related to the planet face limitations, because there is an area of opportunity in conservation and care of the environment.

The proposed indicators provide an overview of the sustainability of the system 41 and how the political, economic, social and technological environment influences management.

The main strength identified is that in public policy, the municipality of Los Cabos is aligned with the 2030 Agenda, the main cluster of the hotel sector, which has sustainability practices with the ability to create shared value.

The area of opportunity was observed in microenterprises, which require initial training on the

2030 Agenda and how to carry out best sustainability practices, while large tourism companies face challenges in alignment and communication of actions.

A limitation of the study is that it does not show the impact on local public policies and the perception of the resident community, both key actors for the management of indicators; therefore, it is recommended as future lines of research, diagnosing the influence of local public policies on the implementation of priority SDGs, as well as the strategic actions of stakeholders have addressed within their scope of action.

It is concluded that, in general, there is positive progress in the integration of sustainable practices, the promotion of public policies for the tourism business sector, and the generation of an intersectoral report of indicators, which favors communication and commitment to sustainable tourism in practice.

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Minors, Justice, and Procedural Safeguards: Impact of Directive (EU) 2016/800 on Portuguese Criminal Proceedings

Ana Paula Guimarães
Portucalense University (Portugal), *apg@upt.pt*, https://orcid.org/0000-0002-0813-4789
Fernanda Rebelo
Portucalense University (Portugal), fmnr@upt.pt, https://orcid.org/0000-0002-4598-1629

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Introduction

The Convention on the Rights of the Child and Directive (EU) 2016/800 of the European Parliament and of the Council, of 11 May, outline a coinciding concept of child and minor suspect or defendant in criminal proceedings, respectively, in Articles 1 and 3, referring to a person under the age of 18, with the sole exception of the possibility that national law establishes a lower age of majority. According to our civil law, a minor is anyone who has not yet reached the age of eighteen (Article 122 of the Civil Code) and does not have the full capacity to exercise rights or the capacity to act (Article 123 of the Civil Code). Criminal law, in turn, considers anyone who, at the time of the offence, has not yet reached the age of 16 to be incapable on grounds of age (Article 19 of the Penal Code).

There is a time gap between the ages of 16 and 18, when a person is responsible for the criminal acts they commit and are considered minors. It is no coincidence that Article 40 of the Convention on the Rights of the Child strongly emphasises the position of minors in contact with the justice system, taking into account their age and, consequently, their vulnerability, specifying a set of special rights and guarantees, with a particular focus on children suspected or accused of having broken the criminal law. Very briefly, minors can only be deprived of their liberty as a last resort, for the period of time strictly necessary and under adequate material and procedural guarantees, placement in institutions should be avoided whenever possible and, in the event of legal detention, minors have the right to be treated in a manner appropriate to their age with respect for their dignity and personal worth, they should not be detained together with adults, preference should be given to alternative measures to detention to protect the best interests of the child and to promote their reintegration, which may include 'care orders, guidance and supervision, counselling, probation, orphanage, education and vocational training programmes'. Directive (EU) 2016/800, of 11 May, declared the need for guarantees due to the maturity and vulnerability of the agents concerned, applicable in the context of criminal proceedings and no other types of proceedings, namely proceedings specifically aimed at minors and which may give rise to protection, corrective or re-education measures. The Directive will not apply to some minor offences except when the minor suspect or defendant is deprived of their liberty.

As far as methodology is concerned, we mainly analysed documents, especially international instruments and national legal sources, as well as some of the doctrine on the subject, in order to understand the meaning and scope of the particular protection needs of minors when they come into contact with justice, particularly criminal justice.

The results obtained indicate that the duty to care for minors who are suspects or defendants underpins the proper administration of justice, particularly when minors are deprived of their liberty and therefore in a particularly vulnerable situation. This Directive was transposed into Portuguese law by Law no. 33/2019 of 22 May, which introduced changes to eight provisions of the Code of Criminal Procedure (articles 58, 61, 87, 90, 103, 194, 283 and 370).

The conclusions clearly point towards the procedural law reserving a greater role for parental responsibility holders, the legal representative or the person who actually has custody of the minor defendant. In addition, they must be informed of the order imposing coercive measures. There is also an intensification of information on the rights of minors, the inclusion of the exclusion of publicity as a rule in cases involving minors, the indication of the social report or information from the social reintegration services in the indictment, under penalty of nullity, and its inclusion in the case file, for the purposes of sentencing, if it is not already part of it, unless there is justifiable justification for dispensing with it in view of the circumstances of the case and as long as it is compatible with the best interests of the minor.

Keywords: Children's rights; Directive (EU) 2016/800; Juvenile suspects or defendants; Defence guarantees; Criminal proceedings.

Preliminary point

Our investigation centres on minors, a group of people who are particularly vulnerable because of their age and who therefore need special protection from the vigour of the justice system, especially in criminal matters. It has been recognised that

> 'the immaturity inherent in children of a certain age entails, as a natural consequence, a particular vulnerability, which justifies specific and additional protection, complementary to that given to adults who are in full enjoyment of their capacities.' (Dias, 2023, p. 84).

Let's start by discussing the concepts of minor/child.

Concept of child/children

In the Convention on the Rights of the Child and Directive (EU) 2016/800

Article 1 of the Convention on the Rights of the Child (CRC) defines a child as 'every human being below the age of 18 years unless, under the law applicable to him or her, he or she attains majority earlier'. About this issue, it is interesting the analysis of CRC implementation, including the definition of a child and its problems in the work of Borská, Vacková & Small (2016). Article 3 of Directive (EU) 2016/800 of the European Parliament and of the Council of 11 May on procedural safeguards for minors suspected or accused in criminal proceedings defines a 'minor' as a person under the age of 18. This is a universal concept of the child, as it is currently used in international law and also in European law, although in European Union law there is no single definition that is valid for all instruments, neither in the treaties nor in secondary legislation or case law. The terms "minor" and "child" are equated and, in principle, the criterion of under 18 years of age is followed; with the exception of the possibility of national law establishing a lower age of majority, under the terms and for the purposes enshrined in the CRC and also in other international and national normative instruments specifically dedicated to the defence and protection of minors/children.

The Committee of Ministers of the Council of Europe has also stated the same. In various European and international normative instruments on the protection of children's rights, there is a consensus around the equation of "minors" with "children", the common element being the age of less than 18 years. It should be noted that the European Convention on Human Rights does not contain a definition of "child", but according to Article 1, states are obliged to guarantee the rights enshrined therein to 'everyone'. Article 14 also guarantees 'without distinction of any kind', including 'on grounds of age', the enjoyment of the rights recognised in the Convention. For its part, the case law of the European Court of Human Rights, following the meaning of the Convention on the Rights of the Child, also adopts the concept of children under 18. Moreover, this Court has accepted applications from children, or submitted on their behalf, without distinction as to age (in this regard, the case of Marckx v. Belgium, no. 6833/74, 13 June 1979, in which the minor applicant was six years old when the Court handed down its decision). Likewise, the European Social Charter and its interpretation by the European Committee of Social Rights (CEDS), in the case of Defence for Children International (DCI) v. Netherlands, § 25, no. 47/2008, 20 October 2009, adopts the concept of minor as synonymous with a child under the age of 18.

In civil law

According to our civil law, a 'minor' is anyone who has not yet reached the age of eighteen (Article 122 of the Civil Code) and does not have the full capacity to exercise rights or the capacity to act, under the terms of Article 123 of the Civil Code: 'Unless otherwise provided, minors lack the capacity to exercise rights'. (Gonçalves, 2016, p. 5 and p. 10). However, article 124 states that the incapacity of minors is compensated for by parental responsibilities and, in the alternative, by guardianship, as is clear from the legal regimes established in articles 1877 and 1927 and seq, respectively. Incapacity to exercise rights or incapacity to act is understood to mean

> 'the lack of suitability to act legally, exercising rights or fulfilling duties, acquiring rights or assuming obligations, by one's own and exclusive act or through a voluntary representative or proxy' (Pinto, Monteiro & Pinto, 2020, p. 231).

In criminal law

According to Article 19 of the Penal Code, minors under the age of 16 are not punishable. This means that until the age of 16, when a minor commits a typical unlawful act, they are not susceptible to a judgement of legal and criminal guilt and therefore cannot be punished. In this regard, please note the summary of the Judgement of the Porto Court of Appeal, in case no. 892/24.8Y6PRT.P1, of 02/26/2025 (Rapporteur: Maria Ângela Reguengo da Luz): 'while it is true that being under 16 does not necessarily deprive a minor of the capacity to 'assess the unlawfulness of their conduct 'or 'to determine themselves in accordance with that assessment", the possession of this capacity does not legally imply the capacity for guilt. Legal-penal guilt consists of a judgement of ethical-social censure of the agent's personality. But it is legitimate and plausible to consider that the individual's personality, in a legal-penal sense, is not formed before the age of 16".

For criminal law purposes, we cannot fail to mention that the concept of imputability by virtue of age - over 16 years of age - does not coincide with the concept of minority - up to 18 years of age. Therefore, between the ages of 16 and 18 you are a minor, but you are criminally

imputable. You are criminally imputable from the age of 16, presuming that you have the maturity and intellectual and emotional capacity, at the time of committing the offence, to assess its unlawfulness or to determine yourself according to that assessment. On the other hand, somewhat paradoxically, from the age of 16 anyone can validly consent to the injury of a freely available legal asset that does not go against good customs (provided the other formal requirements laid down in Article 38 of the Penal Code).

Reference assumptions

The issue of criminal non-responsibility on account of age tends to be grounded in neurological and psychological studies. These disciplines indicate that full cognitive and emotional maturity is acquired relatively late, around the age of 25, due to the maturation of the prefrontal region. A specific area of the brain – the cortex – is identified as responsible for thought, reasoning, action planning, self-control, cognitive functions, and sensory perception, and is thus considered pivotal in the development and maturation of cognitive capacity and the regulation of human emotions. Naturally, this neurological element has repercussions for human behaviour, as it shapes both the capacity to resist impulses and the ability to make decisions. As noted by Inês Ferreira Leite, "Colloquially, we refer to these capacities as the ability to exercise discernment (the exercise of discretionary power) and the ability to exercise self-control (the exercise of veto power)" (2023, p. 37).

It must not be overlooked that, in criminal law, subjective culpability is based on the intellectual, volitional, and emotional components of intent (dolus). Furthermore, the ethical-legal judgment of blame presupposes that the agent, at the time of committing the act, possesses both the intellectual element/discernment to be capable of evaluating the unlawfulness of their conduct, and the capacity for self-determination/freedom, to be capable of acting in accordance with that evaluation.

What's more, the judgement of ethical and legal censure presupposes that the agent, at the time of the perpetration of the act, is endowed with the intellectual element/discernment to be able to assess the unlawfulness of the act he or she is practising and endowed with the capacity for self-determination/freedom to be able to determine himself or herself according to the assessment he or she makes. That is why it is essential to establish a connection between criminal law and the contributions of these sciences. In any case, it should be noted that, in addition to brain activity, the experience acquired throughout life also strengthens emotional intelligence. Hence, it is essential to establish a connection between criminal law provisions and the contributions of these sciences, as there is not yet a full articulation between the two fields of knowledge.

Minors and the commission of a typical unlawful act

From a legal point of view, if a minor between the ages of 12 and 16 commits a crime under criminal law, they will be subject to an educational guardianship regime (Law no. 166/99, of 14 September), which is aimed exclusively at 'educating the minor in the law and integrating them into community life in a dignified and responsible manner' (art. 2 of the law). Measures that are appropriate and sufficient are applicable, representing the minimum intervention in the minor's autonomy to make decisions and lead his or her life, which is likely to obtain his or her greatest support and the support of his or her parents, legal representative or person who has de facto custody of him or her - only in this way will the educational purpose of this law be achieved. Of

course, the guardianship measure must be proportionate to the seriousness of the offence committed and the minor's lack of education in the law, in line with the needs felt at the time the decision was made. At this age stage, we have children and adolescents who, although not yet capable of a full decision-making process, are able to distinguish between what is lawful and what is unlawful, at least for certain unlawful offences, perhaps the most impactful in society. In this regard, see Hugo Cunha Lança's text (pp. 86 and 92). It is understood that, due to age, you don't go from being an incompetent person to an imputable person overnight. This is why Ana Rita Alfaiate (2014, p. 125) has argued that

> 'a transition model from the mobilisation of protection law to criminal law that accompanies the development of the offender's capacity to be judged guilty'

as a result of the progression of skills over time and according to the social context. On the occasion of the proposal for a Directive, in a commentary, the same author (2015, p. 54) pointed out that it is

> 'the verification of imputability by the mere attainment of the age of sixteen is insufficient, disregarding absolutely the maturity of the minor and their ability to understand the meaning and scope of their decisions in relation to criminal legal duty'.

The United Nations Regional Information Centre for Western Europe offers us an operative perspective on adolescence and youth: young people are between the ages of 15 and 24, limiting the concept of children to the age of 14.

Procedural guarantees for minors suspected or accused in criminal proceedings as a result of Directive (EU) 2016/800

General Overview

Directive (EU) 2016/800 of the European Parliament and of the Council of 11 May contains provisions applicable to minors who are suspects or defendants in criminal proceedings. Minority is measured at the time the proceedings are initiated (even if they have reached the age of 18 in the meantime). It is an instrument that considers the maturity, or lack thereof, and vulnerability of the person concerned.

One of the vital parts of this instrument consists of treating minors in a way that is appropriate to their age, maturity and level of understanding, considering any special needs they may have, including any communication difficulties. Member States are encouraged to apply the procedural guarantees provided for in the directive until the person concerned reaches the age of 21. However, the applicability of these guarantees extends only to criminal proceedings, with the exception of other types of proceedings, such as those specifically aimed at minors, but with a protective, corrective or re-educational purpose. On the other hand, the directive does not apply to some minor offences, except when the minor suspect or defendant is deprived of their liberty. There are means by which member states must determine the age of the minor: on the basis of their declarations, through verification at the civil registry office, through documentary research and other appropriate evidence. If this evidence is unavailable or inconclusive, a medical examination will be carried out, always respecting the child's rights, physical integrity and human dignity. If there is any doubt about age, the person must be considered a minor. The aforementioned medical examination should also take place when the minor is deprived of their liberty, guaranteeing their personal integrity as a condition for

preserving their future integrity.

Minors are in a particularly vulnerable situation when they are deprived of their liberty. This measure can entail risks for their physical, mental and social development and for their reintegration into society, with the exception of imprisonment in flagrante delicto. Efforts should therefore be made to prevent the deprivation of liberty or detention of a minor at any stage of the proceedings before a final judgement has been handed down. When deprived of their liberty, minors should benefit from protective measures, in particular separation from adults. The deprivation of liberty will be subject to a periodic review by the court at the request of the minor or their defence - a condition for assessing the necessity, appropriateness and proportionality of the deprivation of liberty. Whenever possible and appropriate, alternative measures to detention should be prioritised. These measures will include a ban on the minor going to certain places, an obligation for the minor to reside in a specific place, restrictions on contact with certain people, an obligation to inform the competent authorities, participation in re-education programmes or, subject to the minor's consent, participation in therapeutic programmes or detoxification cures. Maintaining regular contact with parents, family and friends through visits and correspondence is encouraged, unless exceptional restrictions are necessary in the best interests of the child, as well as in the interests of justice itself.

Echoes of the Directive in Portuguese Criminal Procedure

The previously acknowledged

The impact of the Directive on the Code of Criminal Procedure was not notable because the Code already had significant rules protecting minors in this area. Let's remember that its scope refers only to minors between the ages of 16 and 18. In fact, the qualitative shift of a minor from the status of witness to that of suspect (arguido) was already safeguarded in our Code of Criminal Procedure, which, in Article 61(1)(d), provides the right to silence, granting the individual the right "not to answer questions posed by any authority regarding the facts imputed to them or the content of any statements made in relation thereto." The right not to self-incriminate, in this context, is also provided for under Articles 132(2) and 59 of the Code of Criminal Procedure (CPP). Minors under the age of 16 are not required to take an oath, pursuant to Article 91(6) of the CPP. Furthermore, minors must be assisted by legal counsel when appearing before a court or a judge, as well as during detention. Article 64 of the CPP already established the mandatory presence of a defence lawyer, either chosen or court-appointed, for any procedural act involving a minor under the age of 21, a point that was highlighted positively in the Report of the Fundamental Rights Agency of the European Union. The confidentiality of communications between the minor and their legal counsel is essential for ensuring the effective exercise of defence rights and constitutes a core component of the right to a fair trial. Article 61(1)(f) of the CPP likewise already guaranteed the accused the right "to be assisted by a defence lawyer in all procedural acts in which they participate and, when detained, to communicate with them, including in private." This is a fundamental right of the accused. The European Court of Human Rights, in the case of Dayanan v. Turkey, judgment of 13 October 2009, held that this right applies to the accused "as soon as they are detained," and "not only during questioning." The Court reaffirmed this position in Beuze v. Belgium, judgment of 9 November 2018.

What was eventually acknowledged

Law 33/2019 of 22 May introduced the thirty-third amendment to the Code of Criminal Procedure, transposing the aforementioned Directive on procedural guarantees for minors suspected or accused in criminal proceedings. It was essential to promote the commitment of the parents or legal representative of the child accused, taking into account their specific needs and vulnerabilities. The constitution of a minor defendant is immediately communicated to those with parental responsibility, their legal representative or the person who has de facto custody of them (58.7).

The minor defendant now has the right to be accompanied during the procedural steps he or she attends by the holders of parental responsibility, their legal representative or a person who has de facto custody of them or, if they are unable to contact these people, or when special circumstances based on their interests or the needs of the case so require, and only for as long as these circumstances persist, by another suitable person indicated by them and accepted by the competent judicial authority (subparagraph i, paragraph 1, 68). These people must be informed by the judicial authority or the criminal police of the rights of the minor defendant (paragraph 3). If the minor has not nominated another person to accompany them, or if the person they have nominated is not accepted by the competent judicial authority, the latter will appoint a specialised technician to accompany them (paragraph 4). For these purposes, a minor is presumed if, after all the steps have been taken to identify the accused, his or her age remains uncertain and there is reason to believe that he or she is a minor (paragraph 5). With regard to public attendance at procedural acts, Article 87(3) establishes as a rule the exclusion of publicity in proceedings involving minors. As a result, it has also been decreed that it is impossible for anyone to consult the record and obtain a certificate from the record of interrogations or other procedural steps in which a minor defendant takes part (Article 90(2)). Acts relating to proceedings in which minors are involved, even if there are no defendants in custody, take place even during judicial holidays (Article 103(2)(b)) - the same rule as for urgent proceedings, ensuring greater speed in these cases. The court order imposing a measure of restraint and/or guaranteeing assets is immediately communicated to the holders of parental responsibility, their legal representative or the person who has custody of them (Article 194(11)). The indictment must contain, under penalty of nullity, an indication of the social report or information from the social reintegration services, when the defendant is a minor, except when it has not yet been submitted and is not necessarily due to the best interests of the minor (Article 283(3)(g). With regard to sentencing, and more specifically the need for a social report, Article 370(2) states that in the case of a minor defendant, if the social report or information from the social reintegration services has not yet been attached to the case file, it must be attached within 30 days, unless there are grounds to justify dispensing with it in view of the circumstances of the case and provided that it is compatible with the best interests of the minor. These were the changes to the Code of Criminal Procedure that resulted from the transposition of the Directive.

Main Findings of the European Report on the Implementation of the Directive

The European Union Agency for Fundamental Rights published a report on 21 June 2022, analysing the implementation of the Directive on criminal proceedings in Austria, Belgium, Bulgaria, Germany, Estonia, Italy, Malta, Poland, and Portugal. A discrepancy is noted regarding the age of criminal responsibility across Member States: it is set at 14 in Austria,

Bulgaria, Estonia, Germany, Italy, and Malta. In Belgium, it is 18 (or 16 for serious offences); in Poland, 17 (or 15 for serious offences); and in Portugal, 16. Authorities verified the age of children in Germany, Poland, and Portugal. Procedural safeguards in Austria, Germany, Italy, and Portugal ensure children's participation in support programmes, enhancing their sense of security. The right to inform parents or legal representatives is a fundamental and innovative element of the Directive, leading to amendments in criminal procedure codes. This right is enshrined in Austria, Estonia, Germany, Italy, Malta, and Portugal. In the Member States concerned, legislation provides for mandatory legal assistance for children from the moment they become suspects. In Austria and Portugal, legal aid is free if the defendant lacks sufficient means. Minors deprived of their liberty undergo mandatory medical examinations upon arrival at detention centres to assess their health status in Bulgaria, Poland, and Portugal. Ensuring that children are held separately from adults remains challenging. In Portugal, the Leiria Educational Prison Facility houses children separately in individual detention cells across seven pavilions. They are segregated by age and according to whether they are serving a sentence or in pre-trial detention.

Conclusions

Minors are particularly vulnerable due to their age and inherent incapacity to exercise their rights and are in a disadvantaged situation compared to adults who are more capable in terms of cognitive development and exercising their self-determination, requiring the concept of criminal irresponsibility due to minority to be aligned with current scientific knowledge in the fields of neurology and psychology.

The results show that there are legal instruments that aim to provide the public authorities with the necessary means to safeguard the rights of children in conflict with the law and protect their best interests, with Directive (EU) 2016/800 of the European Parliament and of the Council of 11 May playing a key role.

This was transposed into the Portuguese legal system by Law no. 33/2019, of 22 May, which introduced changes to eight provisions of the Code of Criminal Procedure, given that it was a guarantor code that already enshrined fundamental rights (such as the obligation to be assisted by a defender, the prerogative of non-self-incrimination, the recording of interrogations, among others, mentioned in the Directive).

The pattern of legislative changes called for the presence and accompaniment of minors by their parents, legal representatives or those with de facto custody, their right to information and the obligation to communicate decisions to them, such as the application of a coercive measure, the restriction on the publicity of procedural acts involving minors and the need to indicate and attach the social report or information from the probation services in the indictment and final decision.

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The fair trade as a tool for sustainable development in the agricultural sector in Colombia

Andrea Tatyhana Guerrero Robayo
Corporación Universitaria Asturias (Colombia),
andrea.guerrero@asturias.edu.co, https://orcid.org/0009-0003-8643-9304

Introduction

Colombia is a country characterized by a great variety of climates due to its location in the equatorial zone, between two oceans and its complex physiography. Its climate ranges from a few degrees below zero, in the 6 snowy mountains and more than 30 paramo regions, to climates of between 40 and 45 degrees in coastal areas and at sea level. Due to the variability of the climate and the characteristics of the soil and subsoil, its agricultural and livestock vocation has been of interest within the country's productive processes, despite the fact that, in 2010, only 1.6% of the land was under cultivation (Urrego-Mesa et al., 2025), and currently 22 Mha (million hectares) are identified as crop vocation zones and 15 Mha as livestock vocation zones (Unidad de Planificación Rural Agropecuaria [UPRA], 2022)

However, and due to the climate change that the entire planet is experiencing, there have also been changes in temperature, frequency and intensity of precipitation (rainfall), intensity of drought times, among others, which has affected the productive planning processes traditionally used by farmers, where "they observe the sun, the moon, the hills, mountains, animals and plants as a way to feel and predict what will happen with the weather. For them, nature speaks, and knowing how to listen to it is key to adapt to changes" (Instituto de Hidrología, Meteorología y Estudios Ambientales [IDEAM], June 2025), but these changes are so fast that they persist in affecting the periods of the year for land preparation, the beginning and development of planting, harvesting, and of course productivity at the end of the process.

In view of the above, it is essential to understand, as will be seen below, the characteristics, limitations and challenges faced by the agricultural sector in Colombia within the framework of the sustainable development goals adapted by the country and other signatories of the Sustainable Development Goals (SDGs) and 2030 Agenda.

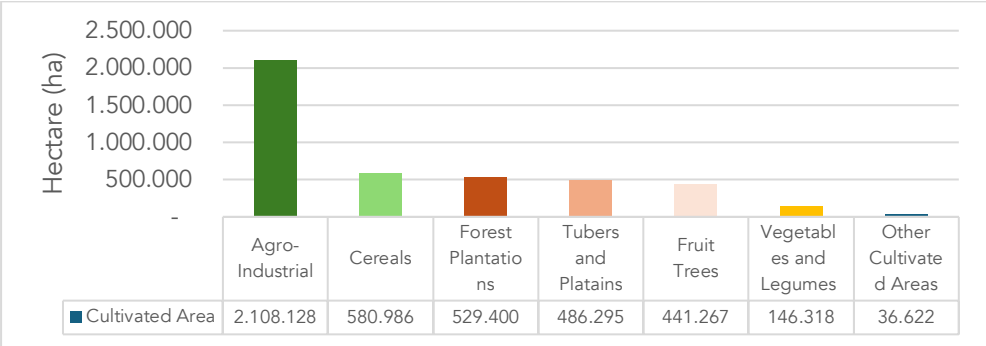
Agricultural activities in Colombia

Productive processes

In Colombia, agricultural activities include crop production, which is composed of transitory crops that are those whose "vegetative cycle is generally not longer than six months or in some cases one year and are characterized by the fact that when harvested it is necessary to sow them again to produce again" (UPRA, 2022, p. 5,) and permanent crops that "after sowing, take a relatively long time to reach productive age, produce several harvests and it is not necessary to sow them again after each harvest" (UPRA, 2022, p. 5). Livestock activities include counting and production of cattle, swine, poultry and other species.

Thus, monitoring the use of crops and livestock land is important. For example, according to Figure 1, the groups of crops of interest for the country are concentrated in agro-industrial crops (coffee, oil palm, cocoa, among others) which correspond to more than 50% of the sown or planted area of the national territory, followed by cereals (mainly rice, barley, corn and wheat), forest plantations (acacia, teak, pine, eucalyptus, among others), tubers and plantain (plus cassava, potato), fruit trees (avocado, banana, uchuva, passion fruit, mango, among others), vegetables, greens and legumes (peas, onions, beans, carrots, tomatoes, vegetables, among others) and other cultivated areas (with forage and aromatic plants in general).

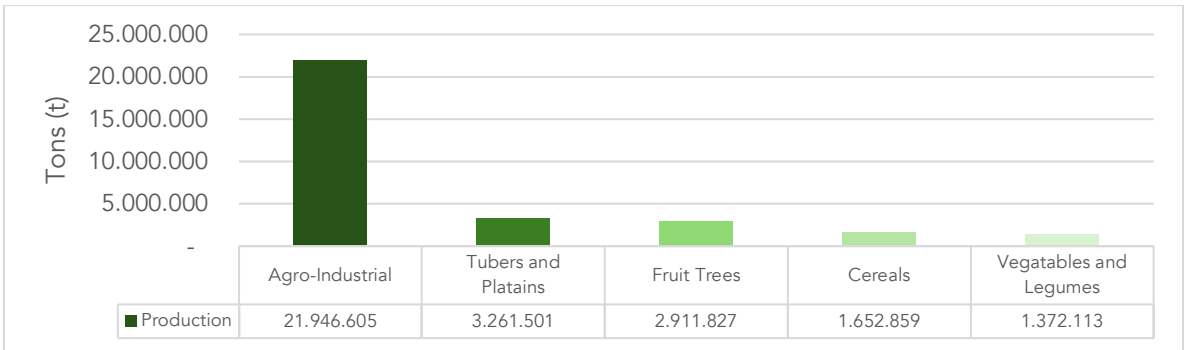
Figure 1. Cultivated area by crop group (hectares) at the national level. First semester, 2019.



Source: Departamento Administrativo Nacional de Estadística [DANE], 2020.

The production of the planted area (Figure 2), of more than 31 million tons, is expected to eventually reach the country's wholesale markets, and once there, it is distributed among retailers and retail sales. However, a part is destined for self-consumption, and others, due to adverse weather and security issues, do not reach the final consumer.

Figure 2. Total production by crop groups (tons). First semester, 2019.



Source: DANE, 2020.

As for livestock production, it is centered on cattle production in large extensions of land, as well as buffaloes. The areas occupied by pigs and poultry are quite small, so the number of animals in each of them will be greater in a smaller number of farms, as shown in Table 1. Thus, in terms of the amount of space occupied, cattle occupy the largest amount with more than 629 thousand farms in the country with more than 30 million head of cattle. In this respect, it is worth noting the growing interest in recent years in the production of buffaloes, with more than 538 thousand heads of cattle.

Table 1. *Livestock production, 2025.*

Type	Holdings*	Animal Count**
Cattle	629.592	30.344.182
Buffalo	4.072	538.574
Swine	189.198	21.336.552
Poultry	466.774	216.109.090
Equines	n/a	964.426
Sheep	n/a	1.689.875
Goats	n/a	112.002

Source: Own elaboration with data from the Instituto Colombiano Agropecuario [ICA] (2025).
* Includes backyard holdings, small-scale commercial family holdings, industrial commercial holdings, and/or specialized/technified farms.
** Total number of animals reported in the census.

Commercial processes

There are more than 29 wholesale markets in the country where the bulk of the country's agricultural production arrives. For the years 2021 and 2022, the supply in thousands of tons was led by tubers, roots and plantains, vegetables and fruits, but also included, from livestock production, meat and dairy products and eggs, as shown in Table 2.

Table 2. *Participation and annual supply variation rate by food group arriving to wholesale markets 2020-2021.*

Food Group	2021		2022		Change (%) 2022/2021
	Suply (Thousand Tons)	Share	Suply (Thousand Tons)	Share	
Meats	173	2,74%	205	3,27%	18,49%
Fruits	1.525	24,17%	1.488	23,76%	-2,42%
Grains and Cereals	404	6,41%	388	6,19%	-4,02%
Dairy and Eggs	55	0,87%	57	0,92%	4,98%
Fish	42	0,67%	44	0,70%	3,60%
Processed Foods	496	7,85%	516	8,24%	4,08%
Tubers, Roots and Plantains	1.822	28,87%	1.767	28,20%	-3,03%
Vegetables and Greens	1.794	28,43%	1.800	28,73%	0,31%
TOTAL	6.311	100%	6.264	100%	-0,74%

Source: DANE, 2023.

The commercialization of agricultural goods in the country is mainly marked by the intermediary action of buyers who stockpile products and often have the logistic strength of transportation and distribution to move the merchandise from the crops to the big cities and their wholesale markets. However, in the process, they do not pay the price established by the farmer, but through the action of "bargaining", they end up offering much lower prices, an offer that is accepted due to the need of the producer and the interest of not losing the food and the resources invested.

Production and Commercialization Constraints

The challenges faced by small farmers include climate change, adaptation of the production process and animal husbandry to environmental changes, full compliance with environmental standards, limited technification in the production process and in packaging, communication and distribution channels dependent on intermediaries, and the price of their products in line with the cost of the production and logistics chain. This leads to a dependence on circumstances and an impact on the quality of life, making it a deficit for small producers and their closest circle, as they do not have a guaranteed payment for their products that covers at least the minimum costs of producing them, in addition to their participation in environmental impacts and the low competitiveness in terms of price and quality of their products.

In terms of commercialization, the main limitation is the lack of logistic infrastructure from the crops to the main markets in the country, but more importantly, to potential customers. On the other hand, the production process with the use of pesticides, fungicides and other materials that pollute the soil, air and water sources is a major constraint. And, finally, the still limited awareness of the final customer regarding the consumption of natural foods.

Environmental impacts

A study conducted by Castañeda *et al.* in 2023 and 2024, showed that some fruits produced in the department of Antioquia, one of the most productive in the country, had heavy metals such as lead, mercury and arsenic, but not due to direct contamination but because of irrigation water (groundwater), "since plants could absorb metals through the roots due to their similarity with essential metals" (Castañeda *et al.*, 2025). This is an aspect that calls attention and invites us to re-evaluate the pest control systems and the use of fertilizers that affect the soil and water tributaries. These practices are regularly used in large-scale plantations or monocultures and in industrialized agricultural production.

Customer awareness

This aspect has gained strength for the logistics chain of the agricultural product because it is required that the customer prefers natural products over ultra-processed ones, that he understands the resources that are committed for a product to reach his table and thus give the required value to it. In addition, it is necessary that they demand and choose products that have a positive impact, throughout the production chain, on the quality of life of all those involved and, finally, that their pockets are not negatively affected.

Sustainable development

According to the analysis presented by Franco (2025) through the UN, there are marked difficulties in achieving the SDGs, an aspect that is supported by the ECLAC report, which indicates that only 23% of the goals will be achieved, with progress of only 41% of the indicators, due to various adverse situations such as institutional weakness, lack of financing due to the unfavorable economic environment that aggravates the situation, among others. However, the report proposes several structural transformations that could mitigate the adverse situation, focused on sustainable productive development, reduction of inequalities, climate action and institutional strengthening.

A redesign of the country's productive system is therefore required, orienting it towards environmentally responsible practices that reduce dependence on fossil fuels and promote technological innovation. It is essential to address social and economic gaps through initiatives that ensure fair access to essential services and economic opportunities. At the same time, the region must accelerate its response to the climate emergency by adopting clean energy and promoting the efficient use of resources. All this requires strengthening institutional infrastructure, improving public management capacity and fostering partnerships at both national and international levels to ensure effective implementation of the SDGs (Franco, 2025).

In this sense, in order to find viable, environmentally responsible and resilient alternatives for society, there is urban agriculture, an activity that seeks to take advantage of public spaces to promote community planting and harvesting of agricultural products, but also to promote production for self-consumption in households, since "the significant advantages of organic urban agriculture in terms of relative yield and productivity, compared to conventional production systems" (Riaño *et al.*, 2023), generate fewer greenhouse effects and ensure clean production and the generation of organic products for immediate consumption.

Fair trade

Fair trade is presented as an alternative model to conventional trade that seeks to transform economic relations through ethical principles centered on equity, inclusion and mutual respect. By establishing trade links between producing communities and different types of customers, including global markets, based on transparency and dialogue. What distinguishes Fair Trade is not only its interest in improving the incomes of small producers and marginalized workers, but also in recognizing their dignity and rights, ensuring fairer and more sustainable working conditions. Likewise, ECLAC states that the collaborative participation between producers, organizations and conscious buyers allows fostering sustainable development with social justice, favoring local economies, promoting responsible environmental practices and advocating for more equitable trade rules at a global level.

Fair trade and sustainable development contain 10 principles, each of which contributes to the creation of a more equitable, inclusive and sustainable economy (ECLAC, 2024); particularly in contexts such as Colombia, where economic and social inequality continues to be a challenge. Each principle is aimed at ensuring that the most vulnerable producers not only have more direct access to markets, but that they do so under conditions that promote their overall well-being.

The main objective of this research is to *identify the production and marketing alternatives that fair trade can offer to the sustainable development of the agricultural sector in Colombia*, based on the needs of small and medium-sized agricultural producers, considering that their production is mainly consumed within the country.

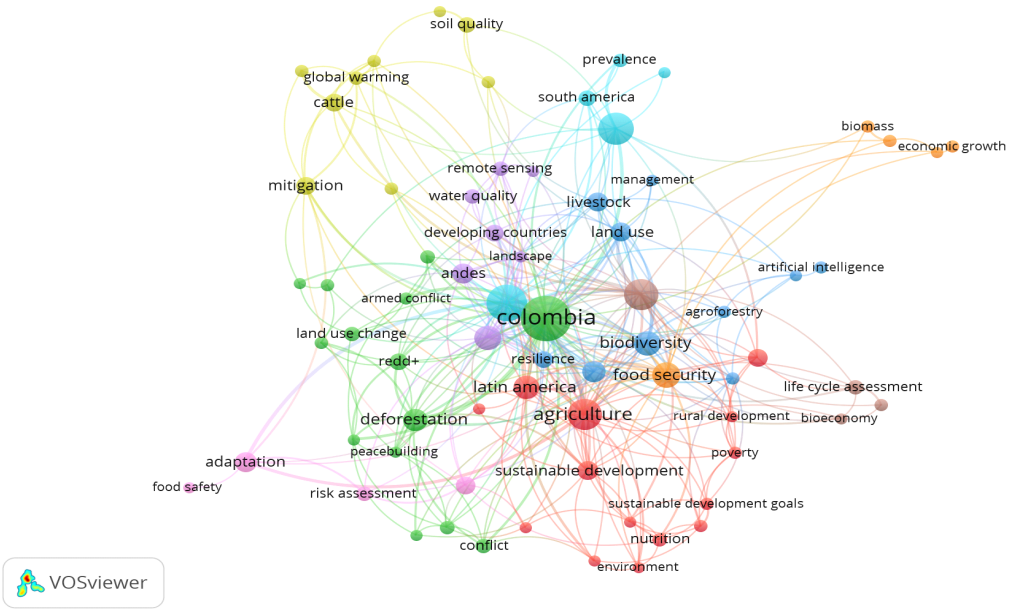
To carry out this study, a documentary review methodology was used, performing a bibliometric analysis, starting with an academic review of the state and evolution of the agricultural sector in Colombia, in terms of (1) production and commercialization and (2) influence on the development of the quality of life of producers in the last 10 years versus the consumption of their products, using publications from the Science direct database and applying the following Boolean expression: Colombian agriculture AND "sustainable

development" OR "fair trade" NOT Health, "international trade"; finding 863 academic papers including book chapters, review articles and research articles.

In addition, the academic production in terms of (3) sustainable development and (4) fair trade was reviewed with the same Boolean expression, establishing the basic guidelines of each of them and their importance for the development of the agricultural sector in Colombia between 2015 and 2025, using publications from the Science direct database, 216 documents related to the topic of sustainable development in the framework of the agricultural sector in Colombia and 41 documents related to fair trade were found. In addition, the results were plotted with the VOSviewer tool.

In the study (Figure 3), it is evident that academic interest is mainly oriented to land use, livestock trends, productivity and the environment. However, they also make a strategic connection with sustainable development issues, emphasizing aspects such as poverty, rural development, nutrition, vulnerability and environment (deforestation, changes in land use, water use and quality).

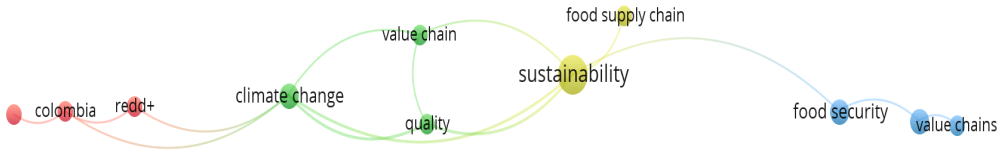
Figure 3. Central aspects studied within the framework of the Colombian agricultural theme between 2015 and 2025.



Source: Own elaboration.

Finally, Figure 4 shows that fair trade is specifically considered from the perspective of sustainability, the supply chain, food safety and climate change.

Figure 4. Relevant aspects studied within the framework of fair trade in the Colombian agricultural sector between 2015 and 2025.

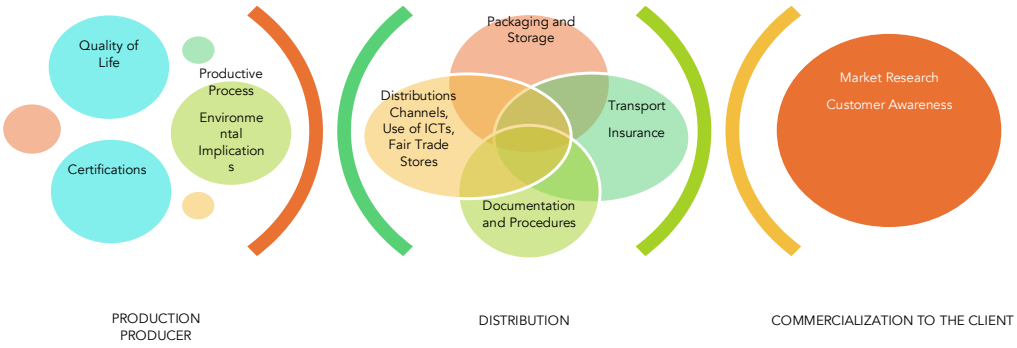


Source: Own elaboration.

Cluster analysis

With the above study, a fair trade logistics and production chain model applied to the agricultural sector is proposed in which the elimination of logistics intermediation is gradually sought, government intervention is promoted in training processes and also in the establishment of logistics platforms that reduce the gap between the producer and the client and finally, training and awareness campaigns are established for the client so that they prefer the consumption of products derived from fair trade, thus:

Figure 6. Proposal for a Model Fair Trade Logistics and Production Chain



Source: Own elaboration.

Production link: At this stage of the production process, it is proposed to apply even small plantations clean and sustainable methods of land preparation, pest control, fertilization, harvesting and post-harvesting, thus ensuring an organic product. Processes for certifying the land and the process as green and fair trade are promoted. In addition, government entities monitor the levels and fluctuations in the quality of life of producers and their families.Distribution link: Through training processes promoted by government entities, encouraging regulatory compliance in terms of product conservation by appropriate packaging and wrapping, proposing distribution channels that include the use of ICTs and electronic media such as social networks and websites, in addition to the use of fair-trade networks and

stores. In addition, the government should ensure logistical platforms that help the effectiveness of this process.

Commercialization Link: Conduct customer awareness campaigns on production and marketing processes to provide them with tools to choose clean, environmentally responsible, organic and healthy products. Ensure that producers are constantly monitoring market trends through fair trade networks.

Conclusions

It is important to emphasize the need to establish other alternatives for monitoring small producers to find strategies that support production processes, ensure environmental sustainability and facilitate fair marketing channels that ultimately contribute to the integral development of the producer, his family and his environment, in addition to improving the quality of life of the client. The creation of opportunities for economically disadvantaged producers is fundamental; this would be achieved through the payment of fair prices that cover production costs and allow for more sustainable development in the long term. This, together with a commitment to training that strengthens local productive capacity, empowering small producers and generating a transformation that is not only limited to the economic sphere, but also extends to the social and environmental spheres.

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Application of artificial intelligence in public bidding in Colombia

Ivon Dayann Gil Pedreros
Corporación Universitaria Asturias (Colombia), ivon.gil@asturias.edu.co
Alfredo Guzmán Rincón
Corporación Universitaria Asturias (Colombia), alfredo.guzman@asturias.edu.co

Introduction

The public contract is one of the main instruments through which the State fulfills its functions, guarantees public duties, and provides essential services, with the collaboration of private parties who carry out the contracted tasks. To achieve this in accordance with the public interest, government procurement must adhere to fundamental principles such as transparency, efficiency, effectiveness, due process, and impartiality, among others.

The Colombian State has been implementing technological tools with the aim of making public procurement more transparent and participatory. However, despite the existence of systems such as SECOP I, SECOP II, and the Colombian State Virtual Store (TVEC), there are still deficiencies that affect the effectiveness of the contracting process. These platforms present usability issues, lack clarity in contractor selection, and have limitations in citizen oversight. This generates risks in contract allocation and undermines public trust. Therefore, there is a need to improve the contractor selection process through tools that optimize decision-making.

The Public Contract and Its Modalities in Colombia

The public contract is a fundamental legal instrument through which the Colombian State fulfills its functions, guarantees public duties, and provides services to citizens, with the collaboration of private individuals. Unlike private contracts, it has characteristics specific to the public interest and administrative function. According to academic analysis, it differs in five key aspects: the absence of contractual freedom, as clauses are determined by law; its instrumental role in serving the public interest; its subjection to state planning, which includes prior studies and budget evaluation; a regulated inequality between the parties, where the administration holds control prerogatives; and unilateral mutability, allowing the State to modify or terminate the contract with binding effect. (Morón Urbina y Aguilera B., 2017).

As stated by the *Corte Constitucional colombiana in Sentencia C-713 de 2009*, mentioned:

> El contrato público es uno de aquellos instrumentos jurídicos de los que se vale el Estado para cumplir sus finalidades, hacer efectivos los deberes públicos y prestar los servicios a su cargo, con la colaboración de los particulares a quienes corresponde ejecutar, a nombre de la administración, las tareas acordadas. (Corte Constitucional, 2009,p.1)

Based on these differences with private contracts, Colombian law establishes various modalities for contractor selection regulated mainly by *Ley 80 de 1993, Ley 1150 de 2007, Decreto 1082 de 2015*, and complementary norms such as *Ley 1474 de 2011*.Public bidding is the main modality for contracting public works and other high-value contracts. It guarantees the plurality of bidders and the objective selection of the most suitable contractor. This

modality is regulated by article 2 *of Ley 1150 de 2007* and is mandatory for high-value contracts, except when another modality is allowed by the nature of the contract.

Merit-based competition is designed especially for hiring consultants, supervisors, and professionals in technical areas such as coordination, project management, and feasibility studies. This modality emphasizes the quality of the proposal over price and is regulated by article 2 of *Ley 1150 de 2007* and *Decreto 1082 de 2015*.

Abbreviated selection is an objective selection modality applicable to goods and services of lower complexity or value. It simplifies procedures and includes: i) Abbreviated selection by lower amount: For contracts above 10% of the minimum threshold and up to the maximum for this modality. ii)Reverse auction: Used when goods or services have uniform technical characteristics, allowing providers to compete by lowering prices and iii) Framework agreements: Where Colombia *Compra Eficiente* preselects suppliers through public bidding, and entities contract directly through the Virtual Store of the Colombian Government, selecting the lowest-priced offer.

Minimum amount applies to contracts whose value does not exceed 10% of the entity's minimum threshold. This modality allows fast and simplified, yet public and transparent processes. According to *Ley 1474 de 2011*, there must be public invitation and bidders must meet minimum requirements. Purchases may also be made in large retail stores via the Virtual Store, provided the economic limits are respected.

Direct contracting is an exceptional modality regulated by article 2, numeral 4, of *Ley 1150 de 2007* and *Decreto 1082 de 2015*. It is only allowed in specific legal cases, such as hiring professional services or support, exclusive suppliers, urgent situations, inter-administrative agreements, or contracts involving military secrecy or national security.

In summary, Colombia's public procurement system is governed by a solid legal framework aimed at balancing efficient use of public resources with principles like transparency, fairness, and public interest. Each contracting modality is designed to suit different needs and contexts, ensuring the State's contractual activities are conducted objectively and effectively.

An Overview of Electronic Public Procurement in Colombia

Public procurement in Colombia is regulated by fundamental principles established in *Ley 80 de 1993*, including transparency, economy, responsibility, efficiency, due process, and impartiality. The principle of transparency, developed in article 24 of the *Estatuto de Contratación Estatal*, involves publicizing the stages of the procurement process, access to documents, clarity in participation requirements, and objective criteria for contractor selection, ensuring equality and free competition.

The principle of economy, established in article 25 of *Ley 80 de 1993*, demands compliance only with the procedures strictly necessary to achieve an objective contractor selection within legal terms. Additionally, the principles of efficiency, due process, and impartiality in article 3° of the *Código de Procedimiento Administrativo y de lo Contencioso Administrativo* require removing formal obstacles, avoiding delays, and acting with neutrality and objectivity to ensure equality and transparency.

The adoption of technological means for public procurement began between 2000 and 2002, driven by *Directiva Presidencial 02 de 2000*, and *CONPES 3186 de 2002* (Laguado Giraldo,

2004). This first stage promoted the publication of information and the offering of online services, although full implementation of online contracting was hindered by lack of technical and legal planning. The second stage (2002-2003) was characterized by *Decreto 2170 de 2002* and *CONPES 3249 de 2003*, which expanded mandatory electronic publication and regulated electronic auctions, advancing transparency but with limitations in technological infrastructure.

Since late 2003 with *Decreto 3816*, the third stage saw the creation of the *Comisión COINFO*, which led technological projects and strengthened the *Portal Único de Contratación*, laying the groundwork for comprehensive electronic contract management. *CONPES 3249 de 2003* defined two functional phases in electronic procurement: an informative phase based on mass online publication and document access, and a contract management phase aimed at digitalizing the entire process.

With *Ley 1150 de 2007*, the *Sistema Electrónico para la Contratación Pública (SECOP)* was created, divided into *SECOP I*, *SECOP II*, and the *Tienda Virtual del Estado Colombiano (TVEC*) for purchases under various modalities. The *Ley 2195 de 2022* mandated that all entities conducting public procurement must register all related documentation in *SECOP II*, yet efficiency and sustainability problems persist. In 2024, the Director of *Colombia Compra Eficiente* acknowledged serious deficiencies in the platform, with operating costs exceeding 25 billion pesos that year and accumulated expenses over 127 billion in the last decade. Furthermore, the system fails to meet international accessibility standards (W3C), limiting use for people with disabilities, especially visual impairments, and does not provide modern tools for efficient negotiation with suppliers (Hernández M., 2025).

In terms of oversight, the platform *Océano,* created in 2024 by the *Dirección de Información, Análisis y Reacción Inmediata (DIARI)* of the *Contraloría General de la República*, integrates data from multiple sources such as *SECOP, SIRECI, Procuraduría, DIAN*, and *Registraduría* to offer a comprehensive and transparent view of public procurement. Océano employs artificial intelligence, data mining, and satellite imagery analysis to detect irregularities like collusion and bid manipulation, as well as monitor public works in real time (Contraloría General de la República, 2024). However, its main function is preventive control and it does not directly facilitate contracting between the State and private parties.

Considering these developments and challenges, a proposal is made to develop an artificial intelligence model that applies the principles of transparency, economy, and impartiality to optimize public procurement processes in Colombia.

Proposal: AI Model for Public Bidding

The *CONPES 4144* document (Departamento Nacional de Planeación, 2025) defines artificial intelligence (AI) from two perspectives: a theoretical one, as intelligence artificially created in beings or machines, and a technological one, as techniques that allow automating useful tasks through data-based systems. For this proposal, the technological approach is adopted, which emphasizes the use of algorithms to generate predictions, recommendations, or decisions that mimic human capabilities.

Since 2022, Colombia has promoted the use of AI to improve operational efficiency and public service delivery through Decree 1263, requiring projects aligned with ethical principles, risk analysis, training, and transparency. Additionally, citizen participation and national monitoring of these initiatives are encouraged.

In light of these guidelines and recognizing the current limitations of the electronic contracting system, a specific AI model is proposed for the public bidding modality, which concentrates contracts of the highest value. This model aims to optimize transparency, economy, and impartiality in the most significant public contracting processes.

The proposed model aims to classify whether a bidder is suitable or not to be awarded a public contract, taking into account multiple dimensions: legal, financial, technical, social, environmental, and transparency aspects. To achieve this, the use of a binary classification neural network is proposed, specifically with a sigmoid output. A set of input variables X=[x1,x2,…,xn]X = [x_1, x_2, \ldots, x_n]X=[x1,x2,…,xn] represents characteristics of the bidder in the bidding process. The model must predict a binary label y∈{0,1}y \in \{0, 1\}y∈{0,1}.

The general architecture can be defined as:

$$Z^{(1)} = W^{(1)} X + b^{(1)}$$

$$a^{(1)} = \sigma (z^{(1)})$$

$$z^{(2)} = W^{(2)} a^{(1)} + b^{(2)}$$

$$\hat{y} = \sigma (z^{\wedge(2)})$$

Where:

1. σ It is an activation function. (ReLU For hidden layers, sigmoid in the output laye).
2. $W^{(i)}$, $b^{(i)}$: Trainable weights and biases.
3. $\hat{y}$: Probability that the bidder is suitable

For the construction of the supervised neural network model that evaluates the suitability of a bidder in public procurement processes, a set of rigorously selected independent variables has been defined and grouped into six analytical factors. Each factor represents a critical dimension: legal, financial, experiential, technical-economic (see Table 1), socio-environmental, and risk. The academic relevance of these factors is supported by the literature on objective selection and transparency analysis in bidding (Morón Urbina & Aguilera, 2017; Departamento Nacional de Planeación, 2025).The data typing (categorical, numerical, or boolean) facilitates standardized preprocessing, which is essential to ensure algorithm convergence and the correct interpretation of synaptic weights during training

Table 1. *Neural network variables for the AI model development.*

Factor	Variable	Data Type
Legal Identification and Validation	tipo_proponente (bidder type)	Categorical
	registro_secop (SECOP registration)	Boolean
	rup_inscrito (RUP registered)	Boolean
	país_origen (country of origin)	Categorical
	vigencia_legal (legal validity)	Boolean
	apoderado_acreditado (authorized representative)	Boolean

Financial and Organizational Capacity	índice_liquidez (liquidity ratio)	Numeric
	índice_endeudamiento (indebtedness ratio)	Numeric
	cobertura_intereses (interest coverage)	Numeric
	rentabilidad_patrimonio (return on equity)	Numeric
	rentabilidad_activo (return on assets)	Numeric
Experience	n_contratos_previos (number of previous contracts)	Numeric
	valor_total_contratos (total contract value)	Numeric
	clasificador_bienes_servicios (goods/services classifier)	CIIU Coding
Technical-Economic Evaluation	precio_ofertado (offered price)	Numeric
	condiciones_técnicas_mínimas (minimum technical conditions)	Boolean
	condiciones_adicionales (additional conditions)	Binary vector or text
	puntaje_técnico (technical score)	Numeric
	puntaje_económico (economic score)	Numeric
	relación_costo_beneficio (cost-benefit ratio)	Numeric
Social and Environmental Criteria	incluye_criterios_ambientales (includes environmental criteria)	Boolean
	incluye_criterios_sociales (includes social criteria)	Boolean
	ponderación_asignada (assigned weighting)	Numeric
Risk and Transparency Analysis	riesgos_identificados (identified risks)	Text or categorical
	medidas_mitigación (mitigation measures)	Text or categorical
	garantías_exigidas (required guarantees)	Categorical vector
	publicación_secop_ii (publication in SECOP II)	Boolean
Risk of Fragmentation	n_contratos_similares_12m (number of similar contracts in 12 months)	Numeric
	valor_acumulado (accumulated value)	Numeric
	tiempo_entre_adjudicaciones (time between awards)	Numeric (days)

For the operationalization of the proposed model, an artificial neural network was implemented using the Python programming language, utilizing specialized libraries such as TensorFlow and Scikit-learn. Since an integrated and cleaned public database containing all the attributes required by the model is not yet available, a simulated dataset was generated to reproduce the typical conditions and structures of a public bidding process in Colombia. This dataset includes categorical, numerical, and Boolean variables related to bidder identification, financial capacity, experience, technical, social, and environmental criteria, as well as indicators of transparency and contract splitting risk.

The implemented algorithm corresponds to a multilayer perceptron (MLP) neural network, with an architecture composed of an input layer, two hidden layers with ReLU activation functions, and an output layer with sigmoid activation, suitable for solving binary classification problems. The model was trained using the Adam optimizer and binary cross-entropy loss function, maximizing the system's accuracy and predictive capability through an iterative process of synaptic weight adjustment on the training set. This configuration allowed for evaluating the technical feasibility of the approach and laid the foundation for a future application using real data from *SECOP II*.

Table 2. *Base neural network programming for the AI model.*

```
# Paso 1: Instalación de TensorFlow (si no está instalado)
!pip install -q tensorflow scikit-learn pandas numpy

# Paso 2: Importar librerías
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import ColumnTransformer
from sklearn.pipeline import Pipeline
from sklearn.impute import SimpleImputer
from sklearn.metrics import classification_report, roc_auc_score
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.optimizers import Adam

# Paso 3: Simular dataset con 1000 ejemplos
np.random.seed(42)
n_samples = 1000

data = {
    'tipo_proponente': np.random.choice(['natural', 'juridica', 'extranjero'], n_samples),
    'registro_secop': np.random.choice([0, 1], n_samples),
    'rup_inscrito': np.random.choice([0, 1], n_samples),
    'vigencia_legal': np.random.choice([0, 1], n_samples),
    'apoderado_acreditado': np.random.choice([0, 1], n_samples),
```

```
    'índice_liquidez': np.random.uniform(0.5, 2.0, n_samples),
    'índice_endeudamiento': np.random.uniform(0.2, 0.8, n_samples),
    'cobertura_intereses': np.random.uniform(1, 10, n_samples),
    'rentabilidad_patrimonio': np.random.uniform(0, 0.3, n_samples),
    'rentabilidad_activo': np.random.uniform(0, 0.2, n_samples),
    'n_contratos_previos': np.random.randint(0, 50, n_samples),
    'valor_total_contratos': np.random.uniform(100, 5000, n_samples),
    'precio_ofertado': np.random.uniform(100, 10000, n_samples),
    'condiciones_técnicas_mínimas': np.random.choice([0, 1], n_samples),
    'puntaje_técnico': np.random.uniform(0, 100, n_samples),
    'puntaje_económico': np.random.uniform(0, 100, n_samples),
    'incluye_criterios_ambientales': np.random.choice([0, 1], n_samples),
    'incluye_criterios_sociales': np.random.choice([0, 1], n_samples),
    'publicación_secop_ii': np.random.choice([0, 1], n_samples),
    'n_contratos_similares_12m': np.random.randint(0, 10, n_samples),
    'tiempo_entre_adjudicaciones': np.random.randint(1, 120, n_samples),
    'es_apto': np.random.choice([0, 1], n_samples)
}

df = pd.DataFrame(data)

# Paso 4: Separar variables
X = df.drop('es_apto', axis=1)
y = df['es_apto']

numeric_features = X.select_dtypes(include=['int64', 'float64']).columns.tolist()
categorical_features = ['tipo_proponente']

numeric_transformer = Pipeline(steps=[
    ('imputer', SimpleImputer(strategy='mean')),
    ('scaler', StandardScaler())
])
```

```
categorical_transformer = Pipeline(steps=[
    ('onehot', OneHotEncoder(handle_unknown='ignore'))
])

preprocessor = ColumnTransformer(
    transformers=[
        ('num', numeric_transformer, numeric_features),
        ('cat', categorical_transformer, categorical_features)
    ])

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

X_train_processed = preprocessor.fit_transform(X_train)
X_test_processed = preprocessor.transform(X_test)

# Paso 5: Crear red neuronal
model = Sequential([
    Dense(64, activation='relu', input_shape=(X_train_processed.shape[1],)),
    Dense(32, activation='relu'),
    Dense(1, activation='sigmoid')
])

model.compile(optimizer=Adam(learning_rate=0.001), loss='binary_crossentropy',
metrics=['accuracy'])

# Paso 6: Entrenar modelo
model.fit(X_train_processed, y_train, epochs=20, batch_size=32, validation_split=0.2,
verbose=1)

# Paso 7: Evaluar modelo
y_pred_probs = model.predict(X_test_processed).flatten()
y_pred = (y_pred_probs > 0.5).astype(int)
```

```
print("\n Clasification Report:")
print(classification_report(y_test, y_pred))


roc_auc = roc_auc_score(y_test, y_pred_probs)
print(f" ROC-AUC Score: {roc_auc:.3f}")
```

Based on the evaluation results of the proposed neural network model using simulated data, the predictive performance was limited. The classification report indicates an accuracy of 0.51 for the negative class (not suitable) and 0.47 for the positive class (suitable), with similar recall and F1-score values, reflecting low discriminative capability. The weighted average F1-score is 0.50, and the ROC-AUC score is 0.518, only slightly above random chance (0.5), indicating the model fails to properly distinguish between suitable and unsuitable bidders. These results were expected given the artificial and random nature of the simulated data, limiting the model's ability to learn meaningful patterns. However, the exercise validated the model's structure, processing workflow, and network architecture, laying the groundwork for future application with real data from the *SECOP II* system or other integrated sources within Colombia's public procurement ecosystem.

Conclusions

Public procurement in Colombia is a fundamental tool for the State to fulfill its constitutional goals but faces significant challenges related to transparency, efficiency, and fairness in contractor selection. Despite advances in regulations and technological platforms such as *SECOP I* and II and the *Tienda Virtual del Estado Colombiano (TVEC*), technical shortcomings, high operational costs, and accessibility and interoperability limitations persist. These issues have weakened public trust and highlight the need for more effective solutions.

In response, a model based on artificial intelligence (AI) aligned with Colombian legal frameworks and digital transformation policies is proposed. Unlike tools like *Océano*, which focus on fiscal control, this model aims to improve decision-making in public bidding processes by prioritizing transparency, impartiality, and cost-efficiency. The proposal is based on a binary neural network capable of classifying bidder suitability, considering legal, financial, technical, social, environmental, and transparency variables.

To validate technical feasibility, a multilayer perceptron (MLP) neural network was implemented in Python using libraries such as TensorFlow and Scikit-learn. Due to the absence of cleaned public data, a simulated dataset representing a real bidding process was created. The model included two hidden layers with ReLU activation and a sigmoid output layer, trained with the Adam optimizer and binary cross-entropy loss function. This setup yielded promising preliminary binary classification results and sets the stage for future applications on real *SECOP II* data.

This initiative demonstrates AI's potential to transform public procurement in Colombia, enhancing efficiency, objectivity, and citizen oversight in the country's most critical public spending processes.

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Non-compliance in the Presentation of Financial Statements from 2020 to 2023 in Simplified Joint Stock Companies in Ecuador: A Risk Analysis

Fabricio Echeverría Briones
Corporación Universitaria Asturias (Colombia),
pedro.echeverria@asturias.edu.co, https://orcid.org/0000-0002-4921-1111

Introduction

The Organic Law on Entrepreneurship and Innovation (Asamblea Nacional del Ecuador, 2020, Ley Orgánica de Emprendimiento e Innovación) established the Simplified Stock Corporation (Sociedad por Acciones Simplificada, SAS) as a new corporate structure in Ecuador. Since its implementation, SAS entities have experienced exponential growth, becoming Ecuador's second most prevalent business form (28.35% of all registered companies), trailing only behind traditional Stock Corporations (Sociedades Anónimas, 48.79%) (Superintendencia de Compañías, Valores y Seguros, 2024).

However, SAS incorporation carries specific legal obligations, including mandatory annual submission of financial statements to the Superintendencia de Compañías, Valores y Seguros (SCVS). For Sanchez (2026) non-compliance triggers financial penalties for legal representatives and, per Article 59 (unnumbered) following Article 317(1) of the Companies Law (Asamblea Nacional del Ecuador, 2023, Ley Reformatoria a la Ley de Compañías), may result in automatic dissolution after three consecutive years of non-compliance.

This research analyses non-compliance patterns in financial reporting among SAS entities from 2020-2023, examining key variables including:

- Economic activity (per UN International Standard Industrial Classification - ISIC)
- Geographic distribution
- Corporate longevity
- The study aims to evaluate dissolution risks and their implications for Ecuador's business ecosystem.

Research Objectives

- Quantify compliance rates with Article 20 of the Companies Law regarding financial reporting
- Identify sectoral and geographic patterns in non-compliance
- Assess systemic risks of automatic dissolution under Article 59

Data Sources

Primary data extracted from SCVS official portals included:

- Corporate registry records (Directorio de Compañías)
- Financial reporting histories (Ranking de Compañías)

Classification by:

- ISIC codes (Clasificación Industrial Internacional Uniforme - CIIU)
- Provincial jurisdiction
- Incorporation year

A longitudinal analysis of 47,222 active SAS entities incorporated through December 2023 was conducted using:

- Descriptive statistics (frequency distributions, contingency tables)
- Stratified sampling by incorporation cohort
- Trend analysis through statistical visualization

Study Population: All SAS entities obligated to submit 2023 financial statements by April 30, 2024 (n=47,222).

Longitudinal Compliance Trends

Compliance behaviour over time shows a progressive decline in financial statement submissions across all incorporation cohorts of SAS entities. Companies established prior to 2020, many of which transitioned from other legal structures, maintained nearly perfect compliance levels until 2022, but experienced a notable drop in 2023. More recent cohorts, especially those incorporated between 2020 and 2022, demonstrate a steady downward trajectory. The most recent cohort (2023) shows the lowest initial compliance, likely due to early-stage operational and administrative constraints. These trends are summarized in Table 1.

Table 1. *Cohort Compliance Evolution (2020-2023)*

Incorporation Year	2020 Compliance	2021 Compliance	2022 Compliance	2023 Compliance
Pre-2020	100.0%	99.3%	98.2%	75.8%
2020	89.5%	85.9%	81.9%	65.1%
2021	-	85.1%	80.6%	63.2%
2022	-	-	80.8%	63.3%
2023	-	-	-	55.2%

Key observations:

- Steady compliance erosion across all cohorts
- 2023 cohort shows weakest inaugural performance
- Pre-2020 conversions maintained >98% compliance until 2023

Sectoral Analysis

Financial reporting compliance among SAS entities varies significantly across economic sectors. Industries characterized by smaller firms or informal operations—such as Arts/Entertainment and Accommodation—show the highest non-compliance rates, placing them in the "Critical" risk category. In contrast, sectors subject to regulatory oversight, like Financial Services and Utilities, maintain better compliance records, likely due to stronger governance frameworks

and resource availability. Table 2 illustrates the classification of economic sectors by non-compliance rate and associated risk level.

Table 2. *Non-Compliance by Economic Sector (ISIC Classification)*

Sector Code	Sector Description	Non-Compliance Rate	Risk Category
R	Arts/Entertainment	45.86%	Critical
G	Trade/Repair	40.51%	High
I	Accommodation	44.33%	Critical
F	Construction	40.56%	High
K	Financial Services	36.42%	Moderate
D	Utilities	32.88%	Low
B	Mining	33.10%	Low

Sectoral highlights:

- Creative industries show highest vulnerability
- Regulated sectors (finance/utilities) perform better
- Construction sector exceeds 40% non-compliance threshold

Geographic Distribution

The geographic location of SAS entities also correlates with compliance behaviour. Coastal provinces like Esmeraldas exhibit consistently high non-compliance rates, likely influenced by limited infrastructure and economic informality. In contrast, provinces such as Azuay show improving compliance trends, potentially due to stronger local entrepreneurial support. The Amazonian region reflects unique barriers, while major economic hubs such as Guayas and Pichincha display moderate but declining compliance levels. These regional disparities are detailed in Table 3.

Table 3. *Provincial Compliance Performance*

Province	Total SAS Entities	Non-Compliance Rate	Compliance Trend
Esmeraldas	350	63.71%	Deteriorating
Pastaza	232	50.86%	Stable
Guayas	15,038	39.17%	Slight decline
Pichincha	17,085	39.45%	Slight decline
Azuay	3,144	33.52%	Improving
Galápagos	371	43.94%	Stable

Geographic patterns:

- Coastal provinces show consistent non-compliance
- Amazonian regions exhibit extreme values
- Andean commercial hubs maintain better compliance

Dissolution Risk Assessment

Persistent non-compliance carries significant legal consequences under Article 59 of the Companies Law, which mandates the dissolution of companies that fail to submit financial statements for three consecutive years. The data reveal that 4.3% of all active SAS entities are already subject to dissolution, while a further 7.5% are at risk if current trends continue. Notably, these risks are concentrated in specific sectors such as Trade and Arts. Table 4 categorizes entities by years of non-compliance, projected dissolution timeline, and sectoral distribution.

Table 4. *Three-Year Non-Compliance Countdown*

Years Non-Compliant	Entities Affected	Projected Dissolution Date	Sector Concentration
3 years (2021-2023)	2,040	Years Non-Compliant	68% Trade/Arts
2 years (2022-2023)	3,540	2025	72% Services
1 year (2023 only)	13,061	Potential 2026	Diverse

Risk analysis:

- 4.3% of SAS population faces imminent dissolution
- Additional 7.5% at high risk for 2025
- Sector-specific vulnerability patterns evident

Conclusions

The findings of this study highlight serious systemic vulnerabilities in Ecuador's Simplified Stock Corporation (SAS) regime, particularly with regard to financial reporting compliance. With a national non-compliance rate of 39.48% and more than 2,000 entities facing imminent dissolution under Article 59 of the Companies Law, the data reveal not only a widespread administrative gap but also a looming threat to business continuity in the country.

The analysis shows that compliance deterioration is most acute among newly incorporated firms, creative industries, and provinces with weaker infrastructure or informal economies. These patterns suggest that current legal and institutional frameworks may be insufficient to support the operational needs of SAS entities—especially micro and small enterprises with limited accounting capacity.

In light of these challenges, public policy should prioritize:

- Strengthening regulatory education for new entrepreneurs at the point of incorporation.
- Providing targeted technical assistance in high-risk sectors and provinces.
- Implementing progressive penalties or grace periods for new firms instead of immediate dissolution threats.

Furthermore, the SCVS could consider the use of early-warning systems based on compliance trends to proactively prevent dissolution, along with simplified reporting tools for micro-enterprises.

Future research could deepen the analysis by incorporating qualitative insights from affected

entrepreneurs, or by exploring the long-term impacts of forced dissolution on regional economies. Ensuring the sustainability of the SAS model will require a coordinated strategy involving regulatory flexibility, capacity building, and better digital infrastructure for reporting.

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Monitoring Tool to Prevent Data Leaks in a RESTful API

René Edmundo Cuevas-Valencia
Universidad Autónoma de Guerrero (México), reneecuevas@uagro.mx, https://orcid.org/0000-0001-9528-7603
Carlos Álvarez Carmona
Universidad Autónoma de Guerrero (México), 15217613@uagro.mx, https://orcid.org/0009-0004-7013-6752

Introduction

In the current cybersecurity landscape, RESTful APIs represent a critical vector of exposure to attacks. Data leaks are becoming increasingly common. The need for tools that provide visibility and early warning of suspicious behavior is becoming a priority. Despite these know risks, there is a lack of specific tools that can monitor API activity in real time, identify misuse or generate preventive alerts without resorting to complex or expensive commercial solutions.

In response to this issue, a security-oriented monitoring tool was developed, capable of recording, analyzing and alerting interactions that represent a potential risk to data integrity. This article focuses on describing the results of its implementation, functionality, and the installation and integration process in real projects. This work contributes to the field of cybersecurity engineering and secure software development by proposing a practical, reproducible, and open-source solution that improves API governance through active observability mechanisms.

Main Features of the Tool

The tool was designed under a data-driven approach (Sydle, 2023) and the prototyping model (ISO Standards, 2022). The main functionalities include:

Comprehensive Activity Logging

Captures all successful requests including HTTP method, endpoint, headers, token, IP address, parameters, and response code. Captures errors with error code, error description, HTTP method, endpoint, headers, token, IP address, parameters, and response code.

Anomaly Detection

The tool currently detects API4:2023 – Unrestricted Resource Consumption risk, one of the OWASP Top 10 API Security Risks (OWASP, 2023), through configurable request and error limits by token, user, and IP address. When these thresholds are exceeded, the system automatically generates an alert based on suspicious patterns.

Statistics and Visualization

The tool displays metrics such as the most accessed endpoint, user with more errors, most active IP, error frequency by HTTP method, number of alerts generated, among others. Below, Figure 1 shows the view of the metrics from the tool.

Figure 1. Tool view.



Flexible Configuration

All tool rules can be configured in the .env file. Below, Table 1 shows the variables and their data types for the tool configuration:

Table 1. *Configuration variables for the tool.*

Variable	Data type
USER_ERRORS_LIMIT	Integer
USER_REQUEST_LIMIT	Integer
TOKEN_ERRORS_LIMIT	Integer
TOKEN_REQUEST_LIMIT	Integer
MONITOR_ALERT	Boolean
USER_BETWEEN_ALERT	Integer
USE_RESOURCE	Boolean

Installation and Deployment

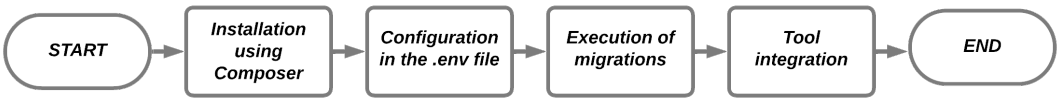
The tool was published as a package in Packagist (Packagist, 2025) and is installed through Composer by executing the command: *composer require bycarmona141/king-monitor.*

Integration Steps

The first step in integration of the tool is the publication of the configuration file using the command: *php artisan vendor:publish --tag=king-monitor-config* or configuring the variables in the .env file (see Table 1). The second step is execution of migrations using the command: *php artisan migrate*.

The third step is tool integration; the line is added to the controller after generating the response. Below, Figure 2 shows the flowchart for installing and deploying the tool.

Figure 2. Tool installation and integration flowchart.



The monitoring tool was developed using Laravel 10 framework, PHP 8.2 language and MySQL 8.0 database. The prototyping development model was selected, allowing iterative versions with continuous feedback. The development environment included the Snyk security tool for static vulnerability analysis (Snyk, 2025) and KNIME for statistical validation of logs (KNIME, 2025).

The tool was designed as a package installable through Composer and published in Packagist, which allows its integration through standard commands in existing Laravel projects. Based on the elements of an API (Álvarez *et al.*, 2024) a series of migrations were development for the automatic creation of the following specialized tables: king_monitors, which records successful; king_monitor_errors, which records errors generated by the API; king_monitor_alerts, which recprds alerts generated by the tool; king_monitor_user_exceededs, which records users, which records users, IPs addresses, and tokens that exceeded the thresholds configured in the tool; and king_monitor_averages, which provides a historical summary of usage and errors by period. These tables are in accordance with Cuevas *et al*. (2024).

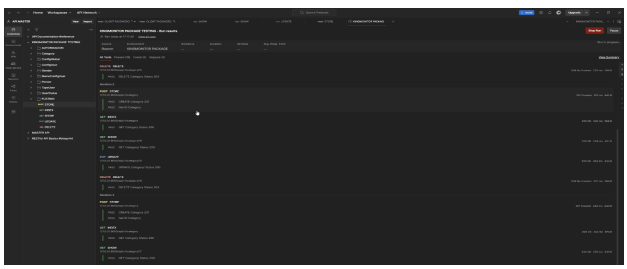
For functional validation, a case study of a RESTful API for the academic management of students was designed using JSON Web Tokens authentication (Auth0, 2025; Jones *et al.*, 2015). Functional tests (Schmitt, 2024; Katalon, 2025) were conducted to validate correct request registration, error tracking, and alert activation.

The tool was validated through a student management API as part of a case study. Functional tests were performed to verify the behavior of the tool.

Functional Tests

Automated tests were executed, correctly recording all API requests, both legitimate and malicious. Every interaction was traced, allowing for a thorough audit of the traffic. Alerts were successfully generated upon detecting anomalous activity. Below, Figure 3 shows the automated tests.

Figure 3. Automated tests.

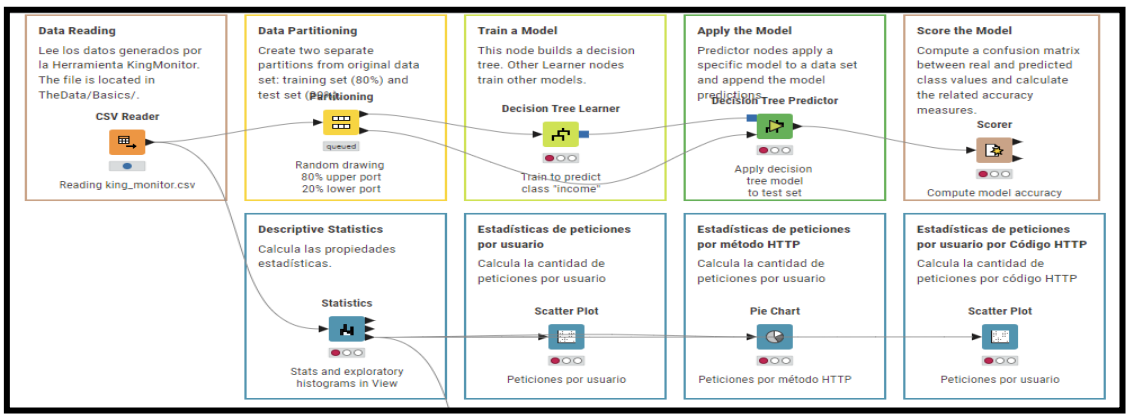


Statistical Validation

The KNIME tool was used to verify that the statistical queries delivered by the tool were

correct, confirming the integrity of the data processing and the accuracy of the calculations. Below, Figure 4 shows the analysis with KNIME.

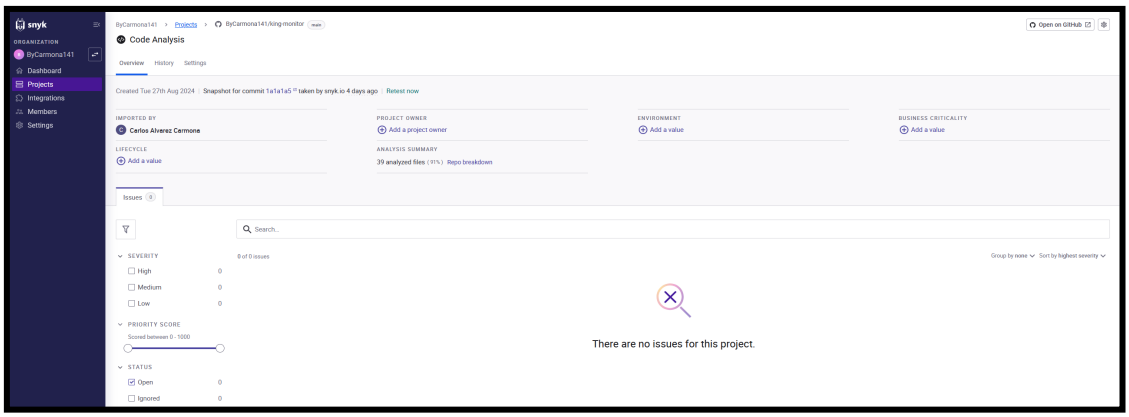
Figure 4. Analysis with KNIME.



Code Security Analysis

With the SNYK platform, vulnerabilities in project dependencies were identified. Below, Figure 5 shows the analysis with Snyk.

Figure 5. Code analysis with Snyk.



Conclusions

The monitoring tools stands out for not requiring external infrastructure, being free and open source, integrating directly into the project's source code and providing security-oriented observability of the RESTful API.

The tool is presented as an effective, extensible and accessible alternative to improve security RESTful APIs. It allows early detection of potential leaks, automatic generation of alerts, detailed visualization of API usage in general or by specific users, identification of malicious users or with anomalous usage. The tool enriches the security approach with its alerts showing tips and ways to prevent the associated risk according to cybersecurity experts.

Validation in a real case confirms its practical usefulness, contributing not only to operational safety, but also to the control and governance of the API in production.

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A model of roboethics at the micro, meso and macro levels: AI under scrutiny

Jorge Alberto Álvarez-Díaz
Universidad Autónoma Metropolitana Unidad Xochimilco (México), jalvarez@correo.xoc.uam.mx,
https://orcid.org/0000-0001-9935-8632

Introduction

Robotics posed enormous challenges and transformations in the way humans interact with technology and its products, as well as in the structure of social, political and economic systems. The development of artificial intelligence (AI) and its integration into autonomous systems in areas such as health, education, law, security, etc., introduce more than techno-scientific advances, as it opens up new philosophical questions, especially ethical ones, and legal ones, especially in the form of enforceable regulation. These advances require a regulatory framework (I understand regulation in a broad sense, first ethical and then legal). This framework must be broad enough to understand and guide actions in these fields without affecting human dignity, fundamental rights and social justice.

Roboethics will be understood as an applied ethics that analyses the interaction between human beings and artificial agents, such as robots, algorithms, autonomous systems, etc. Like other applied ethics, its development is complex because it is not a mere application of existing ethical theories to new problems, nor does it generate novel ethics from particular challenges. Current efforts to regulate AI in general and its application in artificial agents have encountered obstacles such as the lack of consensus (ethical and legal), resistance from some sectors, complexity in the understanding of the problem by some segments of society, weakness of existing frameworks (ethical and legal), etc.

Based on the approach of bioethics that can understand at three levels (micro, meso and macro; Alvarez Diaz, 2016), this chapter aims to apply that structure to the problem addressed by roboethics in relation to artificial intelligence. Under this perspective it is possible to analyse the phenomenon at three levels: microbioethical, mesobioethical and macrobioethical.

Conceptual foundations

In this proposal it is necessary to retake the definition of roboethics (with scope and limits), the idea of technological normativity, and the proposal of the three levels of bioethics.

Roboethics: ethics of human-machine interactions

Gianmarco Veruggio coined the term "roboethics" in 2002, defining it as an interdisciplinary field that analyses the ethical, legal and social aspects related to the use of robots and autonomous intelligent systems (Veruggio & Operto, 2008). The ethics of artificial intelligence usually focuses on abstract computational problems (such as the design of artificial agents, the way they make decisions, etc.), while roboethics focuses on the concrete relationships between humans and technologies with technological autonomy.

Roboethics considers that robots are not merely neutral entities: they are artefacts that have functional agency, a technological autonomy that allows them to interact with humans and their environment; this can influence human decision making by health, education, law professionals, etc. This raises specific ethical issues: should a system with functional agencies be allowed to make decisions that replace personal decisions and/or affect human life? Can it be guaranteed that algorithms respect human dignity and fundamental rights? In case of an erroneous decision made by an algorithm, who would be liable?

Technological normativity: from principles to operational rules

Probably the greatest challenge facing the ethical regulation of AI is the generation of sufficiently sound and well-argued ethical principles that can be translated into operational legislation and policies. For the OECD (2910), this sequence "from words to deeds" implies redefining and extending values such as respect, justice, transparency, etc., into specific and clear mechanisms that can be implemented and evaluated. In the face of technological development, documents have appeared that propose different frameworks: the OECD Principles on AI (2019), the European Union's legislative proposal on reliable AI (2021), the UNESCO Declaration on the Ethics of AI (2021), etc. According to the European Commission's High-Level Expert Group on AI (2019) several of these frameworks share many common principles, which have the difficulty of lacking clear mechanisms for their implementation and subsequent evaluation, limiting their applicability. Technological normativity involves a close link between ethics, law and policy.

The three levels of bioethics

In order to deal with the complexities that apply to ethics as a multi-, inter- and transdisciplinary field, it is useful to distinguish three levels of ethical analysis:

a) Microbioethics, which concerns human-agent interactions and problems such as autonomy, confidentiality, privacy, informed consent, fair algorithms, etc.;

b) Mesobioethics, which analyses institutions and social structures, and therefore examines professional practices, institutional regulatory frameworks, social responsibility of companies and institutions, technological codes of conduct, etc.

c) Macrobioethics, which refers to problems at the global or worldwide level, and therefore focuses on global regulatory frameworks (essentially ethical recommendations), international governance, technological justice, geopolitical tensions arising from the development and control of these new technologies, etc.

This three-level proposal can be applied to roboethics, understanding that the levels are articulated among themselves through deliberative processes so that the macro level has an impact on the meso and the meso on the micro; at the same time, the problems at the micro level transcend the meso and macro levels. This vision would allow an ethical orientation for unstoppable technological innovation, the generation of ethical and legal regulations, the design of public policies, etc. In the face of growing global uncertainty, this theoretical approach makes it possible to consider, on the one hand, proposing universalizable ethical frameworks that respect the cultural plurality of nations and each individual.

The adaptation of this tripartite structure to roboethics is justified by the analogous complexity of ethical challenges in both fields: while bioethics deals with life-sustaining technologies and human biological integrity, roboethics confronts technologies that increasingly mediate human agency, autonomy, and social structures. Although the ontological status of artificial agents differs fundamentally from that of biological life, the relational, institutional, and systemic dimensions of ethical decision-making exhibit comparable layers of interdependence. Therefore, the micro-meso-macro framework provides a scalable and context-sensitive analytical tool for examining the multifaceted impacts of AI, from individual interactions to global governance

Microbioethical level: interactions between people and intelligent systems

Microbioethics addresses the ethical problems of the relationship between human beings and autonomous artificial intelligence systems, especially in spaces where decision making affects the life, security, integrity or rights of people. It includes privacy and confidentiality of data, autonomy of the subject, informed consent, fairness in the results of automated systems, personal safety in the face of automaton machines, responsibility for interactions that have systems that are very difficult to explain or frankly opaque, etc. Part of the complexity includes recognizing that AI is not a purely passive tool, since the capacity they have for massive data management, pattern recognition, the possibility of making decisions, etc., which leads to the understanding that there is a new class of artificial agents that has functional agency or technological autonomy (not agency or moral autonomy). This requires new forms of ethical evaluation.

Autonomy and consent in the algorithmic era

The classic principle of personal autonomy in the face of artificial agents reminds us that autonomy is progressive: it is not the same for an adolescent to interact with an artificial agent as it is for an adult to do so. Furthermore, the relational quality of autonomy is emphasized, with special importance being given to algorithmic opacity (the "black box"), the asymmetry in the information available to developers and users of these technologies, as well as the nature of the decisions made by artificial agents (not always explicit). UNESCO (2021) indicates that informed consent will be valid in these environments when users properly understand the functioning, risks and likely consequences of artificial agents. In practice, unfortunately, these conditions are not always met, either due to insufficient or misunderstood information and structural coercion (automated services, digital platforms, etc.). There is therefore a need to generate informed consent mechanisms that are adapted to the specific characteristics of users (cognitive, affective, technical, etc.) so that they can truly be said to have information that allows them to make a decision in the face of an artificial agent (Floridi et al., 2018).

Privacy and personal data

AI models have been known to be fed with personal data on many occasions obtained from users without full knowledge or understanding of the situation. Using technologies based on facial recognition, behavioural tracking, biometric data, etc., it poses significant risks to the right to privacy, recognized as a fundamental human right by the United Nations (2021). This problem is aggravated when states or private entities use algorithms to influence people and their behaviour, such as in predictive surveillance systems, segmentation of services, etc. The risk of suffering algorithmic discrimination or being victims of abusive use of sensitive personal information leads to the need to establish ethical and legal limits regarding access, storage, processing and use of personal data. According to the European Union's AI Act (2021), AI systems that affect fundamental rights must be subject to rigorous scrutiny.

Transparency, bias and fairness in automated decision making

It has already been well demonstrated that AI systems are not neutral: they have been trained with data, so it is that data that structures the basis for everything else. Studies show that there are algorithmic biases that disproportionately affect ethnic minorities, women, people with disabilities, people in poverty, etc. (Eubanks, 2018; Buolamwini & Gebru, 2018). This translates

into decisions that are not fair when accessing health services, bank loans, justice procurement systems, employment, etc. The poor applicability of decision making in many systems means that people end up not understanding why they were denied some rights or received a certain classification. For this reason, the OECD (2019) has emphasized that there are indispensable ethical conditions that seek to protect users from potentially discriminatory or arbitrary decisions, such as explainability, auditability and traceability.

Personal safety and autonomy of physical systems

The interaction of autonomous robots or artificial agents with technological autonomy (autonomous vehicles, drones, medical devices, etc.) with humans can have direct physical consequences. For example, an autonomous vehicle, who should it prioritize to protect the owner or a vulnerable person? In another example, a medical device, should it obey the person or the medical indication (think, for example, suicidal ideation or eating disorders)? Some of these issues have already been raised by computational ethics (Goodall, 2014). The microbioethical dimension lies in the direct relationship between the person and the machine: how to guarantee the person that he/she has the capacity to control the machine without posing a risk to his/her safety.

Mesobioethical level: institutional frameworks and professional responsibility

At this level, ethical decision making is not shown in unipersonal decisions, but has to do with collective actors: the scientific and technological community, companies, regulatory agencies, state agencies, etc. Moreover, it responds to the growing need to generate ethical frameworks that are operational and propose normative principles applicable in the practice of institutions, as pointed out by the OECD (2019) and the High Level Expert Group on AI of the European Commission (2019). Ethics cannot rest exclusively on individual goodwill, or on declarations of good intentions that do not end up being operationalized, but must be institutionalized in auditable procedures, protocols and responsibilities.

Technology ethics codes and good practice guides

In recent years, various organizations have generated and published codes of ethics for responsible AI development. Varying in scope and depth, they agree on some principles (several already of great tradition in bioethics): justice, nonmaleficence, sustainability, accountability, privacy, transparency, etc. (Jobin, Ienca & Vayena, 2019). However, these codes are usually adopted and followed voluntarily, so their practical application is very limited. They repeatedly serve as instruments to legitimize the institution and not so much as normative guidance. Therefore, there is an increasing emphasis on adopting normative mechanisms that are institutionalized, such as acting as ethics committees, performing audits, generating ethically informed technical standards that can lead to external certifications, etc. (Floridi et al., 2018). An example is the European Union, where the combination of ethical guidelines with the generation of mechanisms for supervision of compliance has been proposed, especially for "high-risk" systems (European Commission, 2021). This type of articulation between ethics and law makes it possible to guarantee greater institutional responsibility.

Ethics committees and institutional oversight mechanisms

Bioethics committees are already widespread in the world of biomedicine and have spread to other fields. This has inspired the proposal of ethics committees to evaluate the ethical, legal and social impact of technologies before their implementation (Morley et al., 2020). These committees could work at a local (companies), sectoral (health, financial institutions), regional or national level (as part of state regulatory mechanisms). Their functions may include risk assessment, monitoring of compliance with standards, transparency, explainability, evaluation of the impact of the evaluated technology on different vulnerable groups, recommendations for adjustments, mitigation policies, etc. UNESCO (2021) has recommended that these committees should be independent, multidisciplinary and representative (points with tradition in bioethics committees), and that the legitimacy of their recommendations should be based on solid argumentation resulting from deliberative processes, access to information and accountability mechanisms.

Organizational responsibility and accountability

Probably, the pivotal challenge in mesobioethics is the assignment of responsibility, particularly in contexts of algorithmic complexity. AI systems are often designed by many people, developed by as many, and used by many more. This enormous fragmentation leads to the "dilution of responsibility" (Matthias, 2004), where it becomes increasingly complex to determine who will be responsible for a biased, harmful or opaque decision. This is why the notion of organizational responsibility is particularly relevant at this level. Companies that design or employ AI systems must have clear and explicit internal and external accountability mechanisms that are auditable. This should include evidence of documentation used in the design process, criteria used when modelling algorithms, traceability of data used, accessibility to complain mechanisms, and the existence of protocols for improvement and correction, as well as remediation in case of damage. The OECD (2019) and the European Commission (2021) agree that regulatory frameworks should ensure that the life cycle of AIs can be fully and transparently traced, clearly assigning responsibilities to developers, intermediaries, and end users.

Ethics training in data science and AI engineering

For ethics to be consolidated at the institutional level, a change is needed in the training of professionals who develop technologies. Training in engineering and data science tends to be oriented towards the development of scientific and technical knowledge and skills, with little or no attention to ethical, legal or political reflections. Recently, some universities have considered integrating ethics training into their programs (IEEE, 2021). The objective should be to train professionals with a profile that includes recognizing problems and proposing ethical, legal and political solutions.

Macrobioethics level: global governance and technological justice

Unlike the previous levels, macrobioethics analyses the complex systemic, civilizational and geopolitical implications of AI, so it must consider the impact of its application on the global distribution of power, the impact on human rights, global justice, planetary sustainability, etc. This level understands that technologies are developed in economic, cultural and regulatory

contexts with enormous inequalities, affecting vulnerable groups, segments of society and even the state's capacity to participate in the generation and regulation of these technologies.

Technological asymmetries and global power gaps

The current development of AI is concentrated in a few geopolitical regions, mainly North America, East Asia and Western Europe. This distribution increases the structural asymmetries between the countries that produce and those that consume technology, which deepens historical inequalities. UNESCO (2021) has warned that if this reality is not addressed, AI can aggravate technology dependence, digital exclusion and epistemic marginalization of the Global South. To this complexity must be added that the universalizable ethical frameworks proposed at the global level face very diverse national legislation, generating a "geopolitics of algorithms" (Cath, 2018). Due to the above, it is essential that global technological powers be redistributed, allowing equitable participation in the governance of AI by ensuring equitable access to the benefits it may bring.

International governance and multilateral regulatory regimes

Among the most relevant supranational proposals are: a) The UNESCO Recommendation on the Ethics of Artificial Intelligence (2021), unanimously adopted by 193 Member States; it is based on four values underpinning ten principles, proposing eleven areas of action; it includes monitoring and evaluation mechanisms. b) The OECD's Principles on AI (2019), which establish criteria for the design of systems that are robust, transparent and accountable; recommends international multisectoral cooperation between the scientific community, civil society, companies and governments. c) The European Union's AI Act (2021), a pioneer in promoting risk-based regulation, establishing specific requirements for what they call high-impact systems, including the requirement for transparency, traceability, the need for human intervention and the protection of fundamental rights. These efforts are important; however, they still have major challenges such as a lack of binding mechanisms, business resistance, regulatory fragmentation, and a very limited representation of the global south in international deliberative processes.

Global algorithmic justice and human rights

The macrobiotic level must have a transversal axis of global algorithmic justice, understood as an obligation to ensure that the development, implementation and use of AI contribute to equity, non-discrimination and the effective exercise of human rights in all regions of the world (Crawford, 2021). This implies recognizing and confronting the differential impacts on historically vulnerable populations, such as women, indigenous populations, people with disabilities, migrants, people living in poverty, etc. It also requires that ethical principles be constructed through processes of intercultural deliberation with multiple worldviews, philosophical traditions and legal systems, preventing them from being imposed univocally from the centres of technological, economic and political power. This justice must also protect the digital commons (data, infrastructure, knowledge, algorithms) from misappropriation by companies that monopolize them, guaranteeing open access, digital sovereignty and socially responsible use of these resources.

Sustainability, intergenerational ethics and civilizational challenges

Macrobioethics is also concerned with ecological sustainability and thus with intergenerational responsibility. Although AI can naively be seen as an immaterial technology, the truth is that its development and use require physical infrastructure with enormous energy consumption, exploitation of strategic minerals (mainly rare earths), generation of technological waste, as well as an impressive water footprint (Vinuesa et al., 2020). Roboethics must incorporate an ethic that questions the neoliberal economic and political model, which has been extractivist and developmentalist; on the contrary, a sustainable model oriented to the common good must be promoted. This vision recognizes that the existence of future generations cannot be dissociated from the care of the biosphere and respect for the limits imposed by the only known habitable planet. This makes us rethink AI not only as a scientific, technical or economic problem: it is a challenge of today's civilization that must lead us to rethink the goals of progress, the models of economic development, and the relations of human beings considering themselves as part of ecosystems.

Proposal: Towards normative roboethics

Given the reality shown, it is clear that approaches based on individual decisions, optional regulatory frameworks, or any other reductionist way of approaching the problem are not sufficient. An approach that articulates operational ethical principles at the micro, meso and macro levels is needed to guide the design, development, application and regulation of AI in democratic, equitable, sustainable and globalized societies. This normative roboethics articulated in levels is not presented as a single, closed solution, but as a theoretical and methodological structure to guide deliberation on the responsible development of AI. Therefore, the recommendations would be:

A) Promote an international regulation on AI that integrates ethical principles defined by UNESCO, the OECD, the EU and supranational bodies that integrate the global south with binding mechanisms for compliance.

B) Establish national plans for the ethical governance of AI, with the participation of academia, civil society, productive sectors, vulnerable groups, etc.

C) Create and strengthen education programs on ethics in general, and on applied ethics in particular, incorporating content on algorithmic justice, technological sustainability, digital rights, etc., into professional training.

D) Encourage the creation of national and international observatories on the application of AI, periodically evaluating its social, cultural, economic and ecological impacts, at least with special attention to the monitoring of vulnerable groups.

E) Encourage responsible innovation models that prioritize inclusion, pluralism, open access, transparency, intergovernmental cooperation and ecological sustainability.

AI and its application in autonomous systems are part of the ethical challenges of the 21st century. How the world deals with these challenges will determine how humans relate to machines: humans in a digital world. There is an urgent need for ethics to put at the centre applicable regulations that place respect for human dignity and rights with respect to ecosystems at the centre. The future of humanity is at stake.

Conclusions

In light of the accelerating integration of artificial intelligence into diverse social, legal, and professional contexts, this study has argued for a multi-level normative framework for roboethics, inspired by bioethical theory. By articulating the micro, meso, and macro dimensions of ethical analysis, the proposed model offers a coherent structure to guide the responsible development, governance, and application of AI. This approach emphasizes the primacy of human dignity, the safeguarding of fundamental rights, and the pursuit of technological justice and sustainability on a global scale. Such a framework not only advances the academic discourse on ethics and AI but also provides actionable principles for policymakers, institutions, and practitioners facing the complex ethical challenges of our time.

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Characterization of the sectoral informality rate in Mexico

Mario Aceves Mejía
Benemérita Universidad Autónoma de Puebla (México), mario.aceves@correo.buap.mx
Rufina Georgina Hernández Contreras
Benemérita Universidad Autónoma de Puebla (México), rufina.hernandez@correo.buap.mx

Introduction

Labor informality is a persistent phenomenon and a structural challenge for economic and social development. This article aims to analyze labor informality in Mexico from a sectoral perspective, examining its behavior across federal entities using microdata from the National Survey of Occupation and Employment (ENOE in Spanish) of the National Institute of Statistics, Geography and Informatics (INEGI in Spanish) between 2018 and 2024.

Our hypothesis is the existence of subsistence economic sectors, which posits a positive relationship between productive complexity and employment levels. It is considered that sustained growth should foster the creation of formal jobs, which would *ipso facto* reduce informality and mitigate social deficiencies such as the lack of social security.

The methodology is structured in three fundamental sections. Firstly, the theoretical framework underlying the research is established by analyzing the principles of subsistence economies to understand the persistence of informality. Secondly, a set of stylized facts about the informality rate in Mexico are presented, using descriptive statistics to illustrate its national evolution and geographical distribution between 2018 and 2024, covering data that will illustrate the dynamics of the 11 sectors considered for the estimation of employment surveys in Mexico.

It was corroborated that federal entities with lower economic growth levels present the highest levels of labor informality, such as the states of Chiapas, Oaxaca, and Guerrero. Additionally, the highest rates of labor informality participation are found in commerce and agriculture. In turn, those states that have amplified their economic growth levels have managed to reduce their labor informality rates, thus proving the existence of subsistence economies among the federal entities in Mexico.

Theoretical framework, subsistence economies, and informality

In the context of developing economies, labor informality represents a phenomenon of deep–rooted persistence and a structural challenge that hinders economic development. Consequently, this theoretical framework addresses the characterization of sectoral informality starting from the fundamental postulates of development economics, particularly Arthur Lewis's (1954) theory of subsistence sectors.

The International Labour Organization (ILO) has stressed that labor informality, in both formal and informal businesses, is intrinsically linked to precariousness and the absence of decent work, which is characterized by fair income, job security, and social protection. Similarly, the 17th International Conference of Labour Statisticians defined informal employment as that which, by law or practice, is not subject to national labor legislation or labor benefits and social protection (Busso et al, 2012; Freislebem et al, 2023; Hussmanns, 2004; Zambrano, 2024).

Thus, the theoretical foundation is based on the hypothesis of the existence of subsistence economic sectors, as conceptualized by Arthur Lewis (1954). Lewis describes a dual economy where a modern capitalist sector, with high productivity and capital accumulation, coexists with a subsistence sector, characterized by low productivity. In this view, the lack of physical capital in the capitalist sector and the prevalence of subsistence technologies in the informal sector result in labor remuneration in the latter sector that may be higher than what would be obtained by employing the entire workforce in the modern sector with a limited capital stock. This perspective implies that informality is an inherent consequence of underdevelopment, and

not its cause per se (Braithwaite, 2019; Ghany, 2019; Lewis, 1954).

Lewis's conceptualization of subsistence sectors is complemented by the Harris and Todaro (1970) models on rural–urban migration and unemployment, to understand the persistence of informality in the Latin American region, where large segments of the workforce are inserted into low–productivity activities, without social protection and with insufficient remuneration.

Informality is traditionally concentrated in sectors such as agriculture and commerce, where small productive units, self–employment, and family businesses predominate. These sectors, often characterized by low technology and limited access to credit, are prone to the generation of informal jobs. Furthermore, Tokman (1986, 1992) has documented the evolution of the informal sector in countries like Peru, Colombia, and Brazil, showing that the expansion of these sectors in the absence of robust formal sector growth tends to perpetuate informality.

Urbanization and demographic growth have also contributed to the expansion of informality in services and retail trade in cities, where a significant portion of the population finds sustenance in precarious activities. Additionally, informality in Latin America is understood not only as an employment issue but also as a problem of exit and exclusion from social protection systems and growth opportunities (Perry et al, 2007).

Missaglia and Vaggi (2025) delve into the notion of dualism in economies, emphasizing that small–scale production (informality) can coexist with capitalist production in a permanent and structural way, especially in the economies on the periphery of the global capitalist system. This perspective highlights the complexity of the phenomenon and the need to consider informality not just as a transitional stage, but as a deep–rooted characteristic of the social and economic fabric.

Labor informality is not a homogeneous phenomenon but presents particularities that vary depending on macroeconomic and microeconomic factors. The probability of entering informality is influenced by elements such as educational level, geographical location, and wage income. The study by Guillermo and Estrada (2025) provides a crucial perspective by estimating and analyzing the influence of the intergenerational transmission of informality on working conditions, wage differentials between the formal and informal sectors, and individual characteristics such as educational level, occupational category, sex, and age, in the probability of being an informal worker. Similarly, in emerging economies, workers may opt for informality if the net wage compensation is perceived as more favorable compared to the costs and benefits of formality.

The quality of employment in the informal sector is also a fundamental aspect to consider. Carriel Bustamante et al (2024), in their regional analysis in Ecuador using the Employment Quality Index, reveal a negative impact of informality on employment quality, suggesting the need for political interventions focused on the structural problems of the labor market.

Therefore, it is possible to consider that the sectoral characterization of informality is essential to understand where and how this phenomenon manifests. Productive sectors do not operate in isolation, and each presents conditions and structures that can promote or mitigate informality.

Research Development. Empirical Evidence of Labor Informality in Mexico (2018–2025)

Having addressed some causal foundations of labor informality, as well as its relationship with Lewis's (1954) model on the dynamics of subsistence economies, it is necessary to corroborate various theoretical propositions that underlie the understanding of this phenomenon in Mexico. The following section presents statistics on the evolution of the labor informality rate by federal entity in Mexico between the first quarter of 2018 and the first quarter of 2025.

Table 1 shows that the federal entities with the highest average informality rates in the sample period are Oaxaca (80.81%), Guerrero (78.55%), and Chiapas (76.19%). The high informality in these regions can be attributed to the predominance of sectors that operate with low levels of productivity and capitalization by nature, and that do not provide the benefits associated with formal employment.

In contrast, entities such as Coahuila de Zaragoza (35.10%), Nuevo León (36.65%), and Chihuahua (36.04%) consistently exhibit the lowest average informality rates (see Table 1). The lower informality in these regions suggests that a higher level of economic growth is associated with an increase in the creation of decent jobs through the reduction of the labor informality rate, which is consistent with Lewis's (1954) theory. This validates the existence of subsistence economies among federal entities in Mexico, where informality manifests more as an inherent consequence of underdevelopment than as its cause per se.

The variability of informality rates, quantified by the standard deviation, also offers relevant perspectives. Entities like Nayarit (2.90%) and Chiapas (2.23%) show a greater dispersion in their rates, which could indicate a vulnerability to economic shocks or a limited capacity to stabilize their labor markets. This instability is intrinsic to subsistence sectors, which by nature, are usually more susceptible to fluctuations.

Regarding the evolution of informality between the first quarter of 2018 and the first quarter of 2025, most federal entities achieved a reduction in their rate, notably Aguascalientes (from 43.87% to 41.07%) and Mexico City (from 48.23% to 44.82%). However, a subset of entities failed to reduce their informality rate during the period, including Morelos (from 65.95% to 66.25%), San Luis Potosí (from 54.27% to 55.43%), Tabasco (from 65.86% to 66.99%), Tamaulipas (from 44.91% to 45.73%), and Veracruz (from 69.49% to 70.30%). This reflects that informality in some entities is not a transitory stage, but rather a deep–rooted characteristic as suggested by perspectives of persistent dualism.

Table 1. *Statistics on labor informality rates by federal entity. Mexico, First Quarter 2018 to First Quarter 2025*

Entity	Min (%)	Max (%)	Mean(%)	Std. Dev. (%)	Initial (%)	Final (%)

Aguascalientes	38.74	43.87	41.04	1.24	43.87	41.07
Baja California	35.86	40.39	37.94	1.18	39.86	37.30
Baja California Sur	35.64	41.10	37.83	1.07	41.10	37.66
Campeche	57.36	64.87	61.78	1.73	62.50	60.77
Chiapas	71.36	80.58	76.19	2.23	80.58	76.32
Chihuahua	33.72	38.20	36.04	1.09	34.96	33.72
Ciudad de México	44.26	50.26	47.33	1.70	48.23	44.82
Coahuila de Zaragoza	33.25	36.76	35.10	0.99	35.63	33.25
Colima	46.16	52.27	49.48	1.70	50.85	48.05
Durango	49.49	53.50	51.52	1.08	53.33	50.28
Guanajuato	53.26	57.13	54.92	1.06	55.21	55.06
Guerrero	76.08	80.10	78.55	1.00	77.34	76.92
Hidalgo	70.88	76.02	72.95	1.40	75.08	71.86
Jalisco	46.62	50.63	48.30	1.22	50.63	47.05
México	53.35	58.68	56.48	1.67	57.95	54.24
Michoacán de Ocampo	64.87	70.91	67.70	1.50	70.91	68.14
Morelos	63.82	69.26	66.54	1.35	65.95	66.25
Nayarit	52.23	65.51	60.38	2.90	64.30	59.26
Nuevo León	32.68	38.89	36.65	1.35	36.28	32.68
Oaxaca	76.67	82.47	80.81	1.48	81.09	76.67
Puebla	69.84	74.40	71.76	1.37	72.62	72.24
Querétaro	39.62	46.95	42.88	1.56	44.43	40.31
Quintana Roo	42.96	50.49	46.58	1.60	45.67	42.96
San Luis Potosí	51.76	58.73	55.08	1.48	54.27	55.43
Sinaloa	45.28	52.36	48.74	1.74	50.70	46.82
Sonora	40.34	45.05	42.35	1.36	43.97	40.97
Tabasco	62.50	67.94	64.86	1.69	65.86	66.99
Tamaulipas	41.39	46.30	44.52	1.18	44.91	45.73
Tlaxcala	68.90	73.53	71.47	1.26	71.70	71.10
Veracruz de Ignacio de la Llave	66.52	72.05	68.81	1.39	69.49	70.30
Yucatán	56.49	63.02	60.59	1.77	62.83	57.28
Zacatecas	58.17	63.00	61.42	1.22	60.43	58.17

Elaboration based on ENOE (2018–2025).

Empirical Evidence of Sectoral Labor Informality and its Relationship with Subsistence Sectors in Mexico (2018–2025)

The analysis of the economic duality of subsistence economies requires delving deeper into the sectoral dynamics of the informality rate. In this regard, Table 2 presents the average labor informality rates for the period 2018–2025, covering the 11 economic sectors that constitute the National Survey of Occupation and Employment. The data confirms that informality is not

distributed homogeneously across the productive structure but is concentrated in those sectors that, by their nature, lend themselves to operation with low levels of capitalization and formalization.

Specifically, Table 2 shows decisively that the agriculture, livestock, forestry, hunting, and fishing sectors, as well as the Construction sector, systematically present the highest informality rates across federal entities. For example, in Chiapas, informality in agriculture is at 94.61%, while in construction it reaches 94.88%. Similarly high figures are recorded in Guerrero and Oaxaca, where informality in the agricultural sector exceeds 95%. This preponderance of informality in these sectors is a clear manifestation of the subsistence sectors hypothesis, which posits the existence of a vast reservoir of labor in low–productivity activities with little need for capital accumulation. The ease of entry and the often–temporary nature of activities in these areas facilitate the persistence of employment without the benefits or social protection inherent to the formal sector.

Likewise, the Commerce and Restaurants and accommodation services sectors also exhibit considerably high informality rates in most entities. Entities such as Chiapas, Guerrero, and Oaxaca show rates in commerce above 70%, and in restaurants and accommodation services, above 80%. These sectors, similar to the primary sectors, often operate with a small–scale and self–employment scheme, which makes them important recipients of the labor force that is not absorbed by the formal capitalist sector. The high informality in these branches of activity can largely be attributed to the predominance of low–productivity and low–capitalization economic units, which not only fail to provide the benefits associated with formal employment but also operate in an environment with lower entry barriers and less strict regulations.

Table 2. *Statistics of the 10 federal entities with the highest labor informality rates by productive sector. Mexico, First Quarter 2018 to First Quarter 2025*

Entity	Agriculture	Extractive industry	Manufacturing industry	Construction	Commerce	Restaurants and accommodation services	Transportation, communications, mail,	Professional, financial, and corporate services	Social services	Miscellaneous services	Government and international
Oaxaca	95.80	50.94	89.24	93.31	74.91	89.98	80.74	48.18	19.56	92.42	30.06
Tlaxcala	95.37	38.40	58.00	92.35	75.82	90.30	65.74	49.93	24.77	90.13	52.87
Guerrero	94.90	22.58	92.77	92.17	75.98	73.50	84.71	44.04	18.19	92.00	29.38
México	94.31	18.92	38.29	81.02	67.24	80.27	56.48	29.65	18.72	85.60	5.51
Hidalgo	93.37	32.98	62.33	89.61	73.25	89.44	60.64	48.70	24.32	90.37	43.13
Chiapas	93.17	29.29	71.63	90.73	68.83	83.39	74.51	45.09	21.78	89.34	34.16

Puebla	91.83	34.89	59.81	90.67	71.53	82.57	61.50	43.37	25.33	87.28	35.89
Quintana Roo	91.40	8.82	69.32	65.33	44.43	30.10	54.95	31.63	19.77	72.50	15.13
Veracruz	89.82	8.73	61.45	84.15	63.09	84.46	58.64	39.62	18.32	84.83	22.01
Campeche	89.49	4.83	68.29	65.64	58.89	76.91	55.01	37.30	19.74	84.18	21.86

Elaboration based on ENOE (2018–2025).

At the opposite end of the spectrum, the sectors with the lowest incidence of informality are, as expected, Government and international organizations, the Extractive and electricity industry, and Professional, financial, and corporate services. Informality rates in the governmental sector, for example, rarely exceed 15% in most entities, reaching as low as 4.54% in Nuevo León. This intrinsic formality is explained by the highly regulated nature, intensive in specialized human capital, and sometimes in physical capital, of these activities, which places them firmly within the formal and capitalist sector of the economy. The contrast between these sectors and the predominantly informal ones underscores the structural dualism of the labor market, where a small–scale and informal economy permanently coexists with capitalist production.

The sectorally disaggregated information also allows for the identification of the federal entities that present the most severe levels of informality, and their relationship with Lewis's approach to subsistence sectors. The five federal entities that consistently exhibit the most severe informality rate levels in the sectors with the highest prevalence are: Chiapas, Guerrero, Oaxaca, Puebla, and Veracruz de Ignacio de la Llave.

In these entities, informality rates in agriculture, construction, commerce, and accommodation services are systematically among the highest nationally. For example, Chiapas records 94.61% in agriculture and 94.88% in construction, while Oaxaca shows 95.80% in agriculture and 89.98% in restaurants and accommodation services. This persistence of extremely high rates in multiple productive sectors robustly corroborates the preeminence of a vast subsistence sector, as conceptualized by Lewis. In these economies, the accumulation of capital in the modern sector is insufficient to absorb the entire labor force available in the traditional low–productivity sector. The high informality in these regions can largely be attributed to the predominance of subsistence economic sectors which, by their nature, operate with low levels of productivity and capitalization, and do not provide the benefits associated with formal employment. Likewise, the probability of entering informality in these entities may be accentuated by microeconomic factors, such as lower human capital accumulation that limits access to formal jobs, or the absence of effective incentives for formalization. The labor surplus, characterized by an abundance that exceeds the absorption capacity of the formal sector, finds refuge in informal activities that act as a kind of social buffer, albeit with scarce opportunities for upward mobility and without access to social protection. This reinforces the thesis that informality in these economies is not a transitory phase of development, but a deep–seated characteristic of the social and economic fabric, a manifestation of persistent underdevelopment.

A comprehensive discussion of the empirical findings reveals that labor informality in Mexico is not merely a uniform challenge but rather a complex phenomenon deeply intertwined with

regional economic disparities and sectoral structures, thereby supporting our hypothesis regarding the existence of subsistence economic sectors. Specifically, the persistent high informality rates in states with lower economic growth (like Chiapas, Oaxaca, and Guerrero) starkly contrast with the formalization trends observed in more economically dynamic regions, highlighting a clear positive relationship between productive complexity, sustained growth, and reduced informality. Furthermore, the disproportionate concentration of informal employment within the commerce and agriculture sectors underscores the critical need for differentiated policy interventions that acknowledge these specific sectorial realities. This robust evidence reinforces the notion that greater economic growth is indeed a driver for formalization, aligning with Lewis's theory, and necessitates targeted strategies to promote productivity, human capital investment, and access to social security to effectively address informality across Mexico's diverse productive and geographical segments.

Conclusions

Particularly in Mexico, the dynamics of informality show a close relationship with the concentration of the population in different productive sectors. The first conclusion is that the persistence of high informality rates in states such as Chiapas, Oaxaca, and Guerrero, in contrast to entities such as Baja California, Coahuila, or Nuevo León, is a reflection of regional disparities in economic development and productive structure. In second place, it is concluded that the commerce and agriculture sectors, as noted, concentrate a significant proportion of the country's labor informality. This suggests that public policies should be differentiated and focused on those sectors and regions where informality is most prevalent, promoting formalization through incentives for productivity, investment in human capital, and access to social security. A third important conclusion is that empirical evidence supports the notion that greater economic growth reduces the informality rate, consistent with Lewis's theory. However, the magnitude of this effect and its variability between sectors and regions warrant a more detailed analysis, which justifies the relevance of a sectoral characterization of informality in Mexico. Finally, it is concluded that understanding the factors driving informality in each sector, from agriculture and construction to services, is crucial for designing decent work promotion policies that are truly effective and adapted to the specific realities of each productive and geographical segment in Mexico.

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Digital Media, Social Media, Political Communication, and Visual Culture

The Role of Social Media in Fundraising: A Strategic Approach for Non-Profit Organisations

Lira Isis Valencia Quecano
Corporación Universitaria de Asturias (Colombia), *lira.valencia@asturias.edu.co*, *https://orcid.org/0000-0002-3501-4774*
Camilo Mauricio Grillo Torres
Corporación Universitaria de Asturias (Colombia), *camilo.grillo@asturias.edu.co*, *https://orcid.org/0000-0002-6636-1082*

Introduction

Over the past decade, social media has revolutionised various social domains, assuming a prominent role in the fundraising and crowdfunding efforts of non-profit organisations. It has significantly broadened the possibilities of reaching diverse global audiences and, consequently, increased the amount of funds raised (Sinha et al., 2025; Hesse & Boenigk, 2024; Cai & Polzin, 2025). In this regard, digital communication tools such as the internet and digital platforms have become essential instruments for communication and emotional engagement (Ng, 2024; Bak et al., 2024; Bhati & McDonnell, 2020). This environment enables organisations to maintain almost continuous contact with their key audiences at reduced costs, thus optimising their fundraising strategies (Cho et al., 2024; Bargoni et al., 2023). Within this framework, social media is not only seen as a communication medium but also as a mechanism for building communities, fostering interaction, and mobilising donors (Liu et al., 2021; Zhou & Ye, 2019). From this perspective, social media can be effective when it is integrated into strategic planning and accompanied by a deep understanding of the factors that influence follower engagement (Yang & Lee, 2019; Hong et al., 2018). Campaigns based on emotional content and ongoing interaction have demonstrated their ability to generate greater donor engagement and loyalty (Rashid et al., 2021; Battisti et al., 2021). Considering recent developments in research related to social media implementation, its use in educational settings has become increasingly noteworthy (Montilla & Valencia, 2021; Valencia et al., 2020), particularly regarding its application as a didactic strategy to strengthen competencies (Valencia & Guzmán, 2020) and the challenges associated with its implementation (Valencia, 2020). Similarly, its use as a marketing and advertising strategy has been explored in the cultural (Grillo et al., 2023) and governmental (Guzmán et al., 2020) sectors.

Concerning the use of social media in fundraising contexts within non-profit organisations, there is an increasing interest in implementing digital communication strategies to support such entities. This includes best practices (Sinha et al., 2025), the use of influencers (Cho et al., 2024), and their connection with social marketing (Ng, 2024; Stötzer & Kaltenbrunner, 2024). However, there are relatively few studies that focus on identifying the specific characteristics of social media that enhance fundraising effectiveness in these institutions.

Given this scenario, the present study seeks to analyse the role of social media in fundraising strategies, identify key success factors, and explore best practices implemented through a scoping review. To this end, the following guiding research questions were proposed:

RQ2: What key features of social media facilitate the achievement of fundraising goals in non-profit organisations?

RQ3: What are the best practices for managing social media as part of a strategic communication plan for fundraising in non-profit organisations?

To answer these questions, the study is structured into four sections. The first provides the theoretical framework and contextualisation of social media and fundraising in non-profit entities. The second outlines the methodology used to achieve the study's objectives. The third presents the main findings, and the fourth discusses the most significant results and the conclusions derived from the research.

Fundraising in Non-Profit Organisations

According to Hesse and Boenigk (2024), fundraising is a crucial activity for non-profit organisations and entities within the social sector, as it enables them to ensure the financial sustainability of their projects and programmes. Werke and Bogale (2024) indicate that fundraising encompasses a set of practices and strategies aimed at securing financial resources through various sources, including individual donations, grants, events, and targeted campaigns. These activities involve not only the procurement of funds but also the development of long-term relationships with donors, which is essential for continued support and the expansion of the organisation's mission. In this context, fundraising in non-profit organisations often focuses on understanding donor motivations and designing campaigns that are perceived as socially relevant and credible. Elvira-Lorilla et al. (2024) emphasise that the management of inter-organisational relationships and effective communication are crucial aspects for enhancing efficiency in resource acquisition. Likewise, elements such as transparency and clarity in presenting project objectives and outcomes strengthen donor trust and enhance their willingness to contribute financially.

Additionally, the fundraising process in these organisations includes the importance of collaboration and networking, which, according to Kusimba (2024), can facilitate the identification of potential donors and improve fundraising strategies. The use of digital tools and crowdfunding platforms has significantly transformed this landscape, allowing for greater social participation and access to a broader base of potential funders. Thus, authors such as Cárdenas ét al., (2025) and Sinha et al. (2025) and Suh and Hijal-Moghrabi (2025) agree that persuasive communication, the appropriate presentation of projects, and the mobilisation of social networks are key elements for successful fundraising campaigns.

Social Media as a Tool for Fundraising

Social media plays a significant role in the fundraising process, particularly in the context of the social sector and non-profit organisations. This is mainly due to its ability to facilitate communication, broaden reach, and foster interaction among stakeholders. As noted by Wymer and Čačija (2023), social media enables the creation of virtual support communities that function as platforms for dissemination and mobilisation, allowing messages to reach a broad, diverse, and global audience. This extensive interconnection reduces geographical and temporal barriers, making it possible to secure resources in real time and to keep donors informed about project developments. Moreover, scholars such as Quevedo and Lee (2023) emphasise that social media is not only helpful in promoting campaigns but also for enhancing trust and organisational credibility through the consistent and transparent sharing of information regarding achievements and needs. Interaction on these platforms encourages active public engagement, which may be understood as a network effect. This implies that as

more individuals contribute and share, the likelihood of attracting additional donors increases, thus boosting crowdfunding and other collective fundraising efforts (Ogwu et al., 2022).

Furthermore, the effective use of social media requires a well-designed communication strategy that highlights social impact and establishes emotional connections with potential donors. In this respect, and as stated by Rashid et al. (2021) and Burtch et al. (2021), the appropriate delivery of messages, the frequency of updates, and the creation of accessible, credible, and transparent content are essential for mobilising and sustaining the support community (Ogwu et al., 2022; Burtch et al., 2021).

The PRISMA (2020) model was employed to conduct a systematic literature review. The search was carried out in the academic database Scopus using keywords such as "fundraising", "social media", and "nonprofit organisations". A total of 234 documents were initially identified, excluding conference papers, book chapters, and literary reviews. After filtering, 172 research articles remained. An initial screening of titles and abstracts was conducted to discard those that did not address fundraising and social media in non-profit contexts.

Based on this process, 40 articles that met the criteria of relevance and quality were selected. These articles were analysed in depth to identify common patterns and key factors influencing the success of social media-based fundraising strategies. Following this, a content analysis matrix was designed and developed. This matrix recorded data such as titles, authors, publication years, journal names, and analytical categories. The categories included key social media factors that facilitate fundraising goals and best practices in implementing social media as part of a strategic communication approach for fundraising.

Key Social Media Factors Facilitating Fundraising Goals in Non-Profit Organisations

The key social media factors that facilitate fundraising objectives are grounded in several dimensions that enhance the effectiveness of fundraising campaigns. Firstly, the capacity for information access and dissemination is fundamental, as it enables broader and faster communication of projects, eliminating geographical and social asymmetries, and reducing search and transaction costs. This, in turn, encourages greater donor participation (Sinha et al., 2025; Sihi, 2018; Anoraga, 2023; Chen et al., 2022). Similarly, the presence of an active virtual community, formed through proactive groups and followers, helps build a strong and cohesive network that fosters both financial and emotional resource mobilisation (Hesse & Boenigk, 2025; Hong et al., 2018; Liu et al., 2021; Bin-Nashwan & Al-Daihani, 2020). Furthermore, the importance of maintaining constant and transparent communication is emphasised, as regular updates on contributions can generate an imitation effect, encouraging further donations and strengthening project credibility (Suh & Hijal-Moghrabi, 2025; Ogwu et al., 2022; Battisti et al., 2021; Nageswarakurukkal et al., 2020).

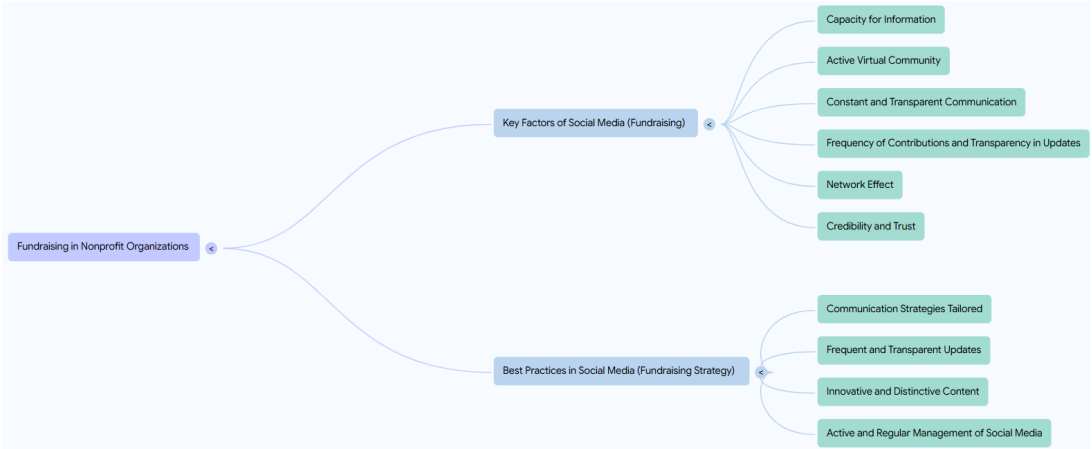
Likewise, the frequency of contributions and transparency in updates are considered critical variables for the success of crowdfunding campaigns, as they maintain donor interest and trust (Cai & Polzin, 2025; Cho et al., 2024; Wymer & Čačija, 2023; Li et al., 2022). Additionally, the network effect derived from the strategic use of social media amplifies message dissemination and extends project reach to broader and more diverse audiences. From this perspective, interconnection, interaction, and user collaboration facilitate a dynamic exchange of data, opinions, and support, increasing the likelihood of achieving financial goals (Bak et al., 2024;

Hung et al., 2019; Bhati & McDonnell, 2020). Lastly, credibility and trust are reinforced by the organisation's presence across various communication platforms—such as social networks, blogs, and instant messaging channels—where storytelling, periodic updates, and public recognition of contributions enhance the perceived reliability of the project, positively influencing donation decisions (Ng, 2024; Quevedo & Lee, 2023; Iniesta et al., 2022; Kim & Reeck, 2019) (see Figure 1).

Best Practices in the Implementation of Social Media as Part of a Strategic Communication Approach for Fundraising in Non-Profit Organisations

When addressing best practices in the implementation of social media within the context of fundraising, one key element is the development of communication strategies tailored to different audiences and channels, using a multi-stakeholder approach that enables message segmentation according to the specific needs and interests of each group. This ensures that communication is more effective and persuasive (Shi et al., 2025; Dehdashti et al., 2022; Bernardino et al., 2021; Zhou & Ye, 2019). Another essential practice is maintaining a frequent and transparent updating of project developments and contributions. The frequency of updates has a direct impact on the success of the campaign, as it encourages new contributions and builds trust by sharing progress and results (Stötzer & Kaltenbrunner, 2024; Shaker & Nelson, 2022; Rashid et al., 2021; Yang & Lee, 2019). In addition, creating innovative and distinctive content—such as audiovisuals, articles, and news updates—is considered a best practice that helps capture attention and sustain interest. The use of diverse formats and both internal and external communication channels enhances the reach of the message and strengthens the digital presence of the project, facilitating emotional engagement with followers and potential contributors (Werke & Bogale, 2024; Bargoni et al., 2023; Ferrari et al., 2022; Burtch et al., 2021). A final practice worth highlighting is the active and regular management of social media through coordinated and planned campaigns, allowing for public interaction and engagement. This creates a network effect that boosts the dissemination and support of the project (Elvira-Lorilla et al., 2024; Morvinski et al., 2022). Interaction with followers, providing timely responses to their questions and comments, and promoting participatory campaigns are practices that strengthen ties with the community and consolidate digital communication as an integral component of the fundraising strategy (Kusimba, 2024; Levenshus et al., 2019) (see Figure 1).

Figure 1. Key factors of social media that facilitate fundraising purposes and best practices for implementing social media as part of fundraising in nonprofit organisations.



Conclusions

In conclusion, the strategic use of social media is identified as a fundamental factor for the success of fundraising campaigns in non-profit organisations, as it allows for the expansion of reach and the enhancement of the effectiveness of communication efforts. It is recognised that an appropriate communication strategy—which incorporates segmentation, a focus on social impact, and the use of multiple channels, both traditional and digital—enables the attraction and retention of potential donors (Bernardino et al., 2021). Likewise, elements such as transparency and the constant updating of information reinforce public trust and promote stronger engagement with social initiatives. Similarly, the frequency, credibility, and transparency of communication foster trust and consolidate relationships with followers, facilitating the development of an active and engaged community (Stötzer & Kaltenbrunner, 2024).

In addition, the creation of innovative content and the effective use of diverse formats are highlighted as best practices that help capture attention and increase project visibility. Finally, as future lines of research, it is suggested that applied studies analyse the relationship between digital communication strategies and their impact on fundraising performance in non-profit organisations within the social sector. It is also recommended to explore the role of emerging technologies and digital platforms in the innovation of social fundraising campaigns.

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From Fame to Founder: Social Media as a Driver of Celebrity Entrepreneurship and Brand Extension

Dyan Haydée Rico Hernández
Universidad Popular Autónoma del Estado de Puebla, UPAEP (México); Universidad Panamericana (México)
dyanhaydee.rico@upaep.edu.mx, https://orcid.org/0009-0002-2614-6684

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Introduction

In 2020, the COVID-19 pandemic led to a global quarantine, forcing people to find new ways to interact, entertain themselves, stay healthy, and purchase products. As a result, the use of digital platforms experienced a significant boom, becoming essential for meeting needs without leaving home (Masciantonio et al., 2021; Paraschiv et al., 2022). According to the 2021 Global Digital Report, while internet users increased by 7.3% year-over-year, social media users increased by 13%. This translates to more than 1.3 million new daily users. Of these, 17.6% stated that they followed celebrities (Kemp, 2021) and were therefore exposed to the products and services they advertised. The rise of social media has changed the way public figures engage with their followers by enabling direct communication, fostering enduring relationships, and offering opportunities to monetize their visibility.

In this context, this study argues that social media functions as a strategic bridge that transforms celebrity visibility into entrepreneurial capital. Celebrities are now co-creators or founders of the brand itself, rather than just endorsing a product with their image (Hackley & Hackley, 2015). By utilizing their celebrity capital to launch and promote their own businesses while taking advantage of the reach and closeness that social media offers them, they are going from endorsing to entrepreneurship. This shift reflects a broader trend where celebrity entrepreneurship becomes an extension of the personal brand, strategically communicated through digital platforms.

This study aims to examine the rise of celebrity entrepreneurship through social media, focusing on how celebrities extend their personal brands into business ventures. It focuses on how actors connect their personal values with those of their businesses, using their platforms to tell a consistent story. The cases of Ryan Reynolds and Jennifer Garner are examined in detail to demonstrate how media visibility, authenticity, and consistency support their business endeavors.

Theoretical Framework

Capital is a versatile concept that extends beyond economics to include cultural and social dimensions (Bourdieu, 1986), which are particularly relevant in the context of celebrity influence. Driessens (2013) builds on this concept, arguing that individuals can also possess symbolic, political, and visibility capital. These forms of capital provide celebrities with

resources to undertake projects that improve their earnings and facilitate the extension of their brand.

Building on the concept of capital, celebrities have long been used in marketing strategies to endorse products as it is believed that qualities such as attractiveness, likability, and credibility will carry over to the products, services, or brands associated with their name (Erdogan, 1999). With the advent of the Internet and social media, celebrities found new channels for communication and interaction with their fans and, instead of maintaining a clear divide between personal and business, they now integrate both. They use their digital presence to extend their brand, not only lending their names to products but also launching their own, becoming its spokesperson, content, and symbol, making the most of their celebrity status and their fandom (Duan, 2022; Edeling & Wies, 2024).

In the context of entrepreneurship, start-ups with an engaging origin story tend to garner attention, contributing to their success. Celebrities already have that narrative and a sizeable platform to share it (Lambertson, 2020) through frequent and controlled interactions that convey their entrepreneurial vision and the products stemming from it, which amplifies the brand's reach. These platforms work as symbolic legitimacy spaces where authority, authenticity, and commercial appeal are projected, while also creating a sense of community with and for their followers (Alguezaui & Filieri, 2010; Ellison et al., 2007)

A successful brand extension relies on the perceived fit between the celebrity and the product, as well as the transfer of credibility (Aaker & Keller, 1990). Celebrity ventures gain legitimacy from the public's trust in their values, lifestyle, and expertise. Hunter and Davidson (2007) argue that celebrities communicate more effectively when it comes to their own ventures than when they endorse products, given their level of involvement. With endorsed products, celebrities have low involvement, but with their own products, they embody the brand.

Following the bricolage methodology (Kincheloe, 2001), the first step in assessing the value of social networks for celebrity entrepreneurs was to select which platforms would be analyzed. When data were collected for this study, the most used social networks, according to the Global Digital Report 2023 were taken as a starting point (Kemp, 2023). Only three platforms are included in the analysis: Facebook, Instagram, and TikTok.

Subsequently, a list of actors who have founded their own companies was compiled to focus the study on celebrity entrepreneurs. To delimit the profile of the study subjects, only international celebrities who primarily gained fame through acting were included.

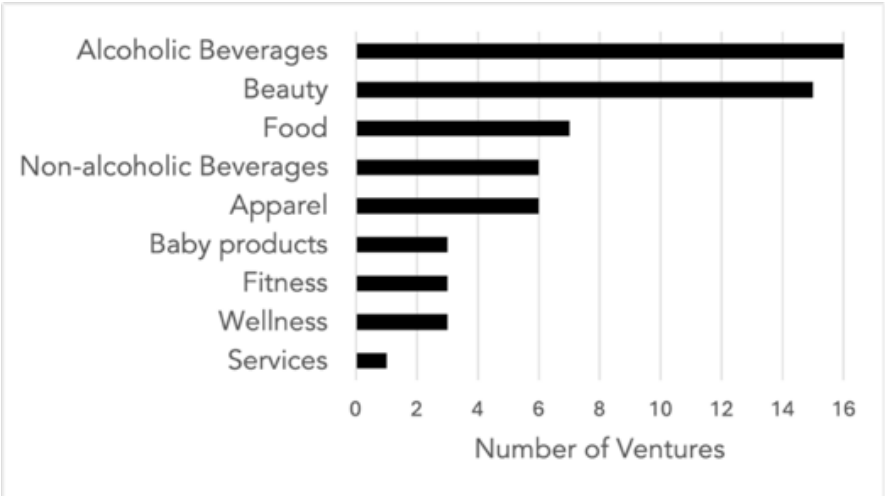
To determine if a consistent presence on social media platforms influences the decision to start a business, a database was created by manually coding public information such as social media activity and metrics as well as business reports. This database includes 43 actors who founded 60 business ventures, recording variables such as the venture's name, industry type, launch year, the celebrity's presence on at least one selected social network before the company launch, and whether the company has active social media accounts. Each business venture was considered as an independent unit of analysis, given that some celebrities have created multiple brands. This was done with the intention of examining whether a consistent presence on social media platforms precedes the decision to start a business, and if such presence works as a transfer from celebrity capital to the "attainment of goals" (Alguezaui & Filieri, 2010), and as a trust-building channel with potential consumers (Ellison et al., 2007).

Finally, two case studies were selected for in-depth qualitative analysis. To guide the selection of the cases, a purposive sampling approach was adopted. The aim was to illustrate celebrity entrepreneurs with visible and strategic use of social media in the promotion of their ventures. The selection criteria included: (a) international recognition in the acting industry, (b) ownership or co-founding of at least one business venture, (c) active presence on Instagram, Facebook or TikTok, and (d) evident integration of their celebrity image within the business communication strategy. Among the potential candidates, Ryan Reynolds and Jennifer Garner stood out for their consistent digital activity, digital communication strategies and the prominence of their personal involvement in business messaging.

The analytical tools included content analysis of social media posts, classified into five dimensions (personal, professional, business, philanthropic, and endorsement-related) to align with the research objective and evaluate how involved they are in the communication strategy of their ventures. Additionally, the companies' social media accounts were analyzed to assess the strategic use of celebrity image in corporate branding.

The analysis of the ventures launched by the celebrities in the sample shows that most business initiatives are oriented to industries associated with lifestyles and personal image. These are aspirational attributes that a celebrity can represent effectively. The leading sectors (Figure 1) are alcoholic beverages and beauty (27% and 25% respectively), followed by food (12%), non-alcoholic beverages and apparel (10% each), baby products, fitness and wellness (5% each), and services (1%). This pattern suggests that celebrities are more likely to engage in industries they presumably know well and where their personal brand can be effectively aligned with the product offered, enhancing credibility (Hunter & Davidsson, 2007). In these sectors, authenticity and proximity are key so the personal profile of the celebrities serves as an extension of the brand's communication strategy, acting as a tool for narrative and engagement (Khamis et al., 2017).

Figure 1. Celebrity Ventures by Industry



Among the 60 ventures, 98.3% have an official social media presence. In 91.6% of cases, the celebrity appears directly in the company's social media content. Additionally, also in 91.6% of cases, the celebrity already had at least one active social media account before launching their business. Most notably, 86.6% of celebrities actively promote their ventures on their personal social media accounts. And a total of 48 ventures (80%) satisfy all four criteria simultaneously

(Table 1). This indicates that digital presence is not only an antecedent but potentially a motivator and facilitator for entrepreneurial activity. Platforms like Instagram and Facebook provide a ready-made audience, enhancing the digital presence that motivates and facilitates entrepreneurial activity. It also shows that these entrepreneurs intentionally bridge their personal identity and business communication to offer consistency in tone, values and messaging to strengthen perceived authenticity and trust in the brand.

Table 1. *Summary of Social Media Presence and Celebrity Involvement*

Indicator	Value (n=60)
Celebrity had social media before company launch	55 (91.6%)
Celebrity promotes company on personal account	52 (86.6%)
Companies with social media presence	59 (98.3%)
Celebrity appears on company social media	55 (91.6%)
Cases that meet all four conditions	48 (80.0%)

Having established an overview of celebrity ventures, the research delves into a more detailed examination of Jennifer Garner and Ryan Reynolds. These two cases were selected not only for their industry relevance and popularity, but also because they represent two different approaches to celebrity entrepreneurship. Reynolds exemplifies a high frequency, humor-driven, cross-brand promotional model, while Garner embodies a values and family-oriented strategy. Their differences in tone and content volume offer comparative insights into how make the most of celebrity capital through digital platforms.

The qualitative component begins with a basic content analysis of both actors' Instagram profiles from account creation to November 7, 2023. A simple frequency report reveals how much space is dedicated to business-related content. Posts from the defined one-year period were then categorized into the previously described dimensions.

Jennifer Garner is active on all three social media platforms covered by this study. She joined Facebook in July 2010, Instagram in August 2017, and TikTok in September 2021. As of November 7, 2023, she had amassed 8.4 million, 14.7 million and 4.2 million followers, respectively. Her first post about Once Upon a Farm came just 12 days after creating her Instagram account. She cultivates a clean and family-oriented image with a tone that is emotionally resonant and aligned with values of health, care and transparency, matching her personal brand with her business persona (Aaker & Keller, 1990). Her company posts often show her wearing farm-appropriate clothing and referring to herself as "Farmer Jen" (Garner, n.d.). Her business-related content is moderate and stylized, using hashtags and themes aligned with her personal brand and identity. During the analyzed period, 60% of her posts were personal, 23% related to her acting career, and only 11% to her entrepreneurial venture. Posts related to philanthropy or brand endorsements accounted for less than 1% of her total content. Her Instagram presence has earned her four nominations and two Webby Awards, one in the Social/Celebrity Fan category in 2021 and one in the Social/Food and Drink category in 2022 (*The Webby Awards*, s/f).

Ryan Reynolds, on the other hand, demonstrates a more intensive and integrated communication strategy with his five brands. He uses humor and storytelling aligned with his on-screen persona to promote his brands. He blurs the lines between personal and promotional content, often using self-deprecating humor and familiar narrative formats to

present his brands as both accessible and irreverent as he seems to be, reinforcing an authentic self-branding (Khamis et al., 2017). He joined Facebook and Instagram in May 2015 and by November 7, 2023 he had 21 million and 50.2 million followers respectively. He also joined TikTok in June 2021—the same day the platform announced it would sponsor Wrexham AFC, the football team he and actor Rob McElhenney purchased in 2020 and by November 7, 2023 had accumulated 22.5 million followers. Reynolds reinforces the communication of his businesses by vertically integrating them into his personal social media strategy to extend their reach (Dan, 2021), so his identity as actor, entrepreneur, and storyteller are inseparable, each reinforcing the other to build consumer trust. About 22% of Reynolds' Instagram posts since joining the platform until November 7, 2023, are related to his businesses and he practices cross-promotion between his brands (Reynolds, n.d.). His narrative is characterized by a proprietary tone ("as owner of" or "as co-chairman"). Even McElhenney acknowledged the value of Reynolds' digital presence to Wrexham's success: "So much of the endeavor is based on growing the exposure of the club. I knew having somebody like Ryan was gonna be important because of social media" (Dewey et al., 2022).

The analysis also shows that both, Garner and Reynolds, are featured into their companies' digital communication strategy. Garner appears in at least 5% of Once Upon a Farm's posts, while Reynolds appears in 60% of Maximum Effort's posts, 25% of Mint Mobile posts and for the remaining brands he is present in fewer than 12% of their posts.

Conclusion

These findings reinforce the central thesis of this study: that social media is a crucial component of brand strategy, particularly for celebrities who need a certain level of visibility to maintain their status. This analysis clearly shows that celebrities' presence on social media did not initially stem from their entrepreneurial spirit but rather from their professional acting profiles, as most joined these platforms before launching their businesses. However, the findings of this study reinforce the argument that social media platforms play a critical role in the entrepreneurial turn of celebrities. These findings suggest that social media functions as both a driver and an extension mechanism in the entrepreneurial journey of celebrities. The presence of prior digital engagement in most cases indicates that social media is usually part of the preexisting infrastructure that enables the business launch, rather than being adopted afterward.

Social media is not just a marketing and communication tool; it is also the bridge that helps celebrities transform their fame into entrepreneurial possibilities. It allows them to shape and control brand narratives, develop emotional proximity with their fans, and create businesses that reflect their personal values, interests, and lifestyles, letting their celebrity capital enhance corporate branding (Driessens, 2013; Hunter & Davidsson, 2007).

While the number of business-related posts may seem low in some cases, their impact is significant due to the potential reach and engagement facilitated by social media. With millions of followers, a single post can be as effective as an entire media campaign. Even those celebrities without personal profiles—like George Clooney, Scarlett Johansson, or Robert De Niro—acknowledge the promotional power of social media, allowing their companies to use their image, thereby transferring personal brand credibility to their products. This highlights the blurring of boundaries between personal and commercial discourse, a hallmark of celebrity entrepreneurship. Followers do not merely consume branded messages; they witness a

continuity between the celebrity's values, identity and business offering, which cultivates emotional closeness and boosts brand trust.

The cases of Garner and Reynolds demonstrate that when celebrities present coherent identities across personal and brand platforms, they strengthen their connection with followers, who become interested parties in ventures they believe in, blending personal meaning with commercial intent. While the results are not statistically generalizable due to potential exclusions, the in-depth focus on two actors provides valuable insight into why social media is an essential tool in celebrity business communication strategies and a foundation for their business ventures. Of course, social media is not the only factor that motivates celebrities to become entrepreneurs. Personal interest, investment diversification, or personal development goals may also drive these decisions. Still, the recent boom in celebrity entrepreneurship—particularly in industries around lifestyle, wellness, and relatability—demonstrates a need for high visual exposure, which social media naturally provides.

In conclusion, this study contributes to the field of strategic communication by offering empirical evidence on how celebrities leverage their celebrity capital and digital presence to build and extend their personal brands into entrepreneurial ventures. Social media is not just a marketing tool; it is the relational infrastructure that enables celebrities to share their own business journeys, connect with their followers, and transform fame into economic gain beyond the entertainment industry and into entrepreneurial success.

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TikTok Use by Third Sector Partners of the Bogotá Food Bank

Daniel Alfredo Ramirez Zarama
Corporación Asturias, Bogotá (Colombia), daniel.ramirez@asturias.edu.co https://orcid.org/0000-0002-6242-0188

Introduction

Over the past decade, digital marketing has transformed organizational communication by positioning social media as essential tools to strengthen bonds between institutions and audiences (Grillo Torres, 2024; Zhang *et al.*, 2023). Among these platforms, TikTok stands out for its innovative micro-video format and its capacity to drive high levels of user engagement, making it a strategic channel for non-governmental organisations (NGOs) seeking to advance their missions and mobilise communities (Hautea *et al.*, 2021; Kaur Gill, 2023).

Within this context, NGOs affiliated with the Bogotá Food Bank face specific challenges in establishing an effective digital presence and promoting active, engaged citizen participation. However, scholarly research on the strategic use of TikTok in such settings remains scarce, especially regarding the influence of posting frequency and content quality on user engagement across digital platforms (Grillo Torres & Vega, 2024; Zhou, 2024).

Prior studies suggest that a consistent and coherent digital content strategy, supported by frequent and authentic posts, can significantly enhance audience engagement and contribute to long-term digital sustainability (Grillo Torres & Moreno López, 2022; Pérez-Seijo *et al.*, 2018). Nevertheless, many NGOs have yet to fully capitalise on the narrative and participatory potential that platforms like TikTok offer.

Against this backdrop, the objective of this study is to examine the impact of content strategies and posting frequency on TikTok in driving user interaction and digital participation, using the NGOs affiliated with the Bogotá Food Bank as a case study. Through this analysis, the study aims to generate insights that inform both theoretical understanding and practical application, providing actionable recommendations for optimising digital communication within the social sector.

Theoretical Foundations and Contextual Background of TikTok Use in Non-Profit Organisations

Social media has profoundly transformed the digital communication strategies of nonprofit organisations (NGOs), enabling them to expand their reach, foster emotional connections, and enhance their public legitimacy. In this context, TikTok has emerged as a high-impact platform, owing to its ability to drive message virality and promote bidirectional engagement through short, dynamic, and highly personalised videos (Rimasari Pramesti, 2021; Santos et al., 2023).

Although TikTok has expanded across educational and commercial sectors, NGOs have yet to embrace the platform widely (Wang et al., 2023). Researchers agree that nonprofit success on TikTok hinges on telling authentic stories, posting regularly, and aligning content with the organization's mission (Barta & Andalibi, 2021; Kemp et al., 2021). Creating emotionally resonant and collaborative content helps audiences connect with social causes and encourages meaningful engagement (Li et al., 2022; Yue et al., 2023)

Empirical studies of successful cases, such as that of the American Red Cross, demonstrate that leveraging live streams, viral challenges, and strategic storytelling significantly increases both reach and engagement (Correll & Buckholtz, 2023; Grillo Torres, 2024). Nevertheless, many NGOs face persistent barriers, including insufficiently trained staff, constrained resources, and the lack of sustainable digital strategies (Nardini et al., 2022).

The literature suggests that the implementation of interactive tools such as thematic hashtags, geolocation features, emojis, and gamification can enhance community participation and strengthen an organisation's digital reputation (Jeon, 2024; Malodia et al., 2024). However, their application in domains related to food security and community development remains underexplored, revealing a notable gap in both theoretical and practical aspects.

Finally, there is a pressing need to evaluate not only immediate audience responses but also the long-term impact of TikTok-driven strategies on community-building, as well as on donor and volunteer retention (Aljarah et al., 2024; Lara Mejía et al., 2022). Longitudinal research and mixed-method approaches are strongly recommended to advance understanding of how content strategies on TikTok can reinforce institutional communication and generate measurable social impact over time (Ozanne & Ozanne, 2021; Risdwiyanto *et al.*, 2023).

This study adopts a quantitative approach to analyse the strategic use of TikTok by foundations affiliated with the Bogotá Food Bank, with the aim of identifying how content strategies and posting frequency influence digital engagement with the audience. A simple random sample of 100 organizations was drawn from a population of 576 active foundations in 2024, using the finite population formula ($Z = 1.96$; $e = 0.09$; $p = 0.5$) and following the methodological guidelines of Das *et al*. (2022) and Hankin *et al*. (2019)

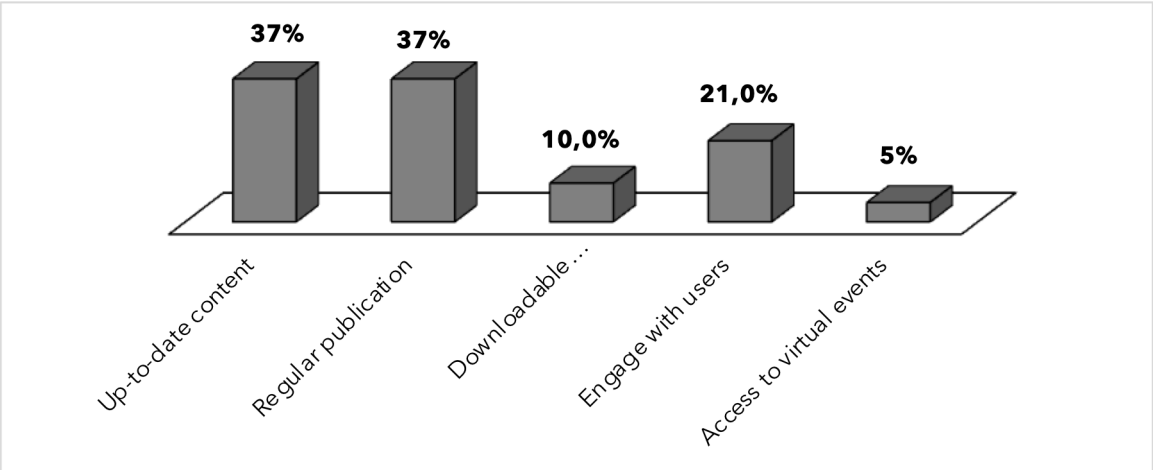
To be included, foundations were required to have an active TikTok account, at least three months of recent activity, and a verifiable affiliation with the Bogotá Food Bank. Inactive accounts or those not representing institutional entities were excluded from the analysis. The data collection process was conducted in two phases: between February and May 2024, official TikTok profiles and institutional websites were reviewed to assess their digital presence; and between July and November, content coding and analysis were carried out using the platforms Fanpage Karma (www.fanpagekarma.com) and the statistical software R.

To this end, a dataset comprising 41 items was developed, organized into three dimensions: Content (9 items), which measures posting frequency, timeliness, and accessibility; Interaction (18 items), which includes variables such as hashtag use, comment responses, and collaboration; and Innovation (14 items), which encompasses aspects such as virtual events, mobile applications, and geolocation. The instrument was designed in accordance with the methodological guidelines of Badell (2015) and Neuendorf (2017), thereby ensuring its content validity and reliability. From an ethical standpoint, the analysis was based exclusively on publicly available data collected for academic purposes, in full compliance with the fundamental principles of digital privacy.

The analysis of institutional TikTok profiles revealed that foundations primarily focus their efforts on two key strategies: delivering updated content (37%) and maintaining a regular posting schedule (37%). Both practices were strongly associated with higher levels of user engagement, notably when posts referenced recent events or ongoing campaigns. Although less frequent (21%), direct user engagement resulted in a notably high volume of comments per post.

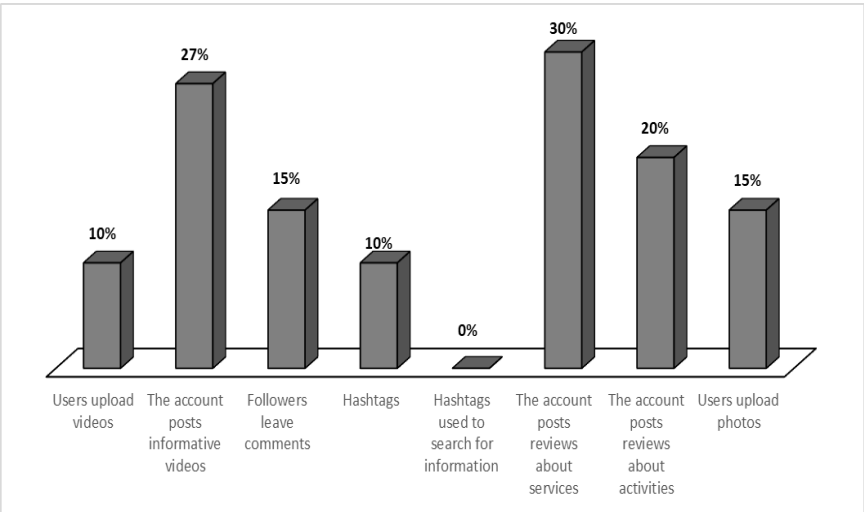
Figure 1 summarises these communicative practices, underscoring a clear preference for the consistent production of updated content over less frequently employed tactics such as offering downloadable materials (10%) or hosting virtual events (5%). These latter approaches elicited limited user interaction, likely due to their lower alignment with TikTok's short-form, immediacy-driven content ecosystem.

Figure 1. Nonprofit Organisations' Communication Strategies on TikTok



Informational content produced by foundations accounted for 27% of the posts, followed by photographs (15%) and user-generated videos (10%). Figure 2 illustrates this distribution, revealing limited use of platform features such as hashtags (10%) and a complete absence of tagging mechanisms to facilitate information retrieval. Public engagement was primarily reflected in comments related to services (30%) and community activities (20%).

Figure 2. Content Types and Audience Engagement Patterns



Overall, the analysis indicates that a moderate posting frequency (three to five times per week) effectively sustains audience interest, though it does not trigger peaks in virality. Moreover, an untapped opportunity was identified in the adoption of innovative tools: none of the

foundations leveraged features such as live events, geolocation, or partnerships with influencers, thereby constraining the potential reach and impact of their messaging.

These findings suggest that, while current strategies foster moderate and consistent engagement, there is significant scope to enhance interaction by utilising the advanced functionalities of social media platforms and adopting a more participatory and dynamic narrative approach.

Analysis of Findings

The findings of this study confirm that both posting frequency and the thematic alignment of content updates on TikTok significantly influence audience engagement levels. Maintaining a consistent posting schedule (3–5 times per week) and aligning content with current events emerged as key drivers of sustained audience interest, consistent with the insights of Carvajal & Barinagarrementeria (2019) and Zhou (2024).

However, the underutilisation of features such as relevant hashtags, live streaming, and interactive tools represents a missed strategic opportunity. While TikTok offers considerable potential for fostering closer and more collaborative interactions, the nonprofit foundations analysed continue to adopt a predominantly informational approach, with limited use of narrative and emotional storytelling techniques. This restricts the viral reach and visibility of their content (Li *et al.*, 2021; Zhang *et al.*, 2023).

Furthermore, the lack of user-generated content and co-created contributions from external collaborators limits the potential to cultivate participatory digital communities, an aspect consistently emphasised in the literature on social engagement (Saikia & Barman, 2023; Shawky *et al.*, 2020; Tricomi *et al.*, 2023).

This analysis thus reveals a gap between current practices and emerging best practices in digital engagement. It suggests that NGOs could benefit substantially from rethinking their digital strategies to incorporate more emotionally resonant narratives, interactive content formats, strategic partnerships with local influencers, and co-created content with community members.

For future research, the adoption of mixed-method approaches is recommended, combining quantitative analysis with qualitative methods such as in-depth interviews, narrative analysis, and digital ethnography. This would provide richer insights into the motivations driving user engagement. Furthermore, longitudinal studies examining the evolution and long-term sustainability of digital engagement strategies would be highly valuable.

Conclusions

This study provides empirical evidence that a coherent and consistent digital strategy on TikTok, characterised by frequent posting and regularly updated content, significantly fosters audience engagement within nonprofit organisations.

In the case of foundations affiliated with the Bogotá Food Bank, communication efforts centred on current events and were implemented on a weekly schedule, achieving stable levels of audience interaction.

Nevertheless, the limited adoption of interactive and innovative features — such as live events, geolocation tools, and collaborations with content creators — constrained the potential for wider content dissemination and viral diffusion. These findings underscore the importance of incorporating more creative, collaborative, and emotionally engaging narrative strategies.

From an academic standpoint, this study provides empirical evidence of TikTok's use in the social sector a relatively unexplored area and proposes new research avenues focused on mixed methods, participatory dynamics, and digital sustainability.

For practitioners, the study provides actionable insights for optimising social media presence, guiding organisations to align their institutional objectives with the evolving expectations and behaviours of their digital communities.

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Long-form livestream influencers. A qualitative analysis of the five most popular Mexican Twitch channels from an affordances perspective

Eduardo Portas Ruiz
Universidad Anáhuac México (México), eduardo.portas@anahuac.mx, https://orcid.org/0000-0001-9117-0061
Luis Felipe Ramírez Alvarado
Universidad Anáhuac México (México), luis.ramirez@anahuac.mx, https://orcid.org/0000-0001-7350-5825

Introduction

Twitch.tv is a popular digital platform that specializes in lengthy video game livestreams and hosts important Spanish-speaking influencers, including some young Mexican streamers that have garnered large followings within the platform thanks in large part to the entertainment value they bring to their transmissions. Yet despite this fact, this group has rarely been studied. The platform itself ranks as the 30th most visited site worldwide (similarweb, 2025) and has about 2.5 million concurrent viewers, on average, at any given time (Twitch, nd). Although impressive, that statistic sits below the peak number in 2021, where it averaged 2.78 million concurrent viewers (TwitchTracker, 2025a). Users spend about 95 minutes on the platform per day and weekends tend to be the most active days on the platform (Doherty, 2024). Two-thirds of its users are younger than 35 years of age and are predominantly male (Iqbal, 2025).

Spanish as the second most used language on Twitch

After English, the second most used language on Twitch is Spanish (TwitchTracker, 2025b). Some of the streamers with the largest number of followers on the platform are Spanish-speaking influencers, consequently, academic research has been published on the subject. One analysis focused on the particularities of Spanish-speaking influencers stated the platform has outgrown its initial goal limited almost exclusively to video game livestreams and has entered its second phase of development wherein content has become very diverse (Gamir-Ríos *et al.*, 2024). Another recent analysis of more than 1,600,000 messages written on the chats of six of the biggest Spanish-speaking channels found that affectivity is key in the streamer-chatter/viewer relationship, and that this interaction is strongly mediated by the monetization options of the platform (Prummer-Arabaolaza *et al.*, 2024). On this same subject, after interviewing a group of Colombian viewers of the platform and a successful local *twitcher*, another author concluded that closeness, genuine interactions and slang play a pivotal role in the differentiation of Twitch as a livestream service against other media, coining it "the GenZ television" (Jiménez-Prado, 2024). The habits of viewers connected to Spanish-speaking streams indicate that the top 100 content producers—that is, less than 1% of the total number of Spanish-speaking streamers—concentrate 76% of the audience that watches the broadcasts in this language and that the highest number of viewers of that particular language connect around 22:00 in Europe, overlapping watchers from that continent and the Americas (Padilla & Navarro, 2022). In summary, academic research about Spanish-speaking channels and audiences on Twitch is very diverse but only a few studies have been published on the practices of Twitch streamers from South American countries (Navarrete, 2024).

Mexican academic interest in Twitch. A gap in the literature.

Although academic research on Twitch in Mexico remains limited (Aguirre *et al.*, 2024; Ceballos-Medina, 2024), broader studies on youth and digital media provide relevant insights into how these platforms shape cultural identity. For instance, research with adolescents in Guerrero reveals that digital tools support the negotiation of hybrid identities, where local and global influences intersect (Avendaño Porras & Correal Cuervo, 2024). Similarly, in the Latin American context, social media are seen as active spaces for cultural production, where young people articulate and transform their identities through digital participation (Nenzen, 2025). This regional perspective helps contextualize the significance of Twitch as a platform for youth identity expression in Mexico.

Theoretical background and our main objective with this study

The theory of affordances was proposed by Gibson in the late 1970s in the context of living beings and their environments. For an organism, the affordances of the environment are what it offers, provides or furnishes, "either for good or ill" (Gibson, 1979, p. 127). The author adds that these characteristics are measured in relation to the living being and are unique to it; therefore, they are not abstract properties. So, if a niche relates to how an environment is used or occupied, then a niche is a set of affordances that offer various possibilities for action to the living beings in that environment. More recently, other scholars have expanded affordance theory to digital technology. Hutchby (2001) argued that affordances frame, but do not determine, the possibilities of action a user can have in relation to an object. Hence, technological artifacts shape and are shaped by the interactions humans have with them, where the constraints of each technological affordance should be considered to empirically analyze the user's actions. The relevance of the study of affordances, he adds, lies not only in highlighting the advancement of technologically mediated interaction, but also in enhancing our understanding of the nature of human participation in communication settings. More relevant to our study is the work of Faraj & Azad (2012) who propose that a technological affordance is not confined to the artifact itself; rather, it constitutes a multifaceted relational structure that emerges from the mutual interactions between the technology and the actor, always emphasizing the user's specific objectives. Bucher & Helmond (2018) underscore that this multilayered approach allows for better understanding of the possibilities for action within an interface and that it is in this relational interstice that human behaviors should be studied. Evans *et al*. (2017), meanwhile, agree with the multifaceted relational structure aspect of affordances but consider affordances a concept rather than a theory. We posit that the most popular Mexican Twitch streamers take advantage of the key affordances available on Twitch to expand their popularity. In conjunction with their personalities and broadcasting styles, they allow these streamers to thrive in a complex attention-competing niche digital environment. This study aims to identify selected key Twitch affordances used by the most popular Mexican streamers to explore the commonalities within this group and better understand their successful use of the platform.

As a basis for our study, we used the work of Sjöblom *et al*. (2019) which examined the use of different Twitch affordances among the most popular 100 streamers. We selected several affordances from their study and added a new category—Frequency and intensity of use—to strengthen our analysis. Additionally, we included "neon lights" under the audiovisual affordances category. From 15 May 2025 to 10 June 2025 we carefully analyzed each Spanish-

speaking channel listed on TwitchTracker (2025c), focusing on follower counts. We selected the top five Mexican channels with the highest number of followers to obtain our sample (Table 1). During the same period, we observed each selected channel directly on the desktop version of Twitch to identify selected key affordances. Subsequently, from the 25 June 2025 to 01 July 2025 we observed the last ten streams of each channel. For each video, we watched a total of 15 minutes—five minutes at the beginning, middle and end—taking detailed notes to identify relevant phrases related to our list of affordances. A total of 690 minutes (11.5 hours) of video were analyzed Videos of less than 15 minutes in length were watched entirely.

Table 1. *Top ranking Mexican Twitch channels by total number of followers*

Rank	Channel	Followers (in millions)	Active days	Hours streamed	Active days per 7-day week
1	ElMariana	10.45	1,104	4,134	4.1
2	AriGameplays	7.05	1,351	4,548	3
3	rivers_gg	6.64	1,014	3,365	5.4
4	elded	5.67	2,774	16,735	6.2
5	QuackityToo	4.77	337	620	1.5

Source: TwitchTracker, June 10, 2025. Data extracted and prepared by the authors.

Key affordances of the five most popular Mexican Twitch channels

Firstly, frequency and intensity of use affordances were analyzed in each of the five most popular Mexican Twitch channels (Table 2). We propose these affordances because they are easy to detect by users and give relevant information of each streamer directly upon entering the channel. In this aspect, the "Recency of last stream" affordance measured in days allows the viewer to identify the last time the channel made a broadcast, as well as the duration of the stream with the aid of an image thumbnail in the "Video" tab of every Twitch channel. The same can be said of the "Recently streamed categories" affordance, accessed through the "Home" tab, which permits viewers an efficient way to know the thematic novelty of the streamed content by showing five large icons corresponding to these categories which can be related to video games, Just Chatting, IRL (In Real Life), etc.

Table 2. *Frequency and intensity of use affordances of the top-ranking Mexican Twitch channels by total number of followers*

Rank	Channel	Recency of last stream (days)	Recently streamed categories (latest)
1	ElMariana	1	Just Chatting
2	AriGameplays	4	Just Chatting
3	rivers_gg	Same day	Just Chatting
4	elded	Same day	Just Chatting
5	QuackityToo	10	Just Chatting

Source: Twitch.tv, June 10, 2025. Data extracted and prepared by the authors.

As observed in Table 2, the top ranked influencers use the platform with strong intensity. All of them, except for QuackityToo, achieve exposure by broadcasting repeatedly, an affordance that is highly visible to their audiences upon entering their channels. As for the second variable, "Recently streamed categories", it can be observed that Just Chatting is the most popular for most of them, a growing trend on Twitch since late 2018 (TwitchTracker, 2025d).

Audiovisual affordances, seen in Table 3, can include many variables that highlight the look and feel of a streamer's channel.

Table 3. *Audiovisual affordances of the top-ranking Mexican Twitch channels by total number of followers*

Rank	Channel	Microphone	Game stream camera	Notification banner	Neon colored lights
1	ElMariana	Yes	Yes	Yes	Yes
2	AriGameplays	Yes	Yes	Yes	Yes
3	rivers_gg	Yes	Yes	Yes	Yes
4	elded	No	No	Yes	Yes
5	QuackityToo	Yes	Yes	Yes	No

Source: Twitch.tv, June 10, 2025. Data extracted and prepared by the authors.

Microphones play a key role in the selected group of streamers and make them immediately distinguishable to viewers who search for gaming livestreams. Not only do they enhance a streamer's voice quality but allow audiences a quick way to link them to gamer culture in general. For example, one streamer that uses his microphone to sing frequently during broadcasts said: "Is this another mic? No, it's the same one, but we stripped it [of the microphone cover]. Where did I leave it? Where did I leave it, dude? But I was right here! There's no way I could've lost it!" (ElMariana, 2025, 00:09:00-00:10:00). The only influencer (elded) who does not use one has a less rich-sounding voice. He is also the only streamer who does not display a game stream camera, a small frame typically located in a corner of the broadcast screen. This element has become a standard visual cue on Twitch and is often integrated using the official Twitch Studio webcam tool. A similar observation applies to the use of background neon-colored lights during livestreams. Most of the analyzed Mexican streamers incorporate this element prominently, while only one (QuackityToo) opts for a less stylized visual environment. In response to a chat message that mentioned her neon light mirror one streamer declared: "What thing? The mirror? It has everything!" (AriGameplays, 2025a, 00:48:50-00:49:00). The notification banner serves as a clear visual announcement tool for the audience and can be used for various functions like stating the number of subscribers to reach in that broadcast (subgoal), a new follower gained, or the monetary transfer or paid subscription of an audience member. It can be mainly visual or textual in nature and appear sporadically or stay in the same place during a broadcast. As noted in Table 3, all the analyzed streamers used this affordance during their broadcasts. Streamers are often effusive and react to it, as one streamer said: "Gretahi, thank you so much for that subscription. Welcome!" (AriGameplays, 2025b, 00:11:50-00:11:55)

Lastly, Table 4 specifies community related affordances. These convey information that allows streamers and audiences to make contact for various purposes, whether personal, through social networks, or commercial.

Table 4. *Community affordances of the top-ranking Mexican Twitch channels by total number of followers*

Rank	Channel	Social media	About me	PC set-up	Sponsors	Subgoal	Schedule
1	ElMariana	Yes	Yes	No	No	Yes	Yes
2	AriGameplays	Yes	Yes	No	No	No	No
3	rivers_gg	Yes	Yes	No	Yes	No	Yes
4	elded	Yes	No	No	Yes	Yes	No
5	QuackityToo	Yes	No	No	No	No	No

Source: Twitch.tv, June 10, 2025. Data extracted and prepared by the authors.

Regarding social media, the first of the community affordances analyzed in this section and shown in Table 4, it's pertinent to underscore that all the top-ranked Mexican influencers prominently link to different social media accounts in their channels, commonly their YouTube, Instagram, and X profiles. Streamers also often refer to them during broadcasts: "I recorded a mini vlog on TikTok that Ari[Gameplays] is supposed to help me edit […] I'll probably never upload it because I don't know how to edit it."(rivers_gg, 2025, 00:11:50-00:12:05). In contrast, the "About me" section is not used always shown, but some include personal details about themselves in the channel description and talk about their personal lives during broadcasts. The "PC set-up" affordance was not by our sample, but mentioned during streams, as one influencer stated: "Tomorrow I'm going to get help with the PC again because it crashed out of nowhere with that damn game. I'm really sorry." (ElMariana, 2025, 00:00:40-00:01:00). In this same vein, two show sponsorships in their channels with banners that send visitors to video game or casino sites after pressing them (rivers_gg, elded). Two use the "Subgoal" affordance in their profiles to let audiences know how close they are to reaching a certain number of paid subscribers and may serve to incentivize viewers into subscribing by nudging them to act. Finally, two streamers post their stream calendar with the "Schedule" affordance in their profiles, while others prefer a more casual approach to this activity by mentioning the next broadcast during their streams. One streaming said: "Tomorrow I'll stream at… I don't know, I'll go live at some point. See you, folks!" (elded, 2025, (04:48:35-04:48:45).

Based on the affordances described in Tables 1 to 4, it can be observed that Twitch enables top-ranked Mexican streamers to foster highly engaged audiences through frequency-based affordances, to captivate viewers with strong visual stimuli (audiovisual affordances), and to maintain interaction with their followers or fellow viewers (community-based affordances) within a technologically mediated environment. The affordances theory proved useful for understanding how the analyzed channels achieve success. Indeed, they attain it through how they utilize their environment, following Gibson's (1979) original idea, in a niche distinct from other influencers. These affordances offer diverse communication possibilities, used in different ways. This illustrates that a single object (the platform) provides different opportunities for

action to different actors within the same environment. For our study, we concur with Faraj & Azad's (2012) multifaceted relational structure view of affordances in the Twitch digital ecosystem that allows complex interactions between creators, viewers, and systems where data flows in two directions empirically: from the creator to the viewers and vice versa. These actions are visible and analyzable and can only be understood in this specific digital environment because of the way Twitch works compared to other streaming platforms. We also share Evans' *et al.* (2017) position regarding certain criteria about affordances since our selection complies with these precepts, as well as Hutchby's (2001) stance that Twitch affordances constrain, but are not deterministic for agents on the platform.

Conclusions

This study aimed to identify selected key Twitch affordances employed by the most prominent Mexican streamers with the objective of exploring shared patterns within this group and gaining deeper insight into their engagement with the platform. This objective was successfully met; however, future research could address limited female streamer representation, or emerging affordances. Notoriety of the top-ranked Mexican twitchers may be better understood through the lens of digital affordances that highlight streamers' broadcasting frequency, visual aesthetics, and community interactions. The selected affordances both enable and constrain possibilities for action within our analyzed sample, though they do not determine their streamer behavior. Regarding limitations of the study, chat-based affordances were excluded as their complexity demands a distinct methodological approach to effectively capture the intricacies of large amounts of text and graphical emotes commonly observed during livestreams.

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Aesthetic hyperrealism in virtual influencers: Perfection and engagement on Instagram

Mónica Pérez-Sánchez
University of Guanajuato (México), moniperez@ugto.mx, https://orcid.org/0000-0002-1327-2174
Javier Casanoves-Boix
University of Valencia (Spain), javier.casanoves@uv.es, https://orcid.org/0000-0001-6993-8708
José Miguel Lorente-Ayala
University CEU Cardenal Herrera (Spain), jose.lorenteayala@uchceu.es, https://orcid.org/0000-0003-2597-0890

Introduction

In the age of visual hyperconnectivity, Instagram has established itself as one of the favourite spaces for influencers, privileged for the creation of identities and aspirational narratives. Within this environment, the figure of the human-like virtual influencer participates by representing and seeking to influence, promoting an idealised aesthetic linked to beauty, through the perfection of their image and digital participation. Nowadays, with the number of images generated through electronic devices and technological advances, it is necessary to recognise the human perspective on how the digital image is displayed and how it is perceived.

The aim of this study is to analyse how aesthetic idealisation and perfection are employed as discursive construction strategies by virtual influencers on Instagram, exploring their implications on the perception of authenticity and social legitimacy in the digital community. The descriptive research design is supported by a mixed methodology that simultaneously combines the analysis of the digital image of twelve human-like virtual influencers, considering semantic content and photographic style, as well as followers' comments.

Thus, by understanding that aspirations and empathic connection are intrinsically human, when facing the phenomena of contemporary virtual influence, new digital subjectivities are being moulded. In social media, virtual influencers construct a curated and highly controlled aesthetic in the pursuit of visual perfection, prioritising extreme stylisation, especially hyper-realistic virtual influencers.

Instagram in influencer marketing

Day by day, new digital proposals emerge, which are novel and guide the masses towards highly attractive channels, such as digital social networks. In this digital context, what Martín et al. (2021) call the 'evolution of advertising communication' is taking place. Among the social networks, Instagram stands out for its constant growth, reaching different audiences and highlighting visual stories (Perreault & Hanusch, 2024); this network is a platform with over two billion users (Shah et al., 2024:581). Instagram, according to Casaló et al. (2018), has been one of the most used platforms by influencers.

The Virtual Influencer phenomenon is recognised from the presence of LilMiquela in 2016. Martín et al. (2021:1138) explain that since then, several IV proposals have emerged from different international creative and technological agencies, with attractive profiles for consumers, proposals that gave more strength to the phenomenon and multiplied online communication strategies, which join the tasks of traditional influencers, but with multiple

advantages over them (Allal-Chérif et al., 2024).

Virtual human-like influence

Influencer marketing is a marketing strategy in which companies rely on influential figures and opinion leaders to encourage consumers to purchase their products or services (Obermayer et al., 2022; Allal-Chérif et al., 2024), to endorse brands and to participate in advertising campaigns (Fowler & Thomas, 2023). Adding to this intention are virtual influencers.

The computer-generated virtual influencer is a digital character created using 3D graphic design, simulation, and animation software (Sookkaew & Saephoo, 2021), and computer-generated influencers (Arsenyan & Mirowsa, 2021). In social media, virtual influencers are an advertising tool (Marlin, 2021), as they present themselves on social media with their own stories and interact with their audience (Hanusand Fox, 2015). They are influencers who participate in the evolution and improvement of digital marketing and help to increase engagement (Allal-Chérif et al., 2024), and are trend-setters in social networks, as they achieve visibility (Arsenyan & Mirowsa, 2021).

Virtual human-like influencers stand out in this trend, that enables businesses to implement new features in their advertising campaigns through the implementation of virtual influencers (De Cicco, 2024). These influencers are built with advanced technology such as AI, augmented reality and 3D animation, using machine learning algorithms and Natural Language Processing programming to achieve more natural and genuine conversations, with more realism; and, as De Cicco et al. (2024:2) point out, they do not autonomously generate content, marketing agencies manage their digital presence.

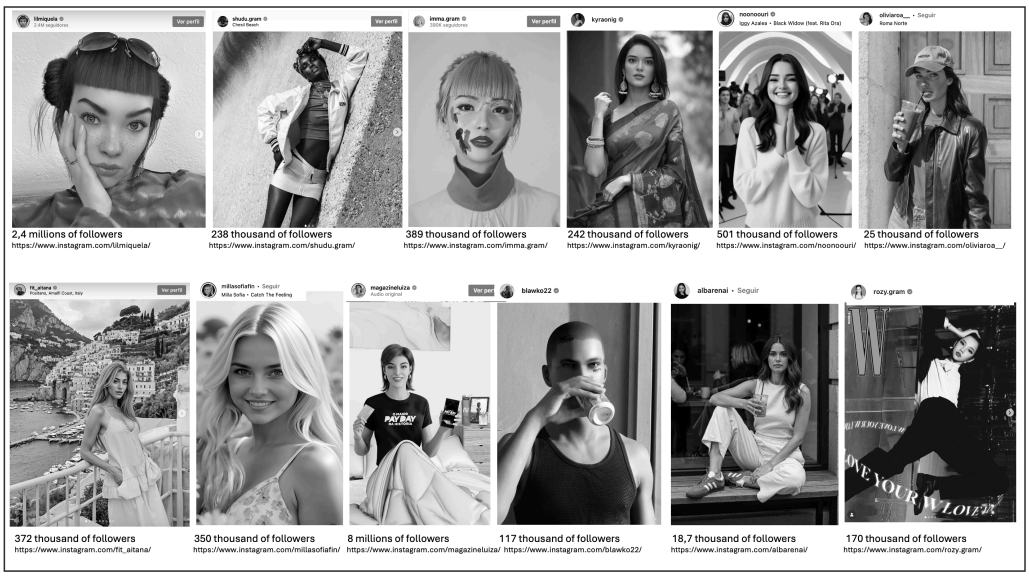
The idealised aesthetics of virtual influencers: youth and *beauty*

Beauty and youth have been highly valued (Danylova, 2020, 2020b). According to Jiang (2023), this is due to the manifestation of human aspirations for the ideal. From a philosophical perspective, beauty has been understood as a bridge between reality and the ideal, allowing human beings to experience aesthetic satisfaction that motivates personal development and creativity (Savile, 2021; Samadov & Gaybullaev, 2023). According to Quvvatov (2021:195), "beauty is interpreted as the aesthetic basis of human life."

As explained by Danylova (2020:3001), "beauty, traditionally considered one of the highest values and one of the most ancient and controversial topics in the discourse of humanity." Even now, in the 21st century, beauty is discussed as a social construct, or in contemporary terms, as an ideal deeply rooted in human nature and based on our genetic inheritance. On the other hand, youth is the gold standard of feminine beauty ideal in the modern world, and beauty itself is seen as a social capital. Advertising joins in on these omens and uses beauty as an unrealistic image (Danylova, 2020). This state is also supported by the virtual entities that are part of influencer marketing. Thus, influencer marketing responds to the needs of digital marketing, promoving visual perfection and simulated authenticity.

In this sense, as shown in Figure 1, human-like virtual influencers promote eternal youth and aesthetics.

Figure 1. *Human-like virtual Influencers*



Descriptive research design involves a mixed methodology based on a simultaneous combined analysis of the digital image, considering semantic content and photographic style, which takes place after collecting multiple comments on that image. This allows for interpretation based on visual content analysis and perception of virtual influencers to understand their connection, aspirational desires, and empathy based on the authenticity of the virtual influencer.

Combined semantic-aesthetic analysis

Semantic content (what is depicted in an image) gives a context and meaning to an image, influencing emotional response and relevance. Images can be related to clear, engaging, o emotionally resonant subjects and are often higher in aesthetics (Xiang et al., 2020). Photographic style (how it is visually presented) includes the observation of color, lighting, composition, an artistic technique; those that affect how the content is perceived, enhancing or diminishing its aesthetic appeal (Xiang et al., 2020). This combined analysis leads to more robust and interpretable aesthetic predictions, because it captures the interplay between what is shown and how it is shown (Xiang et al., 2020).

Human-like virtual influencers selection

Twelve active Instagram accounts of human-like virtual influencers were selected, according to the classification by Arsenyan and Mirowsa (2021). In Instagram, although is a social network that allows data to be made public (Waterloo et al., 2018), It was sought out those influencers who had the 'blue check mark,' a label that verifies their public status (Arsenyan & Mirowsa, 2021:12), and with more than 18,000 human followers (see Figure 1).

Data analysis and collection

Based on the popularity rating of the virtual influencers in the world named by Arsenyan and Mirowsa (2021); and, De Cicco et al. 2024), profiles were selected, considering the number of followers and their young and aesthetic image, using the non-probabilistic sampling technique based on judgement called purposive sampling rather than using random selection. From each

profile, a published image was selected, and its observation included the analysis of followers' comments on the visual composition, aesthetic treatment, associated textualities, and presence of everyday elements or emotional simulation in each digital image. The extraction of information was carried out with Phantom Buster (2025). The corpus was made up of online posts available over a two-month period (March-April 2025). The analysis of the collected data was carried out in May 2025.

Combined semantic-aesthetic analysis

From the twelve images of human-like virtual influencers, N=13,834 comments were collected from human followers, database that allows to identify responses related to the semantic content of the image and those related to its visual aesthetics.

Thematic detection of comments

Using semantic analysis techniques, which implement topic analysis, three main axes of emotional and cognitive response were identified in the comments of the human audience:

Aesthetic validation (53%): comments focused on perfection, photographic quality, lighting, control of expression, retouching, colours, beauty, symbolism, or closeness to the virtual influencer, which ultimately provoke reactions such as: "These are really amazing effects", "Absolutely stunning", "Unbelievable", "Incredible 🔥", "Love it 😮😍🔥👏".

Empathic interaction (24%): comments that reflected emotional connection or identification with the image, highlighting expressions such as "You look great today," "You look happy, I hope you are every day," "You look real," "I like the outfit, I love how you look," "But if you don't feel anything," "I like your life."

Suspicion or dissonance (23%): comments that denote uncertainty about authenticity, such as "Are you real?", "But is this real?", " Actually so pathetic", "Is it artificial intelligence?"

Photographic style

Using CNN, a computational aesthetic analysis model, layers of style and content were obtained, and the images were classified according to three aspects shown in the columns of Table 1.

Table 1. *Layers of style and content.*

Predominant photographic style	Level of engagement	Predominant sentiment
Hyperrealism in detail (no imperfections, lighting)	High	Awe and aesthetic admiration
Naturalised aesthetics (casual poses, warm filters, contrasts)	Medium	Empathy and moderate emotional closeness
Conceptual minimalism (neutral, realistic or futuristic backgrounds)	Low	Comments on artificiality

A significant correlation ($r=0.69$, $p<0.05$) was found between image processing and the nature

of the comments, implying the following: (1) Images with greater aesthetic sophistication generated a higher volume of interactions, but also increased the perception of unreality and dissonance regarding authenticity; and (2) More imperfect images promoted more emotional comments and less suspicion about authenticity.

The results indicate that virtual influencers construct a curated aesthetic that could be described as highly ambitious and controlled, but with varying degrees of intensity in the pursuit of visual perfection. Furthermore, they prioritise technical perfection and extreme stylisation, especially hyper-realistic virtual influencers. The perception of authenticity is conditioned by the balance between aesthetics and closeness, being more effective when a narrative of humanity is incorporated, even if simulated. Virtual influencers are highly questioned and still provoke low levels of closeness with the human audience.

These findings are consistent with those reported by Kim et al. (2020:1552) showing that several factors are simultaneously involved in determining the level of subjectivity of a photo, but it can be predicted with reasonable accuracy. Understanding the digital image of IVs, according to Rodrigo-Martín et al. (2021), allows us to understand the evolution of advertising communication in the current digital context. In particular, advertising based on beautiful images and perfection, with its effects on consumption, could affect people's self-definition (Danylova, 2020). The modern standards of virtual beauty influencers are aligned with those established for the image of a young girl, no longer as someone who will never reach the age of 35, but now the standard has lowered, never reaching 25 years of age. Furthermore, "the new globalized and homogenized beauty ideal emphasizes youth and slimness" (Danylova, 2020b:1).

The phenomenon of virtual influencers is refining its proposals day by day. According to Allal-Chérif et al. (2024), AI-driven virtual influencers appear to be proposals with more refined images, becoming a new way to reach consumers and increasingly achieving a hyper-realistic morphology. However, the female gender predominates, promoting physical beauty and eternal youth. These aspects can have a particular impact on women, as expressed by Danylova (2020b:1): "Advertising and the beauty industry have a huge impact on women and their self-image", aspect that is now also promoted by virtual Influencers.

Conclusions

The results suggest that the digital image of virtual influencers affects human perception not only on an aesthetic level, but also in terms of emotional connection. This finding supports the need for joint analysis models, especially true on Instagram, which operates as a space for the dramatisation of perfection, where idealised aesthetics do not inhibit influence but rather reinforce it when strategically dosed with humanising elements.

The novelty of this research is based on a design that integrates academic knowledge and social reality, which digital social media envelops in real time based on interactions between virtual influencers and human beings. Furthermore, this work allows for a deeper analysis of the innovative forms involved in influencer marketing, including artificial intelligence, and its effects on human perceptions. Contemporary virtual influence is sustained by a constant tension between aspirational desire and empathic connection, shaping new digital subjectivities and patterns of symbolic consumption.

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Governing with Political Communication: An

Analysis of AMLO's Discourse on X (Twitter), 2018–2023

Angélica Mendieta Ramírez
Benemérita Universidad Autónoma de Puebla, angelica.mendietaram@correo.buap.mx
https://orcid.org/0000-0003-0088-2157
José Luis Estrada Rodríguez
Benemérita Universidad Autónoma de Puebla, jluis.estrada@correo.buap.mx,
https://orcid.org/0000-0002-9568-3224

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Introduction

This research aims to analyze the political communication of President Andrés Manuel López Obrador (AMLO), who—through his "mañanera" press conferences—controlled the media agenda and promoted the ideology of the Fourth Transformation, understood as a populist exercise to secure votes, legitimacy, and remain in political power. An analysis based on Agenda-Setting Theory makes it possible to understand how his populist, innovative, and political discourse secured followers and sympathizers via social media, breaking with traditional outlets.

Using a methodology grounded in data mining, classification, regression, clustering, summarization, rule extraction, and interpretive analysis of his morning conferences—together with the Transana software for transcription, coding, and item collection—this big-data process was applied to the speeches delivered by AMLO during the chosen period (December 2018 to December 2023).

In this context, the study is relevant because it explains how communication has become a space for interaction between governors and governed. A power struggle unfolds on social networks through the speeches and information conveyed. Therefore, within political communication, discourse analysis is particularly relevant for understanding how political actors use language to legitimate their power, build consensus, mobilize support, and shape social reality. As Van Dijk (2008) noted, political discourse constitutes a form of social action intrinsically related to other forms of action—such as the exercise of power, ideological reproduction, and the construction of interpretive frameworks.

Authors such as Zapata (2022) and Romeu (2022) recognize that AMLO's arrival to power in 2018 not only marked an ideological shift from previous administrations but also inaugurated a new form of political communication. In this research, discourse analysis is constructed by understanding its social and political interpretation. Van Dijk and Perales (2008) argue that under this dynamic, discourse was transformed both as a social practice conditioned by power structures and ideologies and as an instrument capable of reproducing or transforming those structures.

The methodology employed in this research combined qualitative and quantitative techniques for the systematic analysis of presidential discourse in the morning press conferences, available on the Presidential website and AMLO's official page. The corpus analyzed comprised all "mañaneras" held from December 2018 through August 2023, covering a significant span of

López Obrador's administration. A big-data retrieval method based on Transana software enabled synchronized transcription and coding of the speeches using the published stenographic versions, facilitating identification of relevant paralinguistic elements. The primary sources for this study were the official stenographic versions—that is, the complete transcripts of the conferences—available on the Presidency's website. As Rossiter (2021) highlights, "in interactions such as debates, deliberations, and discussions, actors can set the agenda by directing others' attention toward their preferred topics" (p. 21).

Unlike traditional government communication, which tended to present itself under the guise of technical neutrality, the mañanera discourse displayed an explicit ideological orientation organized around principles such as: a) honesty and the fight against corruption; b) social justice and defense of vulnerable sectors; c) national sovereignty against external interests; d) transformation of the political and economic regime. Ramírez et al. (2022) recognize that this "hate discourse" inaugurated a new stage in governmental communication because the country's chief executive strategically employed traditional stereotypes, collective resentment, and a partial interpretation of national history to harass dissenters and achieve high levels of public approval.

Theoretical Framework: Understanding Populism

Political communication aims to construct a discourse for citizens that allows the government and its actors to gain followers and sympathizers. In this sense, during AMLO's six-year term (2018–2024), the former President of Mexico's rhetoric helped build a narrative based on polarization, populism, and control of the media agenda. Under this framework, Schmidt (2023) acknowledges that the concept of populism is long-standing, but current populist leaders differ significantly: they manage to influence the political agenda of liberal democracies through social networks, internet applications, and all existing audiovisual resources. Several studies explain populism as an ideological framework—Berman (2021), Rosanvallon (2020), Laclau (2002), Mouffe (2018), and Urbinati (2020)—while other authors, such as Levitsky and Ziblatt (2018), consider this form of populism a risk to democracy.

Meanwhile, Ulloa (2023) argues that populism has a polysemic meaning, since it can even be viewed as a denigration of the content of the words promoted by leaders. Likewise, Mendieta and Estrada (2023) highlight that populism is social mobilization. It is directly related to protest and social vindication movements because it serves as an instrument for driving change, amending the constitution, or constructing a new political regime—as in our country with the development of the Fourth Transformation. Populism takes various forms to drive citizen control and domination, such as media populism and anti-elitist, anti-establishment ideas (Müller, 2019). The "Mañanera" press conference became both an ideological information source and a strategic platform for crafting a political agenda on social networks and alternative media.

The evolution of the mañaneras as a direct and precise communication form displaced many mass media outlets that merely reproduced the official discourse. One strategy of populist leaders in their narrative and media presence is the appropriation of a moral value they claim to hold exclusively (Müller, 2016). For example, AMLO coined terms like "fifís" and "chairos" to create polarization on social media, framing regime opponents as corrupt, anti-national elites—an approach clearly observable in the tweets and messages circulating online. Monopolizing the public agenda was one of the objectives planned from the first mañanera on

December 3, 2018, when AMLO took office. "In this regard, during his first thousand days in office AMLO held 682 mañanera press conferences, averaging 108 minutes each—more conferences than George W. Bush or Barack Obama held during their two terms leading the U.S. government" (Zapata, 2022, p. 29).

Alongside populism, several studies examine this governmental innovation, which drove sociocultural transformation through the so-called Fourth Transformation by using morning press conferences. For instance, Leal (2016) notes that for many years in our country the press—especially newspapers—was controlled: newspapers adopted government information as the agenda for their front pages and main news stories.

On the other hand, Hernández *et al*. (2021) argue that AMLO's discourse shifted from an ideological speech to an emotional narrative, where criticism of the corrupt political elite and neoliberal ideology fueled a new model of governance. Similarly, Hernández et al. (2021) emphasize that his nationalist framing—rich in historical references and data from the Mexican Revolution—established a social-justice benchmark, forming the paradigm of Mexico's Fourth Transformation through a nationalist and popular vision.

Finally, in discussing the populist concept and its media-centered variant, Barberis (2021) states that populism is nothing more than a highly successful communication format—infinitely replicable worldwide—characterized by a symbolic construction that enables disintermediation, rendering television unnecessary. It does not require political parties to replicate the message; populist communication is available on social networks to polarize, fragment, and ultimately achieve proximity, notoriety, and domination.

As shown in Table 1, to conduct a cross-sectional time analysis, morning press conferences from December 2018 to August 2023 were examined. Initially, the information presented by President AMLO was categorized into ten topics: 1) Economy and Finance, 2) Security and Justice, 3) Health and Education, 4) Corruption and Transparency, 5) Environment and Energy, 6) Foreign Policy and Migration, 7) Human and Social Rights, 8) Culture and Sports, 9) Government and Internal Politics, and 10) Other Topics. Based on Agency Theory, it was found that through this communication exercise AMLO not only disseminated news but also fostered an ideological construction of events and dominated the media agenda. In Table 1, one can identify the concentration of topics by day, week, and month: the anti-corruption discourse was one of his main narratives, representing over 20 % of his interventions during the first half of 2019, while foreign policy accounted for more than 23 % of topics in 2019 on social networks and in public discussion. This finding aligns with De la Fuente (2020), who identified four primary forms of AMLO's discourse: 1) Informative, 2) Argumentative, 3) Interactive, and 4) Performative—each analyzable with Transana software, matching the major news items disseminated. Furthermore, Garrido and Bravo (2019) found that within AMLO's first 100 days there was a statistical construction of dichotomies—people versus elite, honesty versus corruption—resulting in a polarizing narrative.

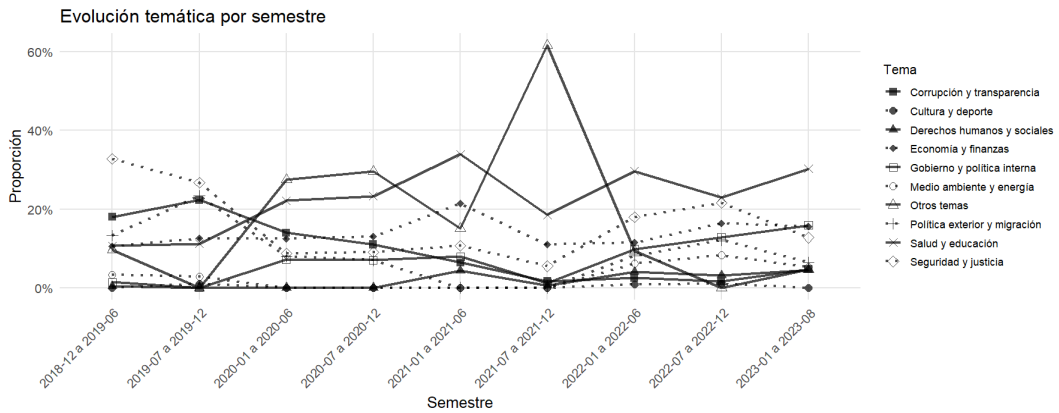
Table 1. *Concentration of topics in AMLO's discourse in "Las Mañaneras."*

Period	Economy and Finance	Security and Justice	Health and Education	Corruption and Transparency	Environment and Energy
2018-12 a 2019-06	10.57%	32.79%	10.69%	18.01%	3.24%
2019-07 a 2019-12	12.57%	26.78%	11.18%	22.30%	2.82%
2020-01 a 2020-06	12.50%	8.67%	22.17%	14.00%	0%
2020-07 a 2020-12	13.00%	9.00%	23.33%	11.00%	0%
2021-01 a 2021-06	21.45%	10.67%	34.00%	6.45%	0%
2021-07 a 2021-12	11.00%	5.50%	18.50%	1.67%	0%
2022-01 a 2022-06	11.50%	18.00%	29.67%	2.50%	6.17%
2022-07 a 2022-12	16.38%	21.67%	22.92%	1.58%	8.28%
2023-01 a 2023-08	15.61%	12.76%	30.29%	4.70%	5.26%

Period	Foreign Policy and Migration	Human and Social Rights	Culture and Sports	Government and Internal Politics	Other Topics
2018-12 a 2019-06	13.27%	0.41%	0%	1.44%	9.57%
2019-07 a 2019-12	23.35%	0%	1.00%	0%	0%
2020-01 a 2020-06	8.00%	0%	0%	7.17%	27.50%
2020-07 a 2020-12	7.00%	0%	0%	7.00%	29.67%
2021-01 a 2021-06	0%	4.38%	0%	7.92%	15.13%
2021-07 a 2021-12	0%	0.50%	0%	1.17%	61.67%
2022-01 a 2022-06	8.17%	4.00%	0.83%	9.83%	9.33%
2022-07 a 2022-12	12.17%	3.17%	1.00%	12.83%	0%
2023-01 a 2023-08	6.41%	4.54%	0%	15.85%	4.57%

As can be seen in Table 1, the concentration of topics is very high in certain months that coincide with issues that impacted the national agenda. This influence of the conveyed information also managed to generate a belief system among citizens—an ideological construction with a narrative in favor of the people; characteristic of populist governments with leadership toward political and social change.

Graph 1. Evolution of topics in AMLO's discourse (2018–2023). Source: Prepared by the author, 2025



Discourse Analysis

To understand how discourse constructs meaning and motivates action, as well as shapes public opinion, it is necessary to consider these elements in the analytical corpus; for in "Las Mañaneras," it was not only a discursive process but also an informational one. Under this framework, Tokeaw (2025) acknowledges that leaders' resourcefulness on social media lies in creating, sustaining, and repeating topics; this is why it achieves great success. For this research analysis, the primary sources used were the official stenographic versions—that is, the complete transcripts of the conferences—available on the Presidency's website. As Rossiter (2021) highlights, "in interactions such as debates, deliberations, and discussions, actors can set the agenda by directing others' attention toward their preferred topics" (p. 21).

Unlike traditional government communication, which tended to present itself under the guise of technical neutrality, the mañanera discourse displayed an explicit ideological orientation organized around principles such as: a) honesty and the fight against corruption, b) social justice and the defense of vulnerable sectors, c) national sovereignty against external interests, and d) transformation of the political and economic regime. Ramírez et al. (2022) recognize that this hate discourse inaugurated a new stage in government communication because the country's head of state strategically employed traditional stereotypes, collective resentment, and a partial interpretation of national history to harass dissenters and achieve high levels of public approval. It was also a performance of the data.

In this sense, this discourse transformed from a governmental mechanism for social control into an open attack on institutions. Flores and Amador (2022) note that there was a transformation of government communication because AMLO used simple language with avant-garde political symbolism, addressing social problems. "Among these stand out corruption in public institutions, elite power control, and inequality between social classes" (p. 23).

Through the review and analysis of AMLO's speeches—using the scheme of the four identified functions—a breakdown into ten themes was proposed for analyzing topics over the period from December 2018 to December 2023. Katsambekis and Kioupkiolis (2019) analyze populism in Europe and find parallels with Latin American populism, characterized by media control (Schmidt, 2023).

With the aim of verifying the influence of the mañaneras on the definition of an issue, "Las Mañaneras" were analyzed every day during the period from December 2018 to August 2023. The goal is to demonstrate that Agenda-Setting Theory remains relevant and can be used for political communication studies—as well as a mechanism of control, domination, and consensus-building by those in power.

Among the main findings, it was possible to identify that the media agenda was constructed around topics that favored a populist vision—such as social welfare, the empowerment of the people, and confrontation with adversaries during sustained week-long periods (Samaniego, 2023; Turri, 2022). Under this framework, the ongoing relevance of Agenda-Setting Theory is confirmed through a conglomerate of socio-digital media that privileged communication as an ideological and political power mechanism.

Following the foregoing analysis, the results align with other investigations on agenda setting. Rossiter (2021) points out that agenda construction is a verifiable phenomenon that can be measured by the responses generated in debates, as well as the deliberation of topics in the

media environment. Security was one of the most frequently addressed issues. In "Las Mañaneras," the topic of security occupied a central place; even during the 100-day address, the fight against corruption was presented as one of its main banners—"from his inauguration onward, he has done so 790 times" (MCCI, 2019).

Likewise, the topic of environment and energy showed sustained growth from March onward, positioning itself as one of the pillars of the discourse, especially due to the strategic projects the President defended, such as the Santa Lucía Airport, the Maya Train, and the Dos Bocas Refinery. A notable shift occurred in June, when human and social rights reached their highest point (33.0%), reflecting the importance acquired by the migration crisis. It should be noted that in October 2018, Central American migration began to occupy the media agenda and contrast within the discourse. These developments generated polarization in the public debate, favoring a rhetorically charged formation of pro- and anti-migration blocs (Colef, 2018).

Toudert (2021) also recognizes that the narrative on social networks—especially on X (Twitter)—was dominated by other actors who portrayed migration as a capitalist phenomenon and criminalized Central American migrants. Other researchers, such as Jara and Morales (2021), acknowledge that AMLO constructed a discourse in support of migrants by seeking humanitarian treatment and even labeling them "migrants in transit" to mitigate the negative connotations of the migrant caravans. In this sense, the migration phenomenon occupied a very important space on the agenda, aiming to build a discourse in favor of migrants and the pursuit of humanitarian treatment in Mexican territory. In contrast, culture and sports, government and internal politics, and other topics showed little to no presence during the analyzed period, highlighting a strong thematic concentration on issues of security, social justice, energy, and the fight against corruption.

Conclusions

As can be observed in the discourse analysis, from the items and words used by the Mexican president, his appearances in "La Mañanera" had a great echo and promoted a populist discourse built through rhetoric and symbols. The concepts of "people," "democracy," "justice," and "fight against corruption" are the words that recur in the discourse and create this space for partisan identification. The empty signifiers precisely built this space for social interpretation, and the discourse—based on the needs of citizens in general—adopted an institutional vision of the message conveyed.

AMLO, as a charismatic president with strong popularity, managed to control the media agenda through informational innovation by presenting information and commenting on data. Most media outlets reproduced the message via social networks. He established permanent communication with citizens and constructed an ideological vision of the Fourth Transformation.

Likewise, an interactive communication between government and citizenry was built through the control of the media agenda, which also fostered the development of non-governmental organizations as support. In the analysis of the ten semesters and sixty months used in this research to inform the study, it was possible to identify the topics that intentionally nourished the public agenda. In Graph 1, one can see the topic of media exposure by month, which, as

can be noted, was not random but rather a saturation that enabled the gain of popularity, governability, and even the continued permanence of the ruling political party.

Moreover, the discourse of "La Mañanera" forged a strong sense of belonging by blending symbolic terms with everyday experiences. By invoking "justice" or "democracy" in a familiar language, the president managed to link national issues to citizens' personal stories. That mix of collective narrative and individual anecdotes created a feeling of "us" that went beyond mere presentation of data and anchored itself in the audience's emotional memory.

The informational innovation—which included real-time charts and simple statistical comparisons—enhanced the perception of transparency and closeness. By commenting on figures instantly and tying them to concrete problems—for example, quantifying the progress of social programs minute by minute—the impression of a government that accounts for itself live was created. This dynamic stifled the emergence of critical narratives by presenting the official version as the preferred frame for interpreting any related news.

However, the deliberate saturation of topics also limited the diversity of the public agenda. By focusing attention on issues such as the fight against corruption or the government's flagship projects, topics of equal relevance—like culture, sports, or housing—were relegated to oblivion, their absence in the media becoming difficult to reverse. This informational asymmetry reinforces identities consolidated under a single perspective and hinders the construction of a plural debate.

Acknowledging the power of these morning press conferences as a tool of persuasion implies questioning the balance between effectiveness and democratic deliberation. It will be essential to explore how the intersection of presidential messages and social-media algorithms strengthens or dilutes dissenting opinions. Only by understanding this communicative web can we fully assess the implications of the Fourth Transformation for the quality of public dialogue and the health of our democracy.

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Representation of Authority and Justice in Crime Narratives on Instagram

Paz Crisóstomo-Flores
Universidad Finis Terrae (Chile), pcrisostomo@uft.cl, https://orcid.org/0000-0002-9761-2112

Introduction

Since mid-2022, Chilean authorities have declared a public security crisis, positioning crime as one of the primary concerns of both citizens and the government. Indeed, in that year, reports of criminal offenses increased by 46.1%, and arrests rose by 35.6%, while the perception of insecurity reached historic highs, with 90.6% of the population reporting feelings of unsafety (UECH, 2023). This phenomenon has been further intensified by media coverage of drug trafficking, violent incidents, organized crime, and homicides. In parallel, the State has strengthened its institutional security framework through the creation of the Ministry of Public Security (Ley 21.730, 2024), which brings together agencies related to public order, criminal investigation, and the supervision and control of individuals deprived of liberty. This strategy has been supported by public policies aimed at reinforcing the role of the State as the guarantor and monopolist of order (Ministerio del Interior y Seguridad Pública, 2025).

Within this context, the representation of crime in social networks and digital narratives plays a central role through visually impactful images and stories, privileging emotional impact and immediacy over analytical context. This logic of urgency—particularly evident on Instagram—focuses attention on the moment of conflict, while the resolution of said conflict is often omitted, a tendency shaped by the platform's brief visual format, which limits opportunities for deeper reflection (Thane, 2024). Visual narratives thus resemble discursive performances rather than reflective news accounts, prioritizing the emotional seduction of the user (Schreiber, 2024). Police forces have adopted Instagram as a channel for carefully curating their self-representation, emphasizing action-oriented imagery, community interaction, and technology to reinforce their role as authoritative actors. Meanwhile, the informational content disseminated on such platforms tends to obscure or downplay the complexity and root causes of crime (Schreiber, 2024).

This research is situated within this discursive framework and seeks to analyze the narrative patterns employed by two national media outlets—CHV and TVN—in their Instagram posts related to crime. The analysis is structured around three axes: the representation of authority, editorial framing (data use and narrative structure), and narrative focalization (victim, perpetrator, authority). By focusing on the period 2023-2024, the study aims to understand how these narratives contribute to legitimizing or challenging the institutional discourse on security and justice in Chile.

Media Representation of Authority in Crime Narratives

One of the key mechanisms for understanding the legitimation of order lies in the media representation of authority. In this regard, crime news functions as a discursive device that grants institutional visibility within the public sphere. Social media platforms, due to their communicative logic, enable the co-construction of authority, forged between journalistic narratives and the content shared by users on their personal profiles (Dawson & Mäkelä, 2020).

Media outlets, through their discursive practices, operate as ideological apparatuses capable of reproducing and reinforcing the institutional hegemony of authorities (van Dijk, 1995). This legitimization does not occur explicitly; rather, it is constructed through the naturalization of institutional discourses, which are embedded within journalistic genres as if they were neutral or self-evident. Through this process, institutional language is transformed into common sense, thereby consolidating its symbolic authority over public opinion (Fairclough, 1992).

Such hegemonic discourse is increasingly contested on social media platforms, where the legitimacy of institutions must coexist with public criticism that exposes contradictions between official discourse and the lived experiences of diverse communities (Abiri & Guidi, 2022). This tension has been notably observed in mediatized judicial processes, where social media has become a vehicle for amplifying counter-narratives capable of reshaping institutional accounts (Prendergast & Quinn, 2021). Victims and witnesses often resort to these platforms as an alternative form of justice, publishing testimonies that challenge or rectify official versions disseminated by mainstream media (Schwartz, 2019). As a result, police narratives are subjected to real-time public scrutiny, with their legitimacy contingent upon resonance with the community's prior experiences (Ellis, 2021). Scholars like Igwebuike and Chimuanya (2021) warn that authority figures are often instrumentalized on social media to legitimize misinformation, especially during crises. Security imagery is used to convey control and legitimacy, masking authoritarian narratives. Similarly, Boutros (2024) highlights the police's "epistemic power," stressing the need to balance this by amplifying the voices of victims and communities in the media.

Crime Narratives and Editorial Framing

Narratives on platforms such as Instagram must adapt to the logic of visual brevity, wherein crime-related images generate multiple focal points —the face of the detainee, the crime scene, the police presence— which fragment meaning and obscure structural responsibility. This fragmented visuality elicits emotional reactions yet impedes critical analysis (Higgins, 2022). Similarly, Björkenfeldt (2024) explores how dominant crime discourse in the media impacts even journalists who attempt to challenge these hegemonic narratives.

Cultivation theory, originally developed by Gerbner, posits that sustained exposure to violent narratives fosters a distorted perception of reality. This mechanism is even more pronounced on social media today. A meta-analysis confirms that the traditional effects of cultivation theory extend to digital media as well, heightening fear of crime and perceptions of insecurity (Morgan & Shanahan, 2010). In parallel, a 2023 study in China demonstrated that exposure to criminal content on social networks significantly increases perceived insecurity, even in environments with low actual crime rates (Sun et al., 2023).

The editorial role in shaping media narratives about crime is also evident in how responsibility is distributed across represented events. Various studies have shown that journalistic and digital discourses tend to shift blame onto victims, thereby reinforcing the legitimacy of repressive institutions. Kamalova (2024) argues that this discursive operation is achieved through narrative frames that minimize the structural context of crime while amplifying behavioral traits attributed to victims—ultimately legitimizing an institutional interpretation of order. Recent studies confirm this pattern. In Australia, an experiment showed that gender in homicide reports affects audience reactions: male victims elicit more sympathy, revealing internalized gender bias (Henry & Powell, 2024).

Narrative Focalization and Institutional Legitimacy

Narrative focalization in media portrayals of crime determines who occupies the symbolic center of the discourse: the victim, the perpetrator, the authority, or a neutral voice. This choice is not merely stylistic, but profoundly ideological, as it shapes the moral point of view of the narrative, establishes degrees of empathy, and delineates the distribution of responsibility. Such displacement contributes to the reproduction of the institutional status quo. In this way, visual content becomes a symbolic device that reinforces authority and restricts the emergence of critical narratives. This focalization also results in a narrative in which crime appears as an isolated event, devoid of identifiable social or economic roots, thereby obstructing a structural understanding of the phenomenon.

When victims attempt to narrate their experiences outside institutional frameworks, they often face delegitimization processes from both the state and the media, which tend to reproduce dominant discourses. In digital environments, this tension intensifies: self-representation clashes with official narratives that focus on the immediate protagonists of crime, omitting structural causes and reinforcing institutional legitimacy (Ebadijalal & Weisi, 2022; Boutros, 2024). Narrative focalization on authority not only organizes the discursive structure of crime but also legitimizes an interpretative framework in which the State is portrayed as the unquestionable guarantor of order. This symbolic configuration limits the possibility of imagining alternative forms of justice or representations of social conflict.

This research aims, as its general objective, to analyze the discursive patterns in the representation of authority and justice within crime-related narratives on Instagram, to understand how texts are constructed that either legitimize or challenge institutions within the judicial and security systems. The specific objectives are: (1) To identify the modes of authority representation in Instagram posts; (2) To examine the incorporation of quantitative data, editorial approaches, and narrative structures that prevail in the argumentative composition of the texts; and (3) To determine the narrative focalization, representation, and cause-effect connection in institutional discourses concerning crime.

The present study combines quantitative and qualitative methods, grounded in critical discourse analysis to examine how authority and justice are constructed within crime narratives on Instagram. A mixed-methods approach is adopted (Creswell, 2014), with a qualitative foundation supported by quantifiable analysis of discursive patterns, thereby allowing for the capture of both the frequency and depth of meanings in media communication. The corpus comprises 962 posts published between January 2023 and December 2024 by the official Instagram accounts of CHV and TVN. The sample was selected through thematic criterion sampling, including posts related to crimes, police operations, judicial proceedings, or issues of public security. Each post is considered a combined unit of analysis, including image, caption, hashtags, and highlighted comments.

The selection of the Instagram platforms of the Chilean television channels TVN and CHV is based on their centrality within the digital media ecosystem and their role as discursive agents in the public construction of crime. Both accounts possess high levels of followers and engagement, and they represent divergent editorial models within Chilean television: TVN maintains a public service orientation, whereas CHV has developed a more sensationalist and emotionally driven approach. This editorial duality enables the observation of narrative contrasts in the representation of authority and crime, as well as an analysis of how different

editorial logics adapt to Instagram's visual and discursive formats. Recent studies have shown that the social media accounts of traditional media outlets are not merely informational extensions, but autonomous spaces where institutional legitimacy is actively negotiated, moral hierarchies are constructed, and specific interpretive frames of crime are amplified.

The analytical categories were defined based on theoretical frameworks from critical discourse analysis and media studies: (1) Representation of Authority: institutional validation, neutralization, questioning, and omission; (2) Incorporation of Quantitative Data: presence/absence; (3) Editorial Approach: purely descriptive, attribution of responsibility, and human-interest angle; (4) Narrative Structure: introduction, development, resolution, and unresolved; (5) Narrative Focalization: victim, perpetrator, authority, and neutral; (6) Cause-Effect Connection: explicit cause or implicit cause; (7) Evaluation of Institutional Discourse: reinforcement, neutralization, and institutional critique. A coding protocol was implemented following Krippendorff (2013), including intercoder training and reliability testing. A minimum threshold of $\alpha \geq 0.80$ was set, as this level is considered acceptable to ensure coding reliability. Coding was done in Excel, followed by image analysis and qualitative interpretation of discursive and symbolic trends.

Table 1. *Modes of Representation of Authority*

Category	CHV	TVN
Validation (Expert source)	68.7%	79.7%
Neutralization (Neutral entity)	10.5%	13.7%
Questioning (Attributed responsibility for failures)	8.7%	1.8%
Omission (No mention of authority)	12.1%	4.9%

The results reveal a predominant tendency toward institutional validation in both CHV (68.7%) and TVN (79.7%), indicating a reproduction of official discourse with minimal critical interrogation. Neutralization—understood as a representation in which authority is portrayed as a technical or neutral actor—is also present, albeit to a lesser extent. Explicit questioning of authority is significantly lower in TVN (1.8%) compared to CHV (8.7%), suggesting a stronger alignment of TVN with governmental narratives. The omission of the authority figure is likewise more frequent in CHV, which may reflect an editorial strategy aimed at the sensationalization of events rather than their institutional contextualization.

Table 2. *Incorporation of Quantitative Data*

Category	CHV	TVN
Absence of quantitative data	82.1%	85.8%
Presence of quantitative data	17.9%	14.2%

Both CHV and TVN display a low incorporation of quantitative data in their posts (17.9% and 14.2%, respectively), reinforcing the hypothesis that emotional appeal is prioritized over contextual analysis. This scarcity of numerical information may hinder a structural understanding of criminal phenomena, contributing to narratives that privilege anecdotal elements over explanatory depth, and omitting key indicators for evaluating crime trends or

institutional effectiveness.

Table 3. *Editorial Approaches*

Category	CHV	TVN
Purely Descriptive	30.8%	30.9%
Attribution of Responsibility	22.3%	23.2%
Human-Interest Angle	18.7%	19.4%

The data show that both media outlets tend to adopt a purely descriptive approach in approximately one-third of their posts (CHV 30.8%; TVN 30.9%). This may reflect a form of apparent informational neutrality in which events are presented without further exploration of responsibility or structural causes. The lower proportions of responsibility attribution and human-interest framing suggest limited problematization of criminal events from social or empathetic perspectives, as well as a low level of narrative contextualization.

Table 4. *Narrative Structure*

Category	CHV	TVN
Introduction	9.5%	21.0%
Development	64.5%	54.6%
Resolution	24.2%	24.2%
Unresolved	1.8%	0.2%

There is a clear preference for conflict-centered structures (narrative development) in both CHV (64.5%) and TVN (54.6%). In contrast, the introduction of events—particularly in TVN (21%)—and their resolution (around 24% in both media) are less common. The very low proportion of posts offering a clear or explicit resolution. The low proportion of posts offering a clear or explicit resolution (24.2% in both outlets)". Los valores 1.8% y 0.2% reveals a fragmented narrative that provides neither closure nor follow-up, thus favoring a sense of immediacy and reinforcing the perception of a persistent threat.

Table 5. *Narrative Focalization*

Category	CHV	TVN
Victim	24.1%	27.6%
Perpetrator	3.8%	6.6%
Authority	63.3%	55.8%
Neutral	8.7%	10.0%

Both media outlets predominantly focus their narratives on the figure of authority, with CHV reaching 63.3% and TVN 55.8%. This focalization reinforces the institutional image as a symbol of order and control. Victims are positioned as the narrative focus in approximately a quarter of the posts, while the perpetrator occupies only a marginal space. The low presence of neutral perspectives suggests that most narratives implicitly adopt a stance regarding who holds narrative control over the crime and its moral representation.

Attributed Causality and Institutional Legitimization in Media Discourse

TVN displays a higher proportion of posts with explicit causal explanations (68.1%) compared to CHV (47.6%), which may reflect an editorial intent to explain criminal phenomena within an identifiable causal framework. In contrast, CHV presents a greater proportion of implicit causes (52.4%), which may reinforce uncertainty or ambiguity regarding events, thereby favoring emotional rather than analytical interpretations. Most posts reinforce institutional discourse, especially in TVN (71.1%) and to a slightly lesser extent in CHV (63.1%), indicating a predominance of narratives that validate the actions of official institutions. Institutional critique is marginal (CHV 8.7%; TVN 3.3%), limiting the emergence of counter-hegemonic or critical perspectives. Meanwhile, institutional neutralization suggests an intermediate strategy, in which the authority is portrayed as a functional actor without explicit value judgments. This suggests a stronger editorial alignment of the public channel (TVN) with official narratives, compared to CHV's more sensationalist framing.

Conclusions

This study reveals how Chilean traditional media, via Instagram, construct crime narratives that reinforce institutional legitimacy during a public security crisis. The analysis of CHV and TVN posts (2023-2024) shows a pattern of emotionally charged content and focus on authority, with little attention to structural causes. Regarding the first objective, the representation of authority is found to be predominantly characterized by institutional validation, which emerges as the dominant category in both media outlets. This form of representation reinforces the hegemonic role of the State as guarantor of order, in line with the arguments of van Dijk (1995) and Fairclough (1992). Institutional critique appears only marginally and, when present, is limited to exceptional cases. As such, the social media platforms of traditional media do not function as spaces of contestation but rather as channels that reproduce and amplify official discourse.

In relation to the second objective, the narrative and editorial structures of the analyzed posts confirm a logic centered more on emotional impact than on rational or informative analysis. The low presence of quantitative data and the predominance of descriptive or human-interest framings reflect a communication model that prioritizes the spectacularization of crime. This brief and fragmented storytelling—focused largely on the "conflict" or central event—follows a logic of immediacy typical of digital platforms (Thane, 2024) and aligns with the premises of cultivation theory (Morgan & Shanahan, 2010), insofar as it contributes to reinforcing perceptions of insecurity and social fear.

As for the third objective, narrative focalization is clearly directed toward the figure of authority, consolidating its symbolic role as the center of discourse. Both victims and perpetrators are relegated to peripheral positions, and when mentioned, their portrayal lacks contextual frameworks that could explain the structural causes of crime. The cause-effect connection—especially in the case of TVN—tends to offer explicit explanations that nevertheless align with and reinforce institutional narratives. In this context, the evaluation of discourse reveals a consistent portrayal of state institutions and law enforcement agencies as unquestionable actors, sustaining public demands for state control in times of heightened insecurity. Media narratives on crime in Instagram—even when produced by traditional media outlets—reproduce discursive patterns that restrict the emergence of critical perspectives,

downplay structural factors, and reinforce the legitimacy of the State as the sole actor capable of confronting crime. This symbolic construction of order not only narrows public debate but also impedes the imagination of alternative models of justice, security, and representations of social conflict. This research therefore provides empirical evidence and conceptual tools to understand how digital media discourse shapes dominant interpretative frameworks on crime in contemporary Chile.

From an editorial perspective, the results highlight the need to critically reassess dominant narrative frameworks on social networks, where the repeated portrayal of an unquestioned authoritarian figure reproduces a logic of spectacle. As Hall et al. (1978) warned, the media often play a central role in constructing "moral panics" by focusing on threatening figures and state-based solutions—ultimately reinforcing a conservative consensus around order. In contrast, Hanitzsch (2007) advocates for a reflective journalism that prioritizes structural questioning over the automatic reproduction of institutional narratives. This tension invites a rethinking of editorial criteria, especially in digital platforms where speed and visual impact tend to displace critical analysis.

From the standpoint of the State, the findings point to the risk that media narratives on social networks function as legitimizing mechanisms for state control, potentially leading to an uncritical punitive consensus. Foucault (1975) warned that visibility devices serve disciplinary power, and in digital contexts this symbolic control is amplified through the circulation of images depicting operations, arrests, or the display of force. Nonetheless, authors such as Loader and Mulcahy (2003) suggest that security can also be democratized through inclusive and deliberative discursive practices that incorporate affected communities in the construction of solutions. This implies that public policy should expand the repertoire of legitimate actors in security discourse, avoiding a representation monopolized by state institutions.

From the standpoint of civil society, the findings highlight the importance of fostering critical media literacy. In the face of emotionally charged and fragmented narratives, media spaces play a crucial role in either reproducing or challenging symbolic inequality. As active audiences, citizens must develop tools to critically engage with media representations, recognize narrative focalization, and question informational silences. In this sense, media consumption is not neutral, and the ways users interpret and circulate stories on social networks can either reinforce or destabilize dominant symbolic orders.

From a methodological and epistemological perspective, this study offers a replicable framework for future research that integrates critical discourse analysis with the study of algorithms and digital platforms. In this regard, authors such as Couldry and Mejias (2019) propose the concept of "data colonialism" to describe how digital media, operating under platform logics, not only disseminate representations but also shape the conditions of possibility for public discourse. Thus, investigating traditional media on social networks allows for the observation not only of their content but also of their adaptation to algorithmic control logics that directly affect the formation of common sense. Future studies should address the limitations of this research, including its focus on only two media outlets and the platform-specific dynamics of Instagram.

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The Presence and Representation of Wixárika Art in Museums Worldwide

María José Sánchez Usón
Universidad Autónoma de Zacatecas (México), mjsanchezu@hotmail.com
https://orcid.org/0000-0002-3409-4055

Introduction

The Huichol are an Indigenous people of western Mexico whose territory extends across the Sierra Madre Occidental, mainly in the states of Jalisco, Nayarit, Durango and Zacatecas. They call themselves Wixaritari (singular: Wixárika), a term that Diguet relates to maize cultivation; "Huichol" is an exonym historically used by non-Huichol populations (Diguet, 1992, p. 121).

Their worldview is articulated around el costumbre, the set of ritual obligations, communal practices and forms of religious knowledge that sustain collective life. This system combines Indigenous ritual traditions, Catholic elements and a complex ceremonial calendar in which the mara'akame, or ritual specialist, plays a central role. Peyote, understood in this context as a sacred cactus rather than merely as a psychoactive substance, forms part of pilgrimages and ritual practices linked to vision, memory and territory (Neurath, 2013).

In addition to agriculture, especially maize cultivation, and to seasonal labour migration, Wixaritari communities produce objects decorated with beads and yarn. Although these works have often circulated under the category of handicrafts, their symbolic density, chromatic intensity and ritual associations also allow them to be understood as visual systems of cosmological knowledge. Their imagery is linked to pilgrimage, sacred geography, deities and ancestral memory (Neurath, 2013). This artistic production has been one of the main channels through which Wixárika culture has gained international visibility.

In Mexico, the National Museum of Anthropology in Mexico City and the Zacatecan Museum in Zacatecas are among the key institutions for the exhibition and dissemination of Wixárika art. The National Museum of Anthropology has presented works such as La visión de Tatutsi Xuweri Timaiweme by José Benítez Sánchez as central to the interpretation of Wixárika cosmovision, while the Zacatecan Museum includes spaces dedicated to Huichol/Wixárika art and culture (Instituto Nacional de Antropología e Historia [INAH], n.d.; Zacatecas Travel, n.d.). Other institutions, including the Huichol Wixárika Ethnographic Museum in Guadalajara, the Museum of the Five Peoples in Tepic, the Museum of Popular Art and the National Museum of Popular Cultures in Mexico City, and regional museums in Durango and Puebla, also contribute to this museographic visibility.

The work of museums and temporary exhibitions has also shaped the international projection of artists such as José Benítez Sánchez and Santos de la Torre Santiago. De la Torre's Vision of a Mystical World is exhibited in the Zacatecan Museum, and the Vochol project has circulated internationally as a highly visible example of Wixárika beadwork applied to a contemporary object (Zacatecas Travel, n.d.; Google Arts & Culture, n.d.). The mural Huichol Thought and Soul, installed at the Palais Royal–Musée du Louvre metro station in Paris, likewise illustrates how Wixárika visual language has entered spaces of cultural diplomacy and public art. Taken together, these examples show the international circulation of Wixárika art, although the

provenance, ownership and exhibition histories of each work should be documented case by case.

This research examines the presence of Huichol/Wixárika art in selected museums and cultural institutions. Its central hypothesis is that Wixárika artistic creation is not merely experiencing a moment of growing visibility, but is also being incorporated into museum narratives as a form of cultural representation through which Mexico projects Indigenous heritage internationally.

The approach is qualitative, analytical-descriptive and interpretive. It combines documentary review with the analysis of museum collections, exhibition references and selected works associated with Huichol/Wixárika art. The study draws on history, ethnography, cultural anthropology and museology in order to situate the objects not only as aesthetic artefacts, but also as cultural mediators between ritual knowledge, institutional display and international circulation. The corpus is illustrative rather than exhaustive; therefore, the museums and exhibitions discussed here should be understood as representative cases.

To speak of the Huichol people as one of Mexico's cultural representations abroad necessarily raises the problem of Indigenous policy. Indigenism in Mexico has not only functioned as a domestic cultural orientation, linked in recent decades to minority rights, environmental debates and heritage discourses; it has also operated as a symbolic language of the State. In this sense, Indigenous cultures have sometimes been mobilised as a diplomatic "calling card", projecting an image of cultural diversity, peace and social inclusion while structural inequalities remain unresolved (Korsbaek & Sámano-Rentería, 2007).

Currently, despite institutional and regulatory reforms, Korsbaek and Sámano-Rentería argue that "[…] el Estado Mexicano continúa con una política indigenista [que] se ha quedado en las buenas intenciones sin lograr un cambio en la política paternalista y asistencialista que han caracterizado al indigenismo de Estado de viejo cuño" (2007, p. 213). From this perspective, the Huichol/Wixaritari are frequently represented through frameworks that recognise cultural value while still reproducing paternalistic forms of political relation.

The contemporary visibility of the Huichol people is therefore ambivalent. On the one hand, it allows the circulation of artistic forms, sacred narratives and cultural knowledge beyond local communities; on the other, it can reduce Indigenous presence to picturesque, exotic or tourist images. Korsbaek and Sámano-Rentería describe this tension when they write: "Encima de lo que podemos llamar la 'cultura real' encontramos un muy delgado barniz que pretende presentar a la nación mexicana y su situación general de una manera que les parezca a sus gobernantes aceptable para el mundo internacional" (2007, p. 211).

This tension is also visible in the relationship between Indigenous communities and state institutions. Public recognition may coexist with limited political agency, material inequality and bureaucratic distance. The existence of a language, a religious system and a traditional political organisation does not automatically translate into full institutional recognition. For this reason, the international museum presence of Wixárika art must be analysed together with the social conditions of the people whose cultural knowledge sustains it.

National Museum of Anthropology. "Gran Nayar" room

The National Museum of Anthropology in Mexico City is one of Mexico's principal ethnographic and archaeological institutions. Opened in 1964, it includes exhibition rooms

dedicated to permanent archaeological and ethnographic collections as well as spaces for temporary exhibitions. Among its ethnographic areas is the Gran Nayar room, named after the region of the Sierra Madre Occidental inhabited by Coras, Tepehuans, Nahuas and Huicholes/Wixaritari. The material culture of the latter has a prominent presence in this room, allowing visitors to approach their religious worldview, artistic production, forms of social and political organisation and subsistence practices (Neurath, 2024).

Figure 1. The vision of Tatutsi Xuweri Timaiweme. José Benítez Sánchez. National Museum of Anthropology, Mexico City. Johannes Neurath collection.



Since its foundation, the museum has undergone expansions, adaptations and museographic reforms. In recent debates, priority has shifted from a static display of supposedly ancient objects towards a more critical and contemporary interpretation of Indigenous cultures. Neurath (2024) describes this as a decolonising and plurinational approach that seeks to move from the contemporary to the ancestral and from large national narratives to more specific community perspectives. The aim is not simply to accumulate ethnographic information, but to foreground themes such as territoriality, autonomy, ritual, food, textiles and Indigenous self-representation.

Se usa una antropología reversa que abarca temas que en la gran mayoría de los pueblos originales y afromexicanos consideran relevantes: territorialidad y autonomía, alimentación y bebida, fiestas y rituales, vestimenta y arte textil […] Nos liberamos, hasta cierto punto, de la pretensión de ofrecer una enciclopedia etnográfica de México, más bien se busca profundizar en temas estratégicos […] En general, en las nuevas salas temáticas se da preferencia a la autorrepresentación indígena (Neurath, 2024, p. 415).

Figure 2. Recreation of a Wixárika temple and mannequins, Gran Nayar room, National Museum of Anthropology, Mexico City. Johannes Neurath collection.



Within this new museum dynamic, Wixaritari material culture is not treated as a remnant of a vanished past, but as part of a living present. From this perspective, contemporary objects, ritual recreations and everyday materials help visitors understand how tradition is continuously reactivated and reinterpreted. Neurath makes this point when explaining the public misunderstanding that can arise in ethnographic displays:

Lo que el público muchas veces no entiende es que las salas de etnografía corresponden al presente. Por eso recibimos quejas de visitantes sobre detalles de las exposiciones etnográficas, en especial de las recreaciones de altares, donde a veces se muestran botes de cerveza o envases de refresco. Se nos reclama que tal o cual objeto aún no existía en la época prehispánica […] La confusión surge porque el museo insiste en un presente etnográfico nostálgico e idealizado (Neurath, 2024, p. 412).

Zacatecan Museum. Wixárika room

Alongside the National Museum of Anthropology, the Zacatecan Museum in the city of Zacatecas constitutes a significant case. The museum includes rooms dedicated to religious and popular art, as well as spaces that present the identity and cultural history of Zacatecas. Its Huichol Art Room contains a diverse range of works, including tapestries collected by the Belgian doctor Enrique F. Mertens, the photographic archive of Colette and John Lilly, and the ethnographic collection associated with Leobardo Villegas Mariscal. Special mention should be made of the mural Vision of a Mystical World by the Wixárika artist Santos de la Torre Santiago, identified by the museum's tourism information as one of its emblematic works (Zacatecas Travel, n.d.).

Figure 3. Wixárika room. Zacatecan Museum, Zacatecas. Museum collection.



Figure 4. Vision of a Mystical World. Santos de la Torre Santiago. Zacatecan Museum, Zacatecas. Museum collection.



Huichol art in museums around the world

The two cases discussed above are among the most significant Mexican examples of museums that exhibit Huichol/Wixárika artworks. However, Wixárika art also circulates through international museum collections, temporary exhibitions and cultural diplomacy initiatives. This circulation should not be interpreted only as a consequence of aesthetic appeal; it also depends on curatorial mediation, institutional acquisition, cultural policy and the symbolic use of Indigenous heritage in Mexico's external projection.

The following non-exhaustive list offers selected examples of museums and institutions where Huichol/Wixárika objects or related works have been identified or displayed:

American Museum of Natural History, New York; National Museum of Mexican Art, Chicago; The Field Museum of Natural History, Chicago; Smithsonian National Museum of the American

Indian, Washington/New York; Fine Arts Museum, San Francisco; Fowler Museum, UCLA, Los Angeles; Los Angeles County Museum of Art, Los Angeles; Mingei International Museum, San Diego; Museum of Indian Arts and Culture, Santa Fe, New Mexico; Museum of the Red River, Idabel, Oklahoma; The Penn Museum, Philadelphia; Ethnologisches Museum, Berlin; Ethnografiska Museerna, Stockholm; Världskulturmuseet, Gothenburg; Kulturhistorisk Museum, University of Oslo, Oslo; British Museum, London; Pitt Rivers Museum, University of Oxford, Oxford; Musée de l'Homme, Paris; Musée du quai Branly–Jacques Chirac, Paris; and the Museum of the Americas, Madrid. For final publication, each entry should be checked against the corresponding museum catalogue or collection record.

Figure 5. Mara'akame hat. The Field Museum of Natural History, Chicago, Anthropology Collections, cat. 165356. Donación de Joaquín M. Preciado. © Field Museum (CC BY-NC 4.0).



Figure 6. The Vochol. Musée du quai Branly–Jacques Chirac, Paris. París. Fotografía: Asociación de Amigos del MAP, A.C. Fuente: Google Arts & Culture.



Figure 7. Huichol men's costume. prior to 1993. Cotton embroidered in cross-stitch. Museo de América, Madrid. Inventory No. 1993/01/136. Photograph: Museo de América, Ministry of Culture of Spain.



To this non-exhaustive list, which is representative of the international circulation of Wixárika art, one may add temporary exhibitions that have contributed to the dissemination of Huichol culture abroad. In 2009, the Mexican Embassy and the Franz Mayer Museum of Decorative Arts in Japan organised Huicholes: Un pueblo que camina en búsqueda del amanecer ("Huicholes: A People Walking Toward Dawn"), which exhibited 192 Wixaritari works at the Kampo Museum in Kyoto. According to Mexican curator and writer Gabriela Olmos, organiser of the event, it was the first Huichol-Zen encounter to date, combining "[…] el delirio estético y el derroche de color de los indígenas mexicanos con la armonía y el equilibrio de los japoneses" (Olmos, 2010). Other examples include L'art sacré des Huichols ("The Sacred Art of the Huichols"), presented at the Mexican Cultural Institute in Paris, and Entre el mito y la costumbre ("Between Myth and Custom"), inaugurated at the Mexican Embassy in Berlin in June 2023 by the Mexican Cultural Institute in Germany and Arte Yawí, with 28 works by artists from the Wixárika people (Secretaría de Relaciones Exteriores, 2023).

Conclusions

The references presented here are not exhaustive; rather, they provide a set of representative cases through which to understand the museum presence of Huichol/Wixárika art. The examples show that this artistic production has been displayed in museums, cultural centres and diplomatic venues, where it is frequently used to communicate distinctive aspects of Wixárika worldview, ritual knowledge and visual language. At the same time, this visibility requires critical interpretation, since museum recognition does not automatically resolve the social, political and economic inequalities affecting Indigenous peoples.

A central factor in the continuity of Wixárika tradition, which Huichol communities call el costumbre, has been its capacity for openness and adaptation. As the examples discussed in

this chapter suggest, Wixárika art has moved beyond local and national spaces without ceasing to be connected to ritual memory, territoriality and community knowledge. Its international circulation allows it to function as a vehicle of cultural diplomacy, but it also confirms that the Huichol/Wixaritari should not be reduced to an isolated or exotic people frozen in time. They are contemporary actors who negotiate tradition, modernity and representation within more than one social and symbolic world. As Neurath explains:

> La pluralidad de mundos y la habilidad de los huicholes de funcionar exitosamente en más de uno no pueden entenderse sino como uno de los rasgos de la modernidad de este grupo. La afinidad entre ideas, mentalidades o estéticas amerindias y modernistas no es ningún descubrimiento. (Neurath, 2013, p. 127).

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What City Do Audiovisuals and the Web Show? Exploring the Representation of Trinidad (Cuba)

Yánder Castillo Salina
Pontificia Universidad Católica del Perú, (Perú)
ycastillos@pucp.edu.pe, https://orcid.org/0000-0003-4149-5620

Introduction

Currently, the city's communication is constructed through a network of audiovisual and digital narratives that function as authentic urban texts, with each frame selecting and enhancing features of the cityscape (Matarín *et al.*, 2024). The emergence of cyberspace and ICTs has boosted the production of content where aesthetics prevails over meaning, turning the city into an aesthetic document for global audiences (Barrado-Timon *et al.*, 2022). In turn, the web and social networks act as place-branding platforms that reproduce and amplify homogeneous visual repertoires, generating an illusion of reality that shapes perceptions of the urban environment (Moura & Baldi, 2021).

This study is part of a broader research project aimed at branding the 500-year-old city of Trinidad (Cuba). Previous stages of this study revealed that the residents of this locality often disagree with the way advertising agencies, influencers, and travel blogs portray their city (Castillo-Salina & Yáñez-Reyes, 2025). Based on these findings, the general objective of this research was to characterize the representations of Trinidad found in the most widely consumed audiovisual and web platforms among residents and visitors.

Trinidad belongs to the province of Sancti Spíritus (Cuba). It is the main tourist destination in the southern center of the island. It was founded by the Spanish crown in 1514, making it the third-oldest town in the country. It is considered one of the best preserved in Latin America and stands out for its craftsmanship in the techniques of weaving with threads and fibers, as well as in clay and woodwork. Its historic center has been declared by UNESCO as a World Heritage Site (1988) and a Creative City of Crafts and Folk Arts (2021). It was also recognized as a World Craft City (2019) by the World Crafts Council (WCC).

Using Trinidad as a case study, this research offers insights into the processes of tourism mediatization of Cuban heritage sites, within a context in which the country is promoting strategies for their commercialization and positioning in the world market (Communist Party of Cuba, 2021). Based on the analysis of highly consumed audiovisuals and websites in the local context, this research expands the academic literature by demonstrating how these products converge to build a "living postcard" that articulates heritage, identity, and territorial branding.

Theoretical Premises

The evolution of audiovisual technologies has enabled the capture, storage, and dissemination of images of cities, revealing their territorial realities from a creative, commercial, and reflective point of view (Huerta-Viso *et al.*, 2024). These visual records become documents that impact the city's memory and, at the same time, serve as material for analyzing urban identities (Nieto-Ferrando *et al.*, 2022). Most commonly, they represent urban morphologies that, in some cases, incorporate features and identity characteristics beyond landscapes (Jiménez-Durango, 2024). Thus, certain products become texts committed to a critical analysis of urban reality

(Moura & Baldi, 2021), revealing a complexity marked by globalization and transnationality (Barrado-Timon *et al.*, 2022).

Urban representation through audiovisuals is currently articulated as a strategic process, in which frames function as texts that select and enhance some attributes to the detriment of others. Studies by Zhu & Zhang (2025) and Chen (2025) conclude that online frames emphasize the urban landscape, the contrast between rural and urban settings, and the presence of local people. This textualization mechanism is reinforced by the notion of the city as an aesthetic document, where the emergence of cyberspace and ICTs invites a prioritization of appearance over content, generating an incessant flow of images that delineate globalized urban landscapes (Popescu *et al.*, 2020).

These audiovisual productions are part of cultural economies and territorial marketing. Several studies (Ramadania *et al.*, 2025; Chen, 2025) have revealed that tourists tend to base their travel decisions on promotional videos that appeal to emotions and convey a sense of authenticity, going beyond the purely informative format and moving towards sensory and narrative experiences. In this way, the city ceases to be a simple geographical space and becomes a cultural product designed to seduce and differentiate itself in a global destination market (Zhu & Zhang, 2025).

The web and social networks thus function as place-branding platforms, where travel blogs, official portals, and collaborative reviews reproduce and expand the same visual and narrative repertoires to guide consumption (Ramadania *et al.*, 2025). All these processes rest on a logic in which audiovisual products establish symbolic hierarchies of spaces, architectures, and cultural practices (Fernandez de Osso-Fuentes et al., 2024). The present study aimed precisely to characterize the urban morphology represented in audiovisuals and the web in the case of Trinidad (Cuba).

To meet the proposed objective, the study was divided into two in-depth phases: a quantitative phase focused on the content analysis of widely circulated audiovisuals about Trinidad and a qualitative phase analyzing ten websites that show information about the city.

The selection of the units of analysis was based on a list of audiovisuals and web platforms mentioned by people (inhabitants of Trinidad and visitors) during previous fieldwork sessions. However, it was decided to extend the search to include as many materials as possible. It is worth noting that it has been described as a global trend to search for online information about destinations that can be catalogued as ideal for cultural tourism—those involving history and heritage—even when such destinations can also be conceived as "sun and beach" (Fernandez de Osso-Fuentes *et al.*, 2024). This is precisely the case with Trinidad.

During the search process to complete the list of materials to be analyzed, access was gained to a compilation of audiovisuals created by specialists at the Office of the Curator of the City of Trinidad and Valle de los Ingenios. It was found that almost all of them (17 out of 22 audiovisuals) are available on the Internet, and that most of them coincide with those mentioned by the subjects interviewed in the previous stages of the study. Five audiovisuals produced by the Office of the Curator of the City of Trinidad and the Valle de los Ingenios (OCCTVI) were included in the final list, and although not available online, they are broadcasted on television programs in Cuba (Table 1).

Table 1. *List of Audiovisual Materials Analyzed*

	Video Title	Institution/Channel	Available at
1.	THIS Is TRINIDAD, the Coolest City in CUBA	Pegameunviaje	https://goo.su/DhDvEcU
2.	Charming Villages - Trinidad	Alan por el mundo Cuba #8	https://goo.su/t0zzdY
3.	What to See in Trinidad?	El Viajero Feliz	https://goo.su/uHWH
4.	Trinidad Cuba What to Do? How Much Does It Cost?	Oscar de Guru (Youtube)	https://goo.su/6yxED
5.	Trip to Cuba (3/6) – Trinidad, the Most Beautiful City in Cuba	Guías Viajar (Youtube)	https://goo.su/ekUrLt
6.	Trinidad Cuba	De Ville En Ville De Port En Port	https://shre.ink/eUfg
7.	Trinidad, Cuba	Amazing Places on Our Planet	https://shre.ink/eUf8
8.	Trinidad, a Beautiful City	Rey Fabré	https://shre.ink/eUfI
9.	Trinidad, a City of Discoveries 1	RTV Comercial	https://shre.ink/eUfB
10.	Trinidad, a City of Discoveries 2	RTV Comercial	https://shre.ink/eUfW
11.	Trinidad, a City of Discoveries 3	RTV Comercial	https://shre.ink/eUfQ
12.	Trinidad, a City of Discoveries 4	RTV Comercial	https://shre.ink/eUfa
13.	Trinidad, a City of Discoveries 5	RTV Comercial	https://shre.ink/eUfH
14.	Trinidad, a City of Discoveries 7	RTV Comercial	https://shre.ink/eUf9
15.	Trinidad at Your Door 1	Canal Educativo	https://shre.ink/eUfU
16.	Trinidad at Your Door 1 (part 2)	Canal Educativo	https://shre.ink/eUIP
17.	Trinidad Gourmet (spot)	Ministry of Tourism	OCCTVI Archives
18.	Trinidad SIACOT	OCCTVI	OCCTVI Archives
19.	Trinidad Promo	OCCTVI	OCCTVI Archives
20.	Trinidad Postcards 1	OCCTVI	OCCTVI Archives
22.	Trinidad Postcards 2	OCCTVI	OCCTVI Archives

Source: Own elaboration.

To select the websites, the study took into account that users of metasearch engines typically do not go beyond the first ten search results when seeking information on tourist destinations (Rovira *et al.*, 2010). However, it was decided to expand the search scope to include the first 70 sites shown. Since metasearch engines provide personalized results (Gonzalo *et al.*, 2015), the "incognito mode" setting was used to minimize the influence of search algorithms as much as possible. The search for sites about Tinidad was conducted using Google, considering that it is the most widely used metasearch engine on a global scale. The terms entered were "Trinidad+Cuba" two keywords commonly used to look up information about the city.

Finally, ten websites were selected by intention for their typological heterogeneity (encyclopedias, tourism services, blogs, etc.), which provided a broad overview of the available content. The process considered as a final filter the information provided by the previous phase of the study. The content analysis was qualitative. The websites chosen are described in Table 2.

Table 2. *Websites Analyzed in the Content Analysis*

	Link	Description
1.	https://lc.cx/CaUysj	Trinidad page on the *Wikipedia* encyclopedia.
2.	https://lc.cx/ak4H90	Website promoting tourism in Cuba.
3.	https://lc.cx/LfbKaw	Travel section of elDiario.es.
4.	https://lc.cx/YSr4Dp	Tourist site with sections on Trinidad.
5.	https://lc.cx/IzQfXB	Website of the Organization of World Heritage Cities.
6.	https://lc.cx/dPKxq-	Blog from an online tours site.
7.	https://lc.cx/s1zZUG	Blog by Spanish travelers.
8.	https://lc.cx/eZSnms	Trinidad page from the Cuban encyclopedia *Ecured.*
9.	https://lc.cx/hknMqE	Reviews website on Trinidad from TripAdvisor.
10.	https://lc.cx/Zr1Ny2	Travel blog Chavetas.es.

Source: Own elaboration.

According to the aims of this research, the categories addressed in the content analysis included: color(s) related to the territory; prominent places; words, epithets, or ideas used to describe the locality; historical, cultural, and natural features with high levels of identification.

Results

Trinidad Represented in Audiovisual Products

The audiovisuals analyzed offered insight into how Trinidad is portrayed by different subjects who produce this type of material. Their analysis made it possible to identify framing tendencies of the local reality, which differ from how residents and visitors perceive the city. Table 3 shows the hierarchy of the general topics addressed.

Table 3. *General Topics Addressed in Audiovisuals on Trinidad*

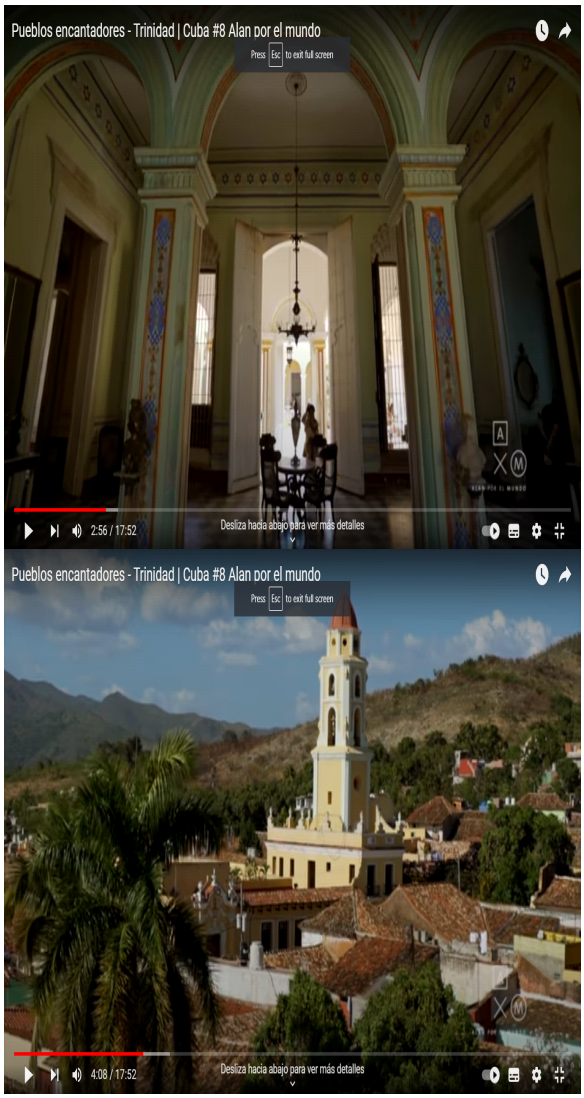
Topics	Number of mentions	%
Architecture	135	24
Nature	88	16
City Sites	72	13
People	55	10
Culture	50	10
History	37	7
Crafts	37	7
Daily Life	26	5
Gastronomy	17	3
Variety/Integrity of the Destination	13	2
Agencies/Tours	12	2
Colors	6	1
Prices	5	0.9
Accommodation	2	0.4
Total	**555**	**100**

Source: Own elaboration.

As can be seen in Figure 1, "architecture" is the most frequently mentioned characteristic in the audiovisuals, accounting for 24% of the total number of mentions. The most frequently

mentioned features of this topic include colonial buildings, cobblestone streets, and architectural details such as roofs, tiles, railings, and windows. To a lesser extent, the form of structural organization of the city and the furnishings of houses, businesses, museums, and other antiques are alluded to.

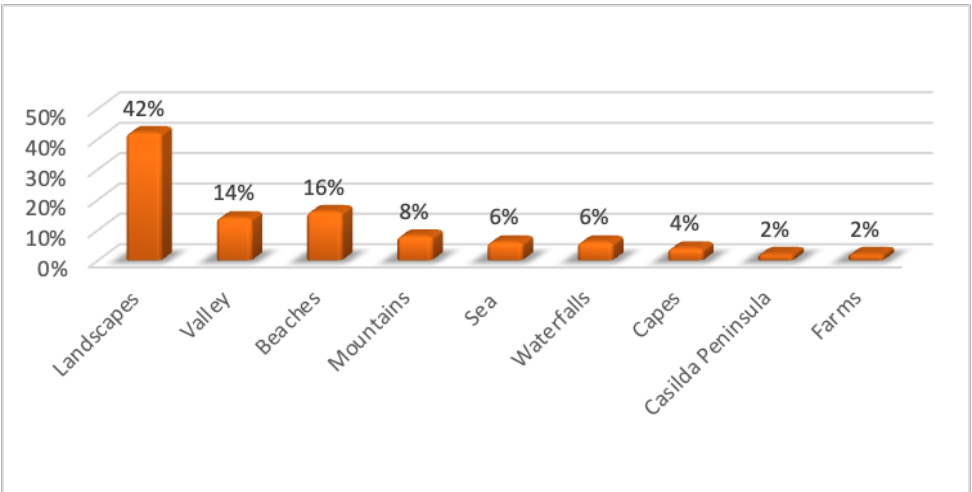
Figure 1. Screenshots of the Audiovisual "Alan por el mundo"



Note: Youtube, minutes 4:08 and 2:56 (link in Table 1).

In turn, the audiovisuals placed "nature" in second place in terms of relevance. This category accounted for 15.9% of the total number of mentions, which included beaches, mountains, waterfalls, landscapes, the valley, keys, reefs, and local fauna. Figure 2 shows the most frequently represented natural sites and elements.

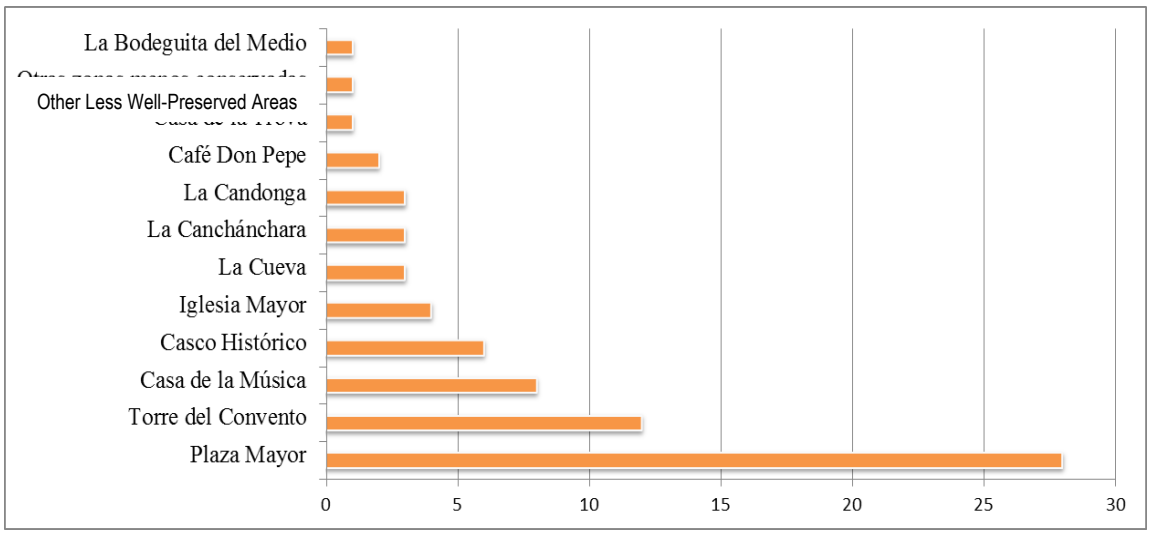
Figure 2. Nature-related Topics Addressed



Source: Own elaboration.

The aforementioned trend was also observed in the category "city sites," which ranked third in number of mentions (Figure 3).

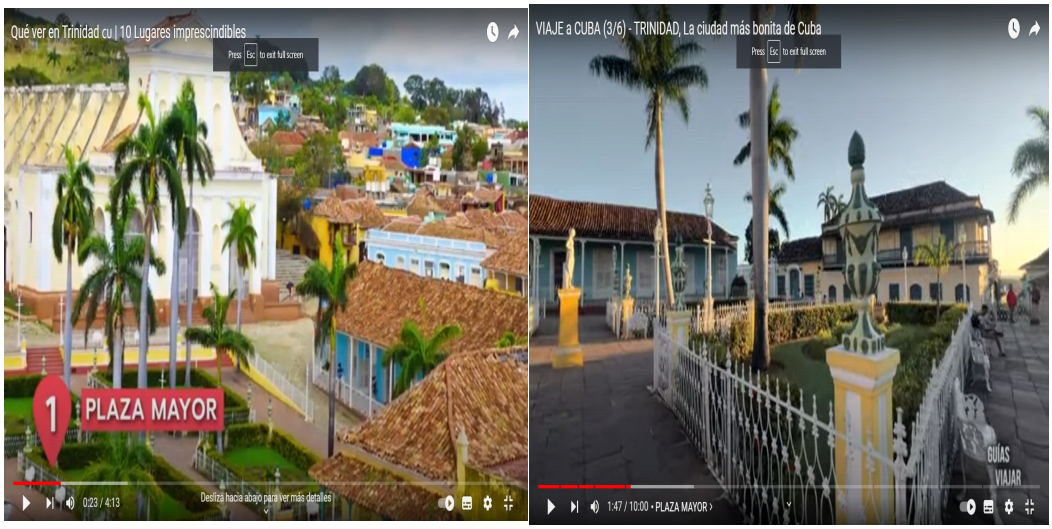
Figure 3. City Sites Most Frequently Shown in the Audiovisuals



Source: Own elaboration.

Figure 3 shows that the Plaza Mayor (Main Square) is positioned as the urban site most represented in the audiovisuals. This aligns with the fact that the iconic image of Trinidad's historical and patrimonial center is located within its premises. It is not surprising then that the Tower of the Convent of St. Francis of Assisi (currently the Museum of the Fight Against Bandits) is the next most featured site. In fact, the iconic image of the city shared by the advertising sites is precisely a perspective frame from one of the corners of the plaza towards the tower (Castillo-Salina & Yáñez-Reyes, 2025). Figure 4 shows screenshots of the vicinity of the Plaza Mayor.

Figure 4. Screenshots from the audiovisuals "What to See in Trinidad" and "Trinidad, the Most Beautiful City in Cuba"



Note: Youtube, minutes 0:23 and 1:47 (link in Table 1).

It should be noted that the category "museums" was counted as part of the Plaza Mayor indicator, since the institutions recommended in the audiovisuals are in its perimeter, so the square served as a reference for them. The reviewed YouTube videos emphasize these institutions as a quick way to access the municipality's history, culture, and traditions.

On the other hand, the presentation on the topic "people" was *sui generis*. Although the number of mentions reached only 55 (10% of the total), 16 of the 22 audiovisuals reviewed (73% of the total) dedicated space to positively highlighting the qualities of the Trinitarians. This indicates that, although it is not a quality that outweighs the rest of the categories mentioned, it is a characteristic that is intended to distinguish the local reality. A similar behavior was observed in the "culture" category, which appears in 100% of the audiovisuals, although it groups 50 mentions (9% of the total).

Statistical analysis shows that the five most mentioned general topics—architecture, nature, city sites, people, and culture—account for 72% of the total mentions. Among the nine least-mentioned topics is the framing of Trinidad as an integrating destination (culture, nature, urbanity, heritage, sun, and beach, etc.), with only 13 mentions (2% of the total).

The qualitative analysis of the audiovisuals showed that there is homogeneity in the representation of Trinidad, regardless of the source or type of material analyzed. They coincide in showing Trinidad as a must-visit city in Cuba, emphasizing its architectural and cultural heritage values, the warmth of its people, the exuberant nature, and the peaceful and quiet daily environment, which differentiates it from other Cuban cities such as Matanzas and Havana. Trinidad is recognized as an eminently touristic locality, and it is specified that it still preserves the magic of the Cuban people.

Among the negative aspects mentioned are delays in the tourist transportation services, street cleanliness, and rising prices. It is striking that the epithets used by locals to identify Trinidad are not alluded to, and instead, the city is described using much simpler qualifications such as

beautiful, photogenic, and welcoming, as reflected in reviews on TripAdvisor (Castillo-Salina & Yáñez-Reyes, 2025).

Trinidad Displayed on Websites

The content analysis of the ten websites revealed important similarities with the audiovisuals. Interestingly, seven of the sites analyzed promoted tourism in Trinidad, the Valle de los Ingenios, and the Topes de Collantes nature reserve. The remaining websites show information contained in the collaborative encyclopedia *Wikipedia* and in the Cuban virtual encyclopedia *Ecured*. Likewise, the official website of the Organization of World Heritage Cities shows the entry form of Trinidad to UNESCO's World Heritage List.

The texts are interspersed with photographs that denote urban heritage spaces, streets, buildings, and nature scenery. These photographs distinguish a warm and peaceful climate, quiet, and patrimonial city environments, as well as colorful settings. Among the most outstanding sites are the palaces and small palaces, museums, Topes de Collantes, and Ancon Beach. The OnLine Tours website offers a video of approximately 1 minute showcasing the city's historic center, beaches, and hotels.

The review of the contents highlights the patrimonial values of the territory of Trinidad as one of the first towns founded in Cuba. Emphasis is placed on the prosperity brought by the sugar industry from the 17th to the 19th centuries, which led to the construction of sugar mills, palaces, and colonial houses that distinguish Trinidad as one of the most beautiful and opulent towns in the Caribbean during specific periods of its history.

Regarding current values, almost all the websites agree that the architectural heritage and the good conservation of the historic center of the city, as well as the Valle de los Ingenios, give Trinidad an atmosphere typical of the 18th and 19th centuries. In other words, the city is perceived as a historical and heritage site, with no attributes associated with modernity being mentioned.

It is noteworthy that only the *Ecured* website dedicated a section to talk about the citizens of Trinidad. On this site, Trinidadians are portrayed as friendly and humble, willing to fraternize with visitors, and known for being excellent hosts and conversationalists. This representation aligns with how Trinidadians see themselves and with visitors' impressions as reflected in TripAdvisor reviews of the city (Castillo-Salina & Yáñez-Reyes, 2025).

Another feature about Trinidadians can be found—albeit indirectly—on the *site La Respuesta es Viajar* (*The Answer is Travel*). On this page, tourists are recommended to stay in family-run hostels because of their excellent hospitality and because it is an interesting approach to the Cuban way of life. It is common in these sites—as well as in TripAdvisor reviews about Trinidad—to value the locality as an excellent opportunity to appropriate the Cuban way of life.

The analysis shows consensus in highlighting urban values associated with the architectural and folkloric heritage (linked to Cuban colonialism and sugar culture, as well as the weaving culture that has earned the city the title of Creative City in Crafts by UNESCO), the beautiful environment (beaches, Topes de Collantes Natural Park), and the peaceful and quiet city environment (ideal for relaxation.

Several adjectives were used to describe Trinidad. There is evidence of a relegation of the natural values of the locality to a second level. The most frequently mentioned adjectives and

value ideas were World Heritage; Artisan and Creative City of the World; National Monument of Cuba; Treasure of Cuba; Trinidad, the city where Time Stopped; Legend City; and Wonder of Colonial Architecture.

The most emphasized places are those related to urban and historical heritage, as well as the Valle de los Ingenios, the beaches, and the Topes de Collantes Natural Park. Among those with the highest number of mentions include History Museum, Guamuhaya Archaeology Museum, Romantic Museum, Manaca-Iznaga Tower, Colonial Architecture Museum, Topes de Collantes Natural Park, La Boca Beach, Ancon Beach, Parish Church, Plaza Mayor, Amargura Street, and the Bell Tower of the Museum of the Fight Against Bandits.

With respect to the colors used to identify Trinidad, bright tones contrast very well with the natural environment—blue sky and beaches, white sand, cobblestone streets, red-tile rooftops, and green fields. The texts reinforce this visuality by describing the city with terms such as "colorful" or "polychrome."

Conclusions

The analysis of representations of Trinidad in audiovisuals and websites reveals how the framing privileges architecture, configuring the built landscape as an urban "text" with a strong semiotic power, as suggested by Zhu and Zhang (2025). At the same time, the repeated presence of natural and monumental elements confirms the city's vision as an aesthetic document, where the photogenic qualities prevail over its sociocultural complexity, as described by academic like Popescu (Popescu *et al.* 2020) and others authors (Barrado-Timón *et al.,* 2022). However, this visual homogeneity—aligned with Moura and Baldi's (2021) and others (Ramadania *et al.,* 2025) critiques of hegemonic place-branding—leaves out local voices and internal narratives. Meanwhile, the constant mention of human warmth provides an experiential nuance— many authors (Fernández de Osso-Fuentes *et al.,* 2024) point out as fundamental to give authenticity to territorial marketing discourses.

This study enriches the field of urban representation research by combining analysis of audiovisuals and web portals—formats that are usually studied separately. It also highlights the need to question dominant representations, as the findings reveal social and cultural dimensions absent from widely circulated images of the urban.

Despite the contributions noted above, the research has limitations. It should be considered that the use of incognito mode reduces personalization in search results, but it does not eliminate algorithmic biases or geographic or device variations. Similarly, the selection of 22 videos and 10 websites does not cover emerging social networks such as TikTok or Instagram, nor does it consider locally generated user content, which could provide alternative narratives. Future studies could delve deeper into how different audiences perceive and interpret representations of urban spaces disseminated by various media and users.

Similarly, comparing Trinidad with other Cuban heritage cities would be valuable for understanding the variations in their territorial branding strategies. It would also be worthwhile to delve deeper into the subjective experiences and the collective construction of local identity. Finally, a longitudinal follow-up study would enable us to evaluate the evolution and resilience of the audiovisual and digital discourses shaping Trinidad's image.

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Development, Education, Social Innovation, and Gender

Student psychological well-being and its link to the development of entrepreneurial skills

Saldaña Orozco Claudia
University of Guadalajara, Southern University Center. Mexico claudias@cusur.udg.mx
https://orcid.org/0000-0001-6152-2740
Vargas Iñiguez Jessica Carolina
University of Guadalajara, Southern University Center. Jalisco. Mexico jessicav@cusur.udg.mx
https://orcid.org/0000-0001-5953-1269
Abel Rentería Castillo
University of Guadalajara, Southern University Center. Jalisco. Mexico abelr@cusur.udg.mx
https://orcid.org/0009-0001-3074-9157
Ibarra Rentería Guadalupe Montserrat
University of Guadalajara, Southern University Center. Jalisco, Mexico gmontse.ibre97@gmail.com
https://orcid.org/0000-0001-9603-6179

Introduction

Well-being is a construct whose main conceptions are medical, philosophical, economic, and political. Doctors interpret it as the psychosomatic health of the body; philosophers as happiness or a fulfilling life; economists in terms of per capita income or the GDP of a region's citizens; and politicians and leaders understand it as a fixed objective or goal to be achieved by citizens. From the field of philosophy, happiness and well-being signify a mental or psychological state of satisfaction, which can be interpreted as an abundance of material goods and means to meet human needs, as well as desires (Spinoza, 1999 cited in Salas and Garzón, 2013).

Initially, studies on well-being were considered solely as an educational activity focused on research. In recent years, there have been countless proposals to apply the new knowledge gained about psychological well-being in various contexts (Biswas and Diener, cited in Joseph, 2015). The various ways in which psychological well-being research is applied can be simplified by noting that there are currently action plans promoting well-being in different settings, such as corporations and organizations, schools, daycare centers, and senior living facilities.

The definition of psychological well-being first appeared in the United States during the 1980s. The first studies on this topic began 50 years ago; psychologist Carol Ryff was one of the pioneers who believed that psychological well-being is of utmost importance for achieving full human development (Martínez, 2016). The earliest studies focusing on psychological well-being sought to analyze the influence of objective variables, such as socioeconomic and sociodemographic factors, in an effort to determine which individuals were more or less satisfied with their own lives (Sánchez, 1995, cited in Fernández et al., 2014). According to Moyano and Ramos (2007, cited in Fernández et al., 2014), well-being cannot be measured solely by economic variables; rather, psychological and social aspects—such as income, socioeconomic status, and social comparison—must also be taken into account.

The construct of psychological well-being has been characterized as a multidimensional aspect that can be defined as a person's competencies and individual development through which the individual demonstrates indicators of positive functioning. Carol Ryff and Corey Lee Keyes defined psychological well-being as a subjective perception, a state of mind, or a feeling (Sandoval, et al., 2017). This concept arises from the linear relationship between expectations

(an individual's vision of the future) and achievements (an assessment of the present), which various authors have termed "satisfaction" in the areas of greatest importance to human beings. These areas have been defined as work, family, health, interpersonal relationships, the material aspects of life, and emotional and sexual relationships with a partner.

Psychological well-being has been extensively studied, especially since the creation of Ryff's multidimensional model (1989). This model outlines six dimensions regarding the evaluation of an individual's perception. The first dimension is "self-acceptance," which refers to a positive evaluation of a person's present and past. Autonomy is the second dimension and focuses on the individual's sense of self-determination and independence. The third dimension is personal growth, focused on the sense of growth and development as a person. Purpose in life, referred to as the fourth dimension, emphasizes the belief that life has meaning and a purpose for the individual. The fifth dimension is that of positive relationships, which focuses on developing or acquiring quality relationships with others. The sixth and final dimension is mastery of the environment, which refers to a person's ability to function effectively in their surroundings and to successfully utilize the opportunities it offers (Maldonado, et al., 2015).

With regard to the university student population, there is evidence that they face numerous and increasingly frequent potentially stressful situations on a daily basis. The difficulties each student faces in achieving academic success constantly lead to a decline in their academic performance and the development of negative attitudes toward learning (Dwyer and Cummings, 2001). In turn, González et al. (2012) found that students' psychological well-being can decline considerably, along with their persistence in achieving goals, as their opportunities for growth are threatened by the stressful academic environment.

This set of issues typical of university life can lead students to develop conditions such as burnout or a decline in psychological well-being. It leads the individual to approach academic life with high levels of disinterest, a frustration that manifests physically and emotionally, and includes avoidant or escapist behaviors (Caballero et al. 2009). This entire process results in a desire to complete their academic life in a way that is not positive for students.

In contrast, the promotion of entrepreneurial skills—which are understood as a set of personal and professional resources that include "problem-solving competencies, critical thinking, autonomy, entrepreneurial self-efficacy, communication, project planning, and action orientation" (Ploum et al., 2018)—has been proposed as a personal resource that protects and enhances the well-being of university students. Recent studies show that the perception of employability and the development of competencies linked to the entrepreneurial profile are associated with better indicators of psychological well-being and help generate personal resources in the face of academic pressure (Petruzziello et al., 2024). The "entrepreneurial resilience" approach further notes that dimensions such as autonomy, perseverance, confidence in one's own abilities, and problem-solving orientation (core components of many entrepreneurship training programs) enable students to transform stressful events into personal and professional projects, thereby mitigating the negative impact on mental health. In line with the demand-resource model applied to the academic setting, these competencies act as personal resources that reduce the likelihood of entering spirals of burnout and cynicism (Jagodics & Szabó, 2022; Liu et al., 2023).

For this reason, the central objective of this research is to analyze levels of general psychological well-being and their relationship with the development of entrepreneurial skills

in a sample of university students from various majors at a public university during the lockdown period due to the COVID-19 pandemic.

To this end, a non-experimental, cross-sectional, descriptive, and correlational study was conducted, with the study population consisting of 1,134 university students from southern Jalisco who were in lockdown. They were selected using a non-probability sample. A self-administered instrument was used. The Psychological Well-being Scale was created by Carol Ryff (Díaz et al., 2006). For the descriptive analysis, means, standard deviations, minimums, and maximums were calculated; for categorical variables, simple and relative frequency measures were calculated. The conclusion was that lockdown led students to exhibit low levels of well-being and low institutional support.

This research is a non-experimental, cross-sectional, descriptive, and correlational study, as the researchers had no control over any variables and only describe the characteristics of the study population and the strength of correlation among the factors measuring psychological well-being in college students. The study population consisted of university students from southern Jalisco, and the sample was a non-probability sample of 1,134 students who agreed to participate during the lockdown period in 2021. The sample met the inclusion criterion of being a currently enrolled student in any semester and degree program offered in the 2021 B academic year.

To collect the data, a self-administered online questionnaire was used during September and October 2021, which was distributed through the coordinators of each academic program. The same questionnaire included the informed consent form and a brief survey on sociodemographic data such as: age, gender, marital status, degree program, and hours of study during the lockdown. The Ryff Psychological Well-Being Scale (1995) was used to assess psychological well-being and entrepreneurial skills.

The Psychological Well-Being Scale was created by Carol Ryff in 1995, revised in 2004, and adapted into Spanish by Díaz et al. (2006). The scale presents specific perspectives for assessing healthy psychological functioning, in contrast to the traditional clinical psychology focus on pathology and distress. This scale measures six positive dimensions of psychological well-being, which the author established based on theoretical discussions regarding fulfilled needs, motivations, and characteristics that describe a person in optimal mental health.

Its relevance extends beyond the clinical setting: Ryff has argued that her Eudaimonic well-being model—with dimensions such as autonomy, self- n environmental mastery, life purpose, and personal growth—is particularly relevant to the study of entrepreneurship, as many of these dimensions align with core competencies required of entrepreneurs, such as self-determination, initiative, environmental management skills, creativity, resilience, and goal orientation (Ryff, 2019).

Subsequent studies have adopted Ryff's scale in organizational or entrepreneurial contexts to assess well-being as a personal resource that can enhance "soft skills" or entrepreneurial competencies. For example, the study Well-being as a High-Performance Practice in the Organization. An analysis based on Ryff's model concludes that integrating the dimensions of psychological well-being into human talent management promotes the discovery and strengthening of people's potential, skills, and capabilities within companies, suggesting that the scale can serve as a combined measure of psychological well-being and entrepreneurial skills (Mosquera Castro et al., 2021).

Furthermore, the application of the scale in university settings has demonstrated adequate psychometric properties, supporting its use in non-clinical populations (Freire-Rodríguez et al., 2017).

This scale consists of 39 items, 22 positive items (1, 3, 6, 7, 10, 11, 12, 14, 16, 17, 18, 19, 21, 23, 24, 28, 31, 32, 35, 37, 38, 39) and 17 negative items (2, 4, 5, 8, 9, 13, 15, 20, 22, 25, 26, 27, 29, 30, 33, 34, 36) distributed across 6 dimensions. The instrument uses a six-point Likert-type additive scale with the following response options: Strongly Disagree (1), Disagree (2), Somewhat Disagree (3), Somewhat Agree (4), Agree (5), and Strongly Agree (6). A higher score indicates greater well-being.

The dimensions of the instrument are: Self-acceptance: positive self-evaluations and reflections on one's past life; recognition and acceptance of the multiple aspects of the self, including both negative and positive qualities. Items 1, 7, 13, 19, 25, and 31. Minimum 6 points, maximum 36 points. Positive relationships: high-quality, satisfying, and authentic interpersonal relationships; concern for the well-being of others; capacity for empathy, affection, and intimacy; understanding of the reciprocity required in human relationships. Items 2, 8, 14, 20, 26, and 32. Minimum 6 points, maximum 36 points.

Autonomy: sense of self-determination and independence; resistance to social pressure to think and act in a certain way; self-evaluation based on personal standards. Items 3, 4, 9, 10, 15, 21, 27, and 33. Minimum 8 pts., maximum 48 pts. Mastery of the environment: ability to effectively manage one's own life and the surrounding world; competent use of available resources in the environment; ability to choose or create contexts that satisfy personal needs and values. Items 5, 11, 16, 22, 28, and 39. Minimum 6 points, maximum 36 points.

Personal growth: sense of continuous growth and development as a person; self-perception of personal expansion; openness to new experiences; sense of fulfillment of personal potential; changes in directions indicating increased self-knowledge and effectiveness. Items 24, 30, 34, 35, 36, 37, and 38. Minimum 7 pts. Maximum 42 pts.Life purpose: ability to set life goals and sense of self-direction; persistence in achieving vitally important objectives; belief that one's own life, both past and present, is meaningful and has a purpose (García-Alandete, 2013). Items 6, 12, 17, 18, 23, and 29. Minimum 6 points, maximum 36 points. When all items are added together, scores below 116 indicate low psychological well-being, scores from 117 to 140 indicate moderate psychological well-being, scores from 141 to 175 indicate high psychological well-being, and scores above 176 indicate very high psychological well-being.

The dimensions of psychological well-being are interpreted in terms of high, medium, and low:

Self-acceptance: 6–17 points = low, 18–26 points = moderate, 27–36 points = high. Positive relationships: 6–17 points = low, 18–26 points = moderate, 27–36 points = high. Autonomy: 8–23 points = low, 24–35 points = medium, 36–48 points = high. Control over the environment: 6–17 points = low, 18–26 points = medium, 27–36 points = high. r personal growth: 7/20 points = low, 21/31 = medium, 31/42 points = high. Purpose in life: 6/17 points = low, 18/26 = medium, 27/36 points = high.

Student participation was requested through the coordinators of each educational program; students were asked to provide informed consent, and voluntary participation and confidentiality were ensured, in accordance with the relevant ethical requirements for the

research. This study is considered to be of minimal risk, as no tissue or blood samples were used.

For the descriptive analysis of numerical variables, means, standard deviations, minimums, and maximums were calculated; for categorical variables, simple and relative frequency measures were calculated. To identify statistical differences between the comparison groups, which were established by sex, Pearson's and Fischer's chi-square tests were used, depending on the distribution of the variables. For the correlation analysis between the components of psychological well-being, Spearman's correlation coefficient was used. According to Cohen (1988), correlation coefficients with values equal to or greater than .10 and less than .30 indicate a small relationship, values greater than .30 indicate a moderate relationship, while values greater than .50 indicate high correlations. For this analysis, the statistical package Stata 8.0 and an Excel spreadsheet from Office 365 were used.

Student Psychological Well-Being

The concept of Psychological Well-Being stems from a eudaimonic perspective, which centers on human development, self-actualization, and life as the pursuit of positive affect or hedonic satisfaction. One of its leading authors is Carol Ryff (Ryff, 1989; Ryff & Keyes, 1995), who proposed the multidimensional model of psychological well-being. This theoretical framework provides a conceptual basis for studying well-being in educational contexts such as higher education—a setting where students simultaneously face academic, psychosocial, and transition-to-adulthood demands.

In this sense, psychological well-being acts as a psychosocial resource that facilitates students' adaptation to the challenges presented by the university, thereby enabling them to enhance their academic and educational outcomes. Recent studies show that components of well-being in the eudaimonic sense, such as a sense of purpose and mastery of the environment, have a positive relationship with academic performance, resilience to academic stress, and personal growth throughout one's academic career (Ryff, 2019; Chaudhry et al., 2024). Chaudhry et al. (2024) note that psychological well-being is not a static state, as it changes throughout the university experience, being shaped by institutional support, support networks, prior educational experiences, or the institution's own efforts to promote self-regulation and a sense of belonging, thereby fostering integration and the development of competencies.

These competencies—primarily those related to entrepreneurship—are linked to psychological well-being by framing education as entrepreneurial, an institution that seeks not only technical skills but also autonomy, creativity, and self-efficacy. The literature on entrepreneurship indicates that the satisfaction of basic psychological needs (autonomy, competence, and relatedness) improves well-being in entrepreneurial activities, and, in turn, well-being facilitates the persistence and creative exploration necessary to develop projects (Gamboa et al., 2019) and (Shir, Nikolaev & Wincent, 2019).

In this way, entrepreneurial education not only imparts knowledge and techniques but also builds psychological resources (well-being, psychological capital) that increase the likelihood that entrepreneurial skills will be applied effectively and sustainably (Cui, 2021; Wang et al., 2021).

Development of Entrepreneurial Skills

The development of entrepreneurial skills as part of the educational field is currently understood as "a multidimensional process that combines technical knowledge, behavioral competencies, and attitudinal dispositions oriented toward the identification, exploitation, and sustainability of opportunities" (Mitchelmore & Rowley, 2010). When discussing these skills as competencies, we find that they are not merely instrumental repertoires, as they also incorporate cognitive (self-regulation and planning), relational (leadership and teamwork), and ethical-contextual (social responsibility) capabilities (Ploum et al., 2018). This comprehensive approach explains why the most effective entrepreneurship training programs combine theoretical instruction with practical and reflective experiences that promote not only "knowing" but also "knowing how" and "wanting to do" in business.

Systematic evidence suggests that these strategies facilitate the transfer of knowledge acquired theoretically to real-world practice, thereby increasing self-efficacy and entrepreneurship and strengthening traits such as frustration tolerance, resilience, and proactivity—traits that, in turn, correlate with entrepreneurial intent (Khalil, 2024; Mitchelmore & Rowley, 2010).

Furthermore, studies indicate that pedagogical design must address modular factors (course duration, intensity of practice, continuous assessment) and cross-cutting factors (interdisciplinarity, access to mentors, and seed funding) to foster the development of skills transferable to the labor market and business creation (Rosário & Raimundo, 2024).

Statistical analysis of psychological well-being and entrepreneurial skills: results and description of findings by dimension

In the descriptive analysis of the sample of 1,131 students, it was observed that 27.94% (n=316) were male and 72.06% (n=815) were female. The overall average age was 20.07 years with a standard deviation of ±2.7 years, ranging from a minimum of 16 to a maximum of 44 years. Women had a mean age of 19.96 years with a standard deviation of ±2.4 years, ranging from a minimum of 16 to a maximum of 41 years; for men, the mean age was 20.35 years with a standard deviation of ±3.25 years, ranging from a minimum of 17 to a maximum of 44 years. These differences are statistically significant with a $P < 0.05$ (Table 1).

Regarding employment status, 41.73% (n=472) are employed; of these, 64.83% are women and 35.17% are men. Of the 58.27% (n=659) who report not working, 22.76% are men and 77.24% are women. The differences in these percentages are statistically significant with a P-value <0.01 (Table 1).

21.66% (n=245) have completed one semester of online coursework; of these, 30.61% (n=75) are men and 69.39% (n=170) are women; of the 20.42% (n=231) who reported having taken two semesters online, 26.84% (n=62) are men and 73.16% (n=169) are women. 57.91% (n=655) reported having taken three semesters online; of these, 27.33% (n=179) are men and 72.67% (n=476) are women. The percentage differences are not statistically significant (P>0.05) (Table 1).

30.50% (n=345) reported spending less time studying during lockdown; of these, 30.14% (n=104) are men and 69.86% (n=241) are women; 42.62% reported spending more time studying, of whom 23.44% are men and 76.56% are women; only 26.88% did not change their

study hours, of whom 32.57% are men and 67.43% are women. The differences in the percentages are statistically significant with a P-value <0.05 (Table 1).

Based on the distribution of the population (n=1134) by field of study, the following degree programs stand out for their representation: Nursing (12.7%), Veterinary Medicine and Animal Science (10.67%), Nutrition (9.52%), International Business (9.26%), and Agribusiness (8.91%); Law at 7.67%, and Medicine and Obstetrics at 6.88%; the fields of Occupational Safety, Civil Protection, and Emergency Management; Biological Systems Engineering; Hispanic Studies; Geophysics Engineering; Nursing Technician; Agrobiotechnology; and other unidentified fields had a participation rate of less than 1.9%. The highest percentage of women is found in the Bachelor's programs in Nursing at 14.36%, Nutrition at 11.29%, and Veterinary Medicine and Animal Science at 9.94%, while the highest percentages of men are found in the programs in Veterinary Medicine and Animal Science at 12.34%, in Telematics Engineering at 12.03%, and in International Business at 10.76%; these percentage differences are statistically significant (P < 0.01%) (Table 1).

Table 1. *Description of the population by variable according to sex*

		Sexo		
Variable	Dimensiones	Hombres	Mujeres	Total
	n	316	815	1131
			Años	
Edad *	Mínimo	17.00	16.00	16.00
	Máximo	44.00	41.00	44.00
	Promedio	20.30	19.90	20.07
	Desviación estándar	3.20	2.40	2.73
			%	
Número de semestres cursados en línea por pandemia **	Uno	23.73	20.86	21.66
	Dos	19.62	20.74	20.42
	Tres	56.65	58.40	57.91
Trabaja ***	Sí	52.53	37.55	41.73
	No	47.47	62.45	58.27
Horas de estudio invertidas a la semana durante el confinamiento por pandemia*	Menos horas	32.91	29.57	30.50
	Más horas	35.76	45.28	42.62
	Igual de horas	31.33	25.15	26.88
Carrera cursada***	Abogado	6.65	8.10	7.69
	Lic. agrobiotecnología	0.00	0.12	0.09
	Agronegocios	9.81	8.59	8.93
	Cultura Física y Deportes	4.11	1.35	2.12
	Desarrollo Turístico Sustentable	2.85	3.68	3.45
	Licenciatura en Enfermería	6.33	14.36	12.11
	Ing. en Geofísica	1.90	0.37	0.80
	Ing. En Sistemas Biológicos	1.90	1.35	1.50
	Ingeniería Telemática	12.03	2.09	4.86
	Letras Hispánicas	1.58	1.35	1.41
	Medicina Veterinaria y Zootecnia	12.34	9.94	10.61
	Médico Cirujano y Partero	9.18	6.01	6.90
	Negocios internacionales	10.76	8.71	9.28
	Nutrición	5.06	11.29	9.55
	Periodismo	3.16	3.80	3.63
	Psicología	2.22	6.01	4.95
	Seg Lab Protec Civil y Emergencias	2.22	1.72	1.86
	Trabajo Social	1.27	6.63	5.13
	Cirujano Dentista	3.48	2.82	3.01
	Técnico en enfermería	0.32	0.49	0.44
	No identificado	2.85	1.23	1.68

*valor P<0.05 ** valor de P>0.05 *** valor de P<0.01

The results for the *self-perception* construct show that 54.43% (n=172) of men and 39.75% (n=324) of women rate it as low, accounting for 43.85% (n=496) of the study population. 43.35% (n=137) of men and 58.65% (n=478) of women rated it as average, representing 54.38% (n=615) of the population. 1.77% (n=20) of the population rated it as high, with 2.22% (n=7) of men and 1.60% (n=13) of women falling into this range. The percentage differences are statistically significant, with a P-value of *0.0000* (Tables 2 and 3). Among the variables comprising this construct, it is notable that only 20.9% of the population reports feeling

confident in themselves, 10.94% like most aspects of their personality, and 12.34% report feeling proud of who they are and the life they lead (Table 4).

Regarding the results for *the Positive Relationships* construct, 44.30% (n=501) rated it in the low range, 50.49% (n=571) in the medium range, and 5.22% (n=59) in the high range (Table 3). Analysis of these results by sex revealed that 39.87% (n=126) of men and 46.01% (n=375) of women rated it in the low range; 55.38% (n=175) of men and 48.59% (n=396) of women rated it in the middle range, and only 4.75% (n=15) of men and 5.40% (n=44) of women rated it in the high range. The differences in the percentages are not statistically significant (P > 0.05) (Table 2). Notable findings in the assessment of this construct include that only 8.82% of the population reported being able to trust friends and having friends who trust them, while 39.24% stated that they do not have many people who are willing to listen to them, and 51.67% of the study population reported feeling that their friendships provide them with many benefits. (Table 4).

The *Autonomy* construct was rated as low by 18.66% (n=211) of the general population, with 21.20% (n=67) of men and 17.67% of women rating it in this range. 73.30% (n=829) rated it in the medium range, with 74.05% (n=234) of men and 73.01% (n=595) of women. 8.05% (n=91) rate it in the high range, with 4.75% (n=15) of men and 9.33% (n=76) of women. The chi-square test reveals statistically significant differences with a p-value <0.05 (Tables 2 and 3). Notable in this construct is the low percentage of the population reporting confidence in their own opinions over those of the general consensus, and the high percentages regarding the tendency to worry about what others think of them and concern over how the choices they have made are evaluated (Table 4).

The results for *the Environmental Mastery* construct show that 54.75% (n=173) of men and 52.15% (n=425) of women rate it in the low range, representing 52.87% (n=598) of the population. 43.99% (n=139) of men and 46.75% (n=381) of women rated it in the medium range, representing 45.98% (n=520) of the population. Only 1.27% (n=4) of men and 1.10% (n=9) of women rated it in the high range, together representing 1.15% of the total study population. The percentage differences are not statistically significant with a P-value >0.05 (Tables 2 and 3). Noteworthy is the percentage of the population that agrees it is difficult to steer their lives toward a path that satisfies them and the low percentage who feel they are responsible for the situation in which they live; al , those who agree they are good at managing the responsibility of their lives, as well as the low percentage who would change their lives if they felt unhappy (Table 4).

Table 2. *Comparison of the assessment of psychological well-being components by gender*

Componentes del bienestar	Baja		Media		Alta	
	Hombres	Mujeres	Hombres	Mujeres	Hombres	Mujeres
Auto-aceptaci	54.43	39.75	43.35	58.65	2.22	1.60
Relaciones po	39.87	46.01	55.38	48.59	4.75	5.40
Autonomía*	21.20	17.67	74.05	73.01	4.75	9.33
Dominio del	54.75	52.15	43.99	46.75	1.27	1.10
Crecimiento p	87.03	81.35	12.97	18.28	0.00	0.37
Propósito en	58.23	48.71	37.97	45.89	3.80	5.40

Fuente: elaboración propia **Diferencias porcentuales estadísticamente significativas P <0.05*

Personal growth: this construct was rated as low by 82.94% (n=938) of the population, as medium by 16.80% (n=190), and as high by 0.27% (n=3) (Table 3). The results by gender show that 87.03% (n=275) of men rated it as low, 12.97% (n=41) as medium, and none rated it as high. 81.35% of women rated it as low, 16.80% (n=190) as medium, and 0.37% (n=3) as high. The differences in percentages between men and women are not statistically significant, with a p-value > 0.05. (Tables 2). In this construct, it is notable that only 5.03% of the population agrees that it is important to have new experiences and 4.23% feels that they continue to learn more about themselves, as well as 56.79% agree that their life is fine as it is and they would not change anything, and that only 9.17% agree that over time they have developed significantly as a person (Table 4).

Table 3. *Assessment of the components of psychological well-being*

Componentes	Baja	Media	Alta
Auto-aceptación	43.83	54.41	1.76
Relaciones positivas	44.36	50.44	5.20
Autonomía	18.61	73.37	8.02
Dominio del entorno	52.82	46.03	1.15
Crecimiento personal	82.89	16.84	0.26
Propósito en la vida	51.41	43.56	5.03

Table 4. *Weighting of psychological well-being assessment variables*

Variables	Media	DE	1*	2*	3*	4*	5*	6*
			%					
1 Estoy contento con cómo me han resultados las cosas	3.09	1.34	12.43	23.19	27.95	19.84	12.08	4.50
2 A menudo me siento solo/a porque tengo pocos amigos íntimos	3.53	1.73	15.34	19.22	16.58	13.14	17.81	17.90
3 Expreso mis opiniones, aunque sean opuestas a la mayoría	3.08	1.58	20.55	19.93	21.69	15.34	13.67	8.82
4 Me preocupa cómo se evalúan las elecciones que he hecho	4.00	1.62	7.32	13.58	20.81	14.55	17.90	25.84
5 Es difícil dirigir mi vida hacia un camino que me satisfaga	3.76	1.61	10.32	14.11	20.99	17.46	17.72	19.40
6 Disfruto haciendo planes y trabajar para hacerlos realidad	2.45	1.38	32.10	24.69	22.93	10.67	5.82	3.79
7 En general, me siento seguro/a conmigo mismo/a	3.10	1.50	16.58	22.05	24.96	15.52	13.05	7.85
8 No tengo muchas personas que quieran escucharme	3.78	1.66	10.76	14.99	19.49	15.52	18.25	20.99
9 Tiendo a preocuparme sobre lo que otros piensan de mí	3.93	1.68	10.93	12.96	16.05	16.40	19.40	24.25
10 Me juzgo por lo que yo creo que es importante	2.93	1.53	20.90	22.84	24.34	15.17	7.67	9.08
11 He construido un hogar y modo de vida a mi gusto	3.35	1.41	9.61	19.22	28.84	20.72	12.52	9.08
12 Soy activo al realizar los proyectos que me propongo	2.75	1.29	19.05	25.13	30.78	15.61	6.00	3.44
13 Hay muchas cosas de mí mismo que cambiaría	2.71	1.53	28.22	23.81	19.58	11.02	12.26	5.11
14 Siento que mis amistades me aportan muchas cosas	2.63	1.41	26.01	25.66	23.72	12.43	7.85	4.32
15 Tiendo a estar influenciado por gente con fuertes convicciones	3.85	1.48	6.35	13.05	23.54	20.63	18.87	17.55
16 Siento que soy responsable de la situación en la que vivo	2.37	1.27	28.75	33.25	20.55	9.79	5.11	2.56
17 Me siento bien con lo hecho en el pasado y con lo que espero hacer en el futuro	2.88	1.41	19.31	24.07	25.84	16.58	8.91	5.29
18 Mis objetivos en la vida han sido más satisfactorios que frustrantes	2.84	1.43	20.37	24.43	25.57	15.43	8.55	5.64
19 Me gusta la mayor parte de los aspectos de mi personalidad	2.57	1.35	24.51	31.39	21.52	11.64	7.50	3.44
20 La mayor parte de las personas tienen más amigos que yo	2.86	1.71	30.25	19.31	17.37	10.76	11.46	10.85
21 Tengo confianza en mis opiniones por sobre las del consenso general	2.82	1.37	19.58	25.31	26.01	16.23	8.73	4.14
22 Las demandas de la vida diaria a menudo me deprimen	3.43	1.59	13.58	17.99	22.66	16.75	15.96	13.05
23 Tengo clara la dirección y el objetivo de mi vida	2.85	1.54	23.81	22.66	23.28	13.05	9.17	8.02
24 Siento que sigo aprendiendo más sobre mí mismo/a	1.97	1.18	47.18	25.31	17.28	6.00	2.29	1.94
25 Me siento decepcionado/a de mis logros en la vida	4.06	1.57	7.41	10.23	20.99	15.52	21.60	24.25
26 No he experimentado muchas relaciones cercanas y de confianza	3.53	1.61	12.26	17.11	23.46	14.90	16.84	15.43
27 Me es difícil expresar mis opiniones en asuntos polémicos	3.60	1.60	11.38	15.52	24.51	15.17	17.02	16.40
28 Soy bueno/a manejando las responsabilidades de mi vida	2.75	1.31	18.08	29.19	26.72	15.17	7.41	3.44
29 No tengo claro qué es lo que intento conseguir en la vida	4.07	1.67	8.73	12.70	17.02	13.76	19.75	28.04
30 Hace tiempo que dejé de intentar hacer grandes mejoras en mi vida	4.25	1.58	6.61	9.17	18.61	14.46	20.99	30.16
31 Me siento orgulloso/a de quien soy y la vida que llevo	2.64	1.42	26.28	24.51	24.51	12.35	8.02	4.32
32 Puedo confiar en mis amigos, y ellos en mí	2.28	1.41	39.24	26.19	15.52	10.23	4.41	4.41
33 Cambio mis decisiones si mis amigos o familia están en desacuerdo	3.88	1.56	8.02	12.79	22.49	16.14	20.90	19.66
34 Mi vida está bien como está, no cambiaría nada	4.51	1.38	2.82	6.35	15.43	18.61	25.57	31.22
35 Pienso que es importante tener nuevas experiencias	2.07	1.23	42.95	26.54	17.72	7.76	2.91	2.12
36 Realmente con los años no he mejorado mucho como persona	3.85	1.70	11.46	14.20	18.78	12.17	20.28	23.10
37 Con el tiempo me he desarrollado mucho como persona	2.40	1.38	33.86	25.93	19.49	11.55	5.73	3.44
38 La vida ha sido un proceso continuo de estudio, cambio y crecimiento	2.13	1.25	41.80	24.51	19.49	9.17	3.09	1.94
39 Si me sintiera infeliz con mi vida trataría de cambiarla	2.43	1.34	32.80	22.84	23.81	12.96	4.76	2.82

The results for *the Life Purpose* construct were rated in the low range by 51.37% (n=581) of the population, in the medium range by 43.68% (n=494), and in the high range by 4.95% (n=56). By gender, 58.23% (n=184) of men rated it in the low range, 37.97% (n=120) in the medium range, and 3.80% (n=12) in the high range; while 48.72% (n=397) of women rated it in the low range, 45.89% (n=374) in the medium range, and 5.40% (n=44) in the high range. The differences in percentages between men and women are statistically significant. P-value < 0.05 (Table 2). In this construct, only 9.61% reported agreeing that they enjoy making plans and working to make them a reality, and 47.79% reported agreeing that they are unclear about what they are trying to achieve in life (Table 4)

The results of the psychological well-being assessment show that 49.43% (n=559) of the population scores in the low range; of these, 32.02% (n=179) are men and 67.98% (n=380) are women; 44.12% (n=499) scored at a moderate level, of whom 24.85% (n=124) are men and 75.15% (n=375) are women; 6.01% (n=68) of the population falls into the high category, of whom 17.65% (n=12) are men and 82.35% (n=56) are women. Only 0.44% of the population falls into the very high category. The results analyzed by sex show that 56.65% (n=179) of men are in the low category and 0.32% in the very high category; while 46.63% of women were in the low range (n=380) and 0.49% were in the very high range; these percentage differences are statistically significant with a p-value < 0.05 (Table 5).

Table 5. *Assessment of psychological well-being by gender*

Sexo	Bajo	Moderado	Alto	Elevado
Hombres	56.65	39.24	3.80	0.32
Mujeres	46.63	46.01	6.87	0.49
Población total	49.43	44.12	6.01	0.44

Regarding the correlation between psychological well-being and its constructs—positive relationships, autonomy, self-acceptance, and life purpose— , these constructs showed moderate positive correlations, while the constructs of environmental mastery and personal growth showed high positive correlations. These correlations had a p-value < 0.0000 (Table 6). When analyzing the correlations by gender, it was found that the constructs environmental mastery, personal growth, and life purpose showed high positive correlations in women, while in men, only environmental mastery and personal growth showed high positive correlations (Table 6).

Table 6. *Correlations between psychological well-being and constructs by gender*

Constructos	Sexo		
	Hombres	Mujeres	General
Auto-aceptación	0.4461*	0.3893*	0.4120*
Relaciones positivas	0.3136*	0.3973*	0.3672*
Autonomía	0.3674*	0.3749*	0.3770*
Dominio del entorno	0.5227*	0.5059*	0.5104*
Crecimiento personal	0.5361*	0.5097*	0.5183*
Propósito en la vida	0.3997*	0.5003*	0.4784*

The main objective of this study was to identify the level of psychological well-being among college students during the pandemic lockdown, and a response rate of 13.89% of the total population was achieved. The main finding indicates that 49.43% of the sample reported a low level of psychological well-being. 67.98% of women reported low levels of psychological well-being, while 32.02% were men. This contrasts with the results of studies by Bhullar, Hine, and Phillips (2013), Lapa (2015), and Rodríguez et al. (2015), which state that there are no differences between male and female university students—contrary to the findings of this study, which did find significant differences regarding the gender variable.

On the other hand, studies by Cubas (2003), Freire (2014), Meza (2011), and Pérez (2012) reported high levels of psychological well-being in both the overall score and the subscales that comprise it, contrary to this research. These notable differences can be explained by the context in which the instrument was administered. The COVID-19 pandemic and the lockdown imposed on society may account for the low level of psychological well-being; in addition to facing the inevitable changes of this new phase of their academic lives, university students were forced to study from home without the usual social interaction among their peers and even to work under the same conditions.

Conclusions

In the academic sphere, research has been conducted with university student populations that reports high levels of psychological well-being, describing students as having a greater capacity to express their emotions through dialogue. This research demonstrates that university students with low levels of psychological well-being resort to suppressing their own emotions.

Findings in the literature suggest that the relationship between psychological well-being and academic performance is complex and not always linear. While a significant portion of the student body shows difficulties in managing their educational environment and envisioning their studies as part of their future, this does not necessarily imply that their overall well-being is low. The results suggest that psychological well-being and academic performance may be linked in different ways depending on each student's experiences, personal resources, and coping strategies. This reinforces the need to understand both phenomena from a comprehensive perspective, considering both individual factors and the academic conditions that influence student development.

In conclusion, we can state that university students exhibited low levels of psychological well-being due to the context in which they were living during the COVID-19 pandemic. This demonstrates that universities still have much work to do to prevent such situations and to support students' emotional health. There are many factors that can serve as protective factors in coping with adverse experiences such as those observed in this study, and it is necessary to strengthen them through an institutional approach. In this regard, it is pertinent to explore in greater depth how psychological well-being—particularly the dimensions proposed by Ryff, such as autonomy, life purpose, environmental mastery, and personal growth—can be linked to the development of entrepreneurial skills, understood as resources that enhance resilience, creativity, decision-making, and adaptability. Incorporating this perspective opens a strategic avenue for future research, as promoting entrepreneurial competencies in students could not

only enhance their academic performance but also serve as a psychological protective mechanism against crises such as the pandemic.

Finally, university interventions aimed at strengthening socio-emotional skills and coping strategies (for example, online or group programs that train emotional regulation, self-acceptance, and active coping strategies) have shown a reduction in related symptoms and an increase in well-being, suggesting that incorporating training in entrepreneurial skills and personal development programs can contribute to a more fulfilling university experience with a lower risk of dropping out due to academic burnout. Thus, integrating psychological well-being with the development of entrepreneurial skills could have a positive impact on both students' personal development and their ability to navigate uncertain situations.

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Students Perceptions of the intertwined use of Formative assessment and the Learning Knowledge Technologies within history lessons

Verónica Yáñez-Monje
Universidad de Concepción (Chile), veyanez@udec.cl, https://orcid.org/0009-0006-0243-4576
Felipe Ruiz-Rojas
Universidad de Concepción (Chile), felandresr@gmail.com, https://orcid.org/0009-0007-2763-7385
Robinson Dinamarca
Universidad de Concepción (Chile), robidinamarca@udec.cl, https://orcid.org/0000-0002-1062-0786

Introduction

This chapter sets out empirical research that engages formative assessment and Learning and Knowledge Technologies (LKT) within the context of history lessons. This in an attempt of addressing some issues and pedagogical challenges within both educational fields of enquiry.

Although the benefits of formative assessment have been largely documented by literature, a great range of studies have foregrounded difficulties to enact this approach within classroom. According to Wiliam (2018) some key strategies such as sharing success criteria, questioning, making comments, peer and self-assessment and the formative use of summative tests need to articulate more plainly "their precise relationship to each other, to feedback, and to formative assessment" (p.22). The author argues that, while these activities help to distinguish what formative assessment really means, they should be considered as a framework to prompt further discussion and thinking among teachers in a more integrated manner, as it could be the case that they do not entirely encompass all the possible options for this outlook to be instantiated in practice. In line with the purpose of this chapter, a focus on the rationale behind these techniques is placed, as a number of contributions pose a note of caution in terms of its principles being overturned in everyday lessons (Wiliam 2018). For instance, drawing attention to the work with success criteria requires to overcome the practice of designing check lists that communicate isolated aspect of quality, as this may limit the opportunities for pupils to learn how to make holistic judgments on their own ongoing work, particularly within a configurational stance (Sadler, 2015). Similarly, it should be taken into consideration how feedback is conceived. It might be the case that a shift is needed from the telling paradigm (teacher providing feedback to students) towards an approach that actively involves pupils into this process (Carless, 2018). The issue at stake is not just how students receive and make sense of feedback but also how they act upon it to improve their work (Hattie, 2021). This, within a dialogic and iterative process of pupils' discussion with peers and their teachers, enabling them to use what has been already learned in future tasks (Molloy, *et al*, 2020)

Concerning technology, several compelling contributions advocate the need for schools to adjust their teaching, learning and assessment focus in response to new generations of students raised in the digital era (Area -Moreira *et al.*, 2020). In the same vein, studies have highlighted that when LKT are appropriately integrated into lessons, considerably benefits for pupils' motivation can be reached (Shehata *et al.*, 2023), while also providing room to develop

learners' autonomy (Deroncele-Acosta, 2024). Nevertheless, research also spotlights relevant constraints related to the instrumental use of digital tools, which can hinder and divert its pedagogical purpose. It seems that, despite numerous initiatives aimed at integrating technology into education, digital literacy is required not only on the part of the teachers but also of students (Gil-Fernández & Calderon- Garrido,2023).

Thus, linking formative assessment and technology calls for a notion that goes beyond viewing technology merely as a computer-aided tool for saving time and investment instruction, for instance, by providing an increased amount of feedback (Hattie *et al.*, 2021). The value of Learning and Knowledge Technologies within assessment lies in enhancing pupils' capabilities to make informed judgments about their work, thus strengthening their self-regulations abilities. However, this crucial aspect has not yet been distilled yet research, so it requires further exploration from theory and practice (Gross-Salvat & Cano-García,2021)

General context

This inquiry aimed at exploring students' perceptions about the potential contribution to their learning steaming from pedagogical strategies that link LKT and formative assessment.

In line with this purpose, a school located at the VIII region of Chile was chosen as empirical research was chosen as empirical field. Broadly, the establishment was non- state-run, however it still adopted the national curriculum guidelines to settle their own teaching and assessment policy. It should be noted that at the time that this study was accomplished, the Chilean Ministry of Education had already announced a national policy about assessment, whose prime tenets, emphasised a formative purpose (Mineduc,2017).This involved paying attention to the enactment of core notions such us: clarification of goals and assessment criteria, collecting and interpreting evidence of learning and feedback alongside reflection and self-assessment to foster pupil's autonomy (Mineduc,2017).

Regarding LKT, the chosen educational setting had a declared intention about its use within the institutional formal documents, which, encompassed general guidelines highlighting their potential benefits for learning problematisation and enduring knowledge. However, it cannot be asserted how these notions were materialised in classrooms. This might be related with findings from the extant literature illustrating some resistance to utilise digital technologies within actual lessons as well as the need for improving pupils' abilities to manage these tools (Timotheou *et al.*,2023)

Bearing in mind the above considerations, a pedagogical design that entails formative assessment strategies and a selection of Learning and Knowledge Technologies is proposed. The implementation of this proposal sought pupil's recognition of both insights as a reciprocal process. The specific context of the study had to do with a history class consisting of 23 pupils aged between 15 and 16 years old. One third grade secondary class was appointed to look for emphasis and nuances that might characterise pupils' experiences and views on this work.

Implementation

The enactment of the pedagogical sequence comprised five lessons. Each lesson was organised in consistency with the formative assessment cycle (Heritage, 2021), thereby, Phase1 started with a discussion around learning objectives and the success criteria which also implied an elicitation of students' prior knowledge and ideas. This is followed by Phase 2, during which

collective and collaborative work took place throughout the enactment of one specific activity that necessarily involved digital application. Within this phase there was a particular consideration of the learning evidence that could be captured as an ongoing process and how that evidence might be interpreted by the teachers and their students. To conclude the lesson, Phase 3, focused on pupil's reflection and self-assessment on what had been learned.

These common features that framed each lesson were mediated by distinctive digital applications strategies, as follows: using Instagram stories(lesson1), creating a meme (lesson 2) analysing information through X (lesson 3), designing GIFs (lesson 4) and, creating a digital newspaper cover (lessons 5). In addition, three points should be highlighted regarding these tools: i) They were content related to the topic about Transformation of the State's role and the modernisation within society in the first half of the 20th century, ii)They were conceived as enabling activities (Carless & Boud, 2018) as they were designed to support and facilitate pupils' engagement in learning and assessment, thus encouraging peer work, self and peer assessment, iii) They were elaborated having in sight further analyses and reflection as pupils were asked to upload their work to a cloud-based repository. This research is driven by the research question: How do students perceive pedagogical strategies that link LKT and formative assessment in relation to their potential contribution to learning? This question is addressed from a qualitative research paradigm, with an exploratory-descriptive focus (Hernández-Sampieri & Mendoza, 2020). The qualitative nature is grounded in an interpretative perspective of students' opinions, experiences, reflections, contradictions and singularities.

The study was carried out following a case study design (Flick,2022). As inferred from the previous section, the sampling selection rationale was both purposive in accordance with the prime research objective and convenient by considering researchers' opportunities in terms of having access to the empirical field. The criteria for sampling selection revolved around: i) The class should pertain a school whose declared policy regarding assessment were formative oriented and favoured the use of digital tools, ii) The class should be enrolled within a secondary educational level, iii) The disciplinary subject to implement the pedagogical sequence should be history, as it opens the opportunities for discussion, debate, and reflection enhancing the integration of teaching, learning ad assessment. iv) The feasibility of implementing multiple lessons so pupils could access more opportunities for and in-depth reflection in order to appreciate the extent to which the pedagogical sequence that integrates formative assessment and LKT can strengthen or hinder their learning). v)Participants should have signed the informed consent form. Data collection explored pupils' viewpoints or interpretations on the pedagogical sequence fulfilled within classroom setting. Learning journals and focus groups were chosen as prime instruments for gathering information. In terms of the validation procedure, both instruments were assessed by a panel of experts by considering criteria regarding adequacy, coherence, clarity, and relevance (Alonzo & Teng, 2023)

The Learning journals were designed to collect detailed evidence of the proposal's potential influence on pupils' metacognition and self-regulation abilities (Winarti., Ambaryani & Putranta, 2022). Consistent with this aim, the instrument adopted a mixed- format structure. The first section consisted of a Likert Scale (Hernández-Sampieri & Mendoza, 2020) that included items introduced asseverations or statements, seeking to capture the participants' judgments by indicating their level of agreement with each assertion. The second section of the Learning Journals comprised open questions, which triggered students' reflections in an attempt to

understand how they were making sense of the undertaken pedagogical sequence. The focus group followed a semi-structured interview format (Brinkmann,2022) endeavouring to enrich the understanding of pupils' views on the classroom activities oriented by a formative assessment approach intertwined with digital technologies. Data analysis was conducted using Atlas.*ti software*. The ensuing techniques were implemented: i) Frequency analysis to identify the recurrence of students' responses, concepts and value judgments arising from the first section of the learning journals, this is to say, from the Likert scale ii) Thematic analysis to code the qualitative data steaming from the second section of the Learning Journals and from the focus group. This, in line with analytical dimensions that illustrated pupils 'views on what the pedagogical sequence implied for teaching, learning and assessment and the specific contribution of Learning and Knowledge Technologies (LKT). iii) Inductive identification of emerging categories to expand the understanding of participants' perceptions.

The main findings are presented in alignment with the research question that drove this inquiry. Thereby, students' perceptions of the potential contribution to learning steaming from strategies that link LKT and formative assessment are displayed. To illustrate these results the section is structured in accordance with each procedure for data gathering.

Pupils' Overall Positive Value of Assessment Strategies Supported by LKT

As can be observed in Table 1 below, the Likert Scale results show a generally favourable pupils' opinion regarding the implications of the experienced pedagogical sequence on their learning and understanding. The only exception was the item related to effective organisation of time and effort which will be commented onwards.

Table 1. *Frequency Punctuations Steaming from the Likert Scale*

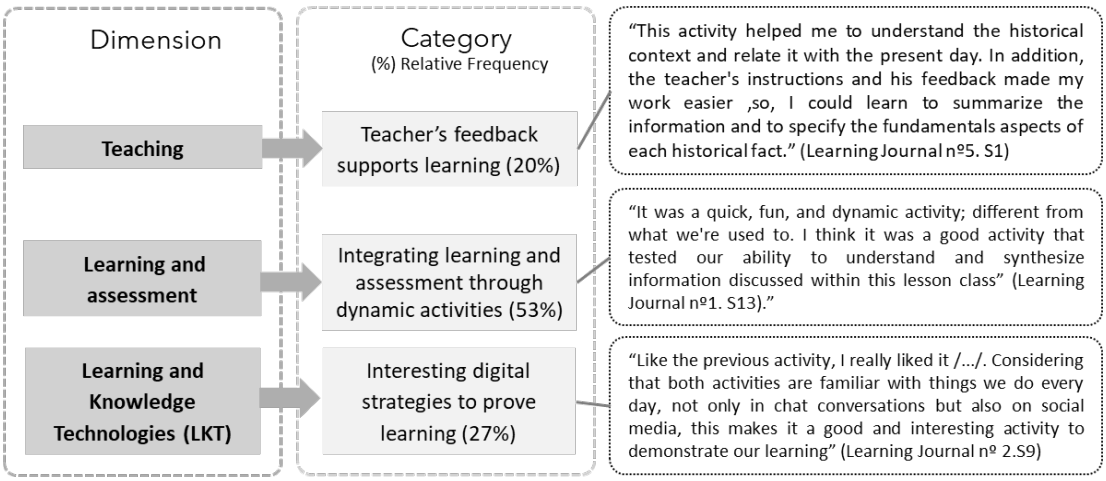
Item	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5
The teacher's methodology facilitated my own learning.	100%	94%	100%	94%	100%
The lesson activity supported me in the in- depth understanding about the historical content.	100%	100%	88%	94%	100%
The lesson activity helped me to organise effectively my time and effort.	29%	100%	52%	88%	64%
The collaboration amongst peers enriched my learning experience.	100%	100%	100%	94%	70%
The use of digital tools, within this lesson, greatly strengthened me in the learning of the historical content.	94%	100%	100%	88%	88%

As shown in Table 1, the item that obtained the highest score was related to the influence of the teacher's methodology on pupils' learning with an average of 97% across the five implemented lessons. This was closely followed by a positive students' view on how the activities helped them gain a deeper understanding of the subject content (96 % average). In the third place, pupils expressed a strong appreciation for the role of digital technologies in supporting their learning within classroom settings (94% average). Similarly, peer's collaboration was also highly valued, with an average score over 90% as strategy that enriched their learning experience. However, punctuations noticeably dropped for the item that measured the extent to which lesson activities supported their abilities to better organise their time and effort, reaching only 66% on average. This was especially evident in Lessons 1 and 3 where the related items received ratings of 29% and 52%, respectively. Therefore, it could be said that this finding aligns with previous research in terms of the need for further inquiry into how technology can foster students' self-regulation (Gross-Salvat & Cano-García,2021). In addition, this might be explained through the notion of digital literacy (Gil-Fernández & Calderon- Garrido,2023). The lowest scores regarding the influence of the pedagogical sequence in the pupils' capacities could be attributed to the specific assessment activities and the digital tools used, such as using Instagram stories (Lesson1), analysing information through X (Lesson 3), and creating a digital newspaper cover (Lesson 5). It is possible that these particulars strategies were more challenging for students to manage effectively.

Novel Methods for Teaching, Learning and Assessment

The analysis of students' responses to the open-ended question in the Learning Journal reported their perspectives in relation to three main dimensions, namely: teaching, learning and assessment, and the LKT. Figure 1 below outlines the resulting categories and includes selected excerpts from pupils' written answers to illustrate the findings.

Figure 1. Prime categories arisen from pupils' response to open-ended question.



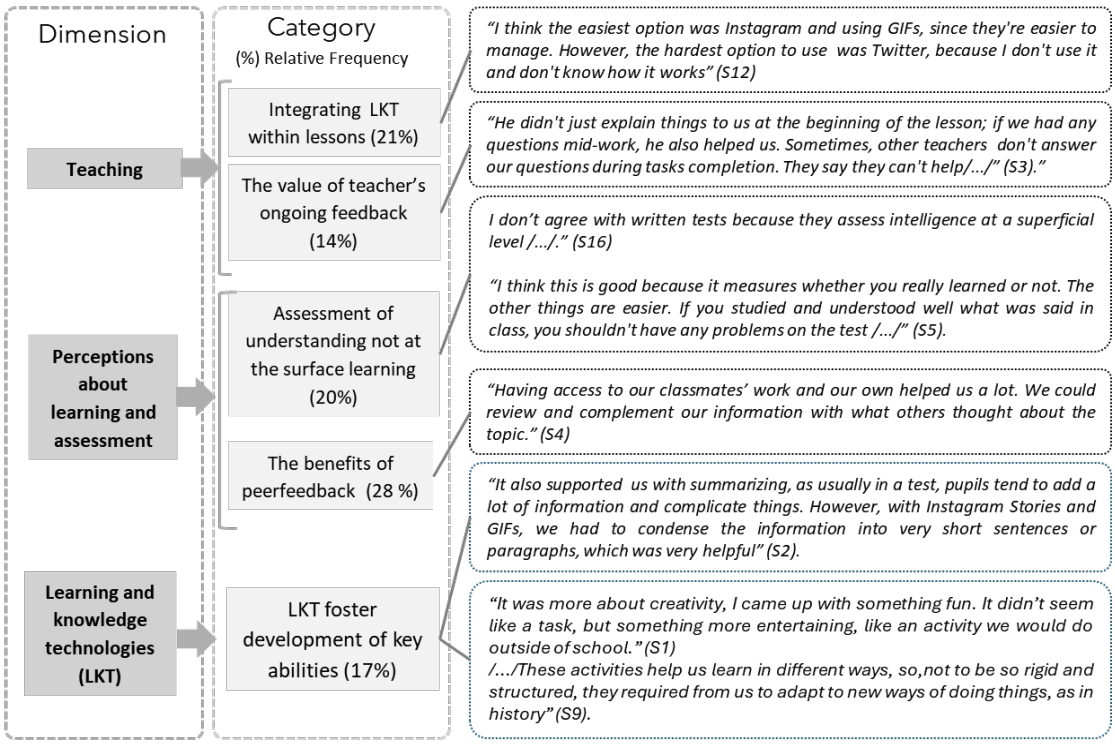
As can be observed, the first category, *Teachers' feedback supports learning,* was represented by in 20% of pupils' responses. This category reflects a recognition of the benefits for learning steaming from practices such as feedback and the appropriate wording of instructions and its subsequent influence on the understanding of historical facts, as well as the development of basic abilities as summarising.

The second category *Integrating learning and assessment through dynamic activities* (53%) depicted that pupils could grasp the mixed notion of the proposed strategies. For instance, they were learning how to synthesize information, while simultaneously having this capacity monitored on an ongoing basis through the use of innovative techniques. The third highlighted category, *Interesting Digital strategies to prove learning* (27 %), relates to the use of LKT within lessons. Results indicated that students acknowledged its value as a teaching and assessment tool. Moreover, they also characterised the digital technologies as familiar which encouraged them to work.

Integrating Formative Assessment and LKT helps Understanding

Data collected through the focus group provided a more detailed account on pupils' views regarding the potential contribution to learning while engaging with a formative assessment methodology Integrated with Learning and knowledge Technologies (LKT). The Figure 2 below displays the participants notions alongside selected extracts from the transcripts exemplifying what is reported.

Figure 2. Main categories steaming from the focus group data.



As shown in Figure 2 the implications of the pedagogical sequence for teaching revealed two important points. Firtsly, different digital technologies entailed a distinctive scope and posibbilities for classroom implementation. While, some of them were more familiar for pupils, others were less frequently used by them, which brings us back to the challenges regarding digital literacy as reported in previous sections. Secondly, the feedback provided by the teacher was considered highly relevant for learning, especially, because this strategy characterised the entire process rather than being limited to the delivey of initial instructions.

Data also indicated that the pedagogical proposal influenced the assessment of learning at a

deeper level of understanding, as opposed to just monitoring superficial knowledge. The excerpts from Figure 2 illustrated pupils' comparisons between traditional tests and the innovative assessment procedures applied within the proposal, which, according to the students' perspective focused more on observing the extent to which they had actually learned rather than simply verifying the information transmited during lessons. Moreover, peer feedback was highligted as a helpful strategy, as it allowed students to share their work and gain insight into their peers' views on the subject beig discussed.

The implications of integrating LKT into the pedagogical proposal involved the development of key abilities for pupils as illustrated by the extracts in Figure 2. In fact, the students accounted how the activities influenced their creativity, their ability to summarise information and how the implemented strategies required them to demonstrate both willingness and capacities to learn through diverse approaches.

Conclusions

The study reported that students identified potential benefits for learning derived from a pedagogical proposal that intertwined formative assessment and LKT. Notably, pupils' notions extended beyond the commonly used elements for incorporating digital tools into classroom. This is to say, although they characterised this device as funny, dynamic and interesting, they also elaborated upon some specific learning capacities that they considered were developed through lessons, such as, synthesising, creativity and adaptation to new ways to learn. Likewise, the students also highlighted opportunities for better understanding through innovative assessment activities, peer feedback and teacher's feedback. This empirical research demonstrated the value of exploring, within a combined and reciprocal approach, two lines of inquiry and analyses the possibilities of documenting how to enhance pupils' learning. More work needs to be done in order to investigate this issue in other contexts and disciplines, specially, by examining further insights in terms of pupils and teachers' digital literacy and how LKT can influence self-regulation.

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Participatory design of a workshop for the empowerment of rural women in Colombia

Magda Alejandra Martínez-Daza
Corporación Universitaria de Asturias, Bogotá (Colombia),
magda.martinez@asturias.edu.co, https://orcid.org/0000-0001-8028-4063

Introduction

The empowerment of rural women engaged in agriculture represents one of the most urgent and strategic challenges for achieving gender equality in developing countries (Nayak *et al.*, 2024). Despite normative progress and the growing recognition of their rights, structural gaps persist in access to productive resources, educational services, technical assistance, and political participation (Food and Agriculture Organisation of the United Nations [FAO], 2017, 2021; ONU Mujeres, 2023). These inequalities restrict both their individual and collective autonomy and also limit their contribution to the sustainability of agri-food systems (Gebre *et al.*, 2021; Njuki *et al.*, 2022). Various studies have shown that when women gain access to education, technology, financing, and appropriate training, they increase their autonomy and decision-making capacity, adopt more sustainable agricultural practices, and promote meaningful transformations within their communities (Cook *et al.*, 2021; Gichungi *et al.*, 2023). In this process, education plays a fundamental role, not merely as a transmission of knowledge, but as a catalyst for raising awareness, shaping the role of women, and fostering social transformation from a gender perspective (Sheshadri *et al.*, 2020).

In recent years, the use of gender-participatory approaches for training and reflection has gained prominence in empowering rural women. These approaches, focused on dialogue, shared experience, and collective action, have proven more effective than traditional methods by enabling women to build knowledge based on their realities, reclaim their voices, and promote training processes within their communities (Leal Filho *et al.*, 2022; Quisumbing *et al.*, 2021). However, many of these interventions lack an explicit pedagogical foundation, which weakens their systematisation, evaluation, and replicability (Phiri *et al.*, 2022). In this context, there is a need to design a formative methodological guide grounded in educational theories, approaches, and strategies that aim to strengthen the empowerment of women in rural settings. Based on these considerations, the main objective of this chapter is to systematise the conceptual validation process that underpins the design of such a methodological guide. To achieve this purpose, a qualitative methodology was adopted, structured into three phases. The first a systematic review of the scientific literature (367 indexed publications, 42 selected). From this conceptual foundation, the following research questions were addressed: (1) What are the trends in the scientific literature on the empowerment of rural women in agriculture through capacity-building in training processes? (2) What educational approaches or theories are employed in studies focused on the empowerment of rural women? (3) What strategies or training practices are related in the studies aimed at strengthening the empowerment of rural women?

The research employed a systematic mapping approach, grounded in the methodological guidelines proposed by Tebes *et al.* (2020). The review focused on studies related to the empowerment of rural women involved in agricultural activities and who had benefited from educational interventions, participatory methodologies, or pedagogical theories. The

methodological process was structured into three phases. In the first phase, four guiding questions were formulated to guide the literature review, as stated in the introduction and carried out in the Scopus database using a combination of keywords such as "agriculture", "women farmers", "women's empowerment", "women's agency", "capacity building", "training program", "educational theory", "educational strategy", "pedagogical model", "participatory methodology", and "participatory education". A total of 367 documents were identified and subjected to a review and screening process.

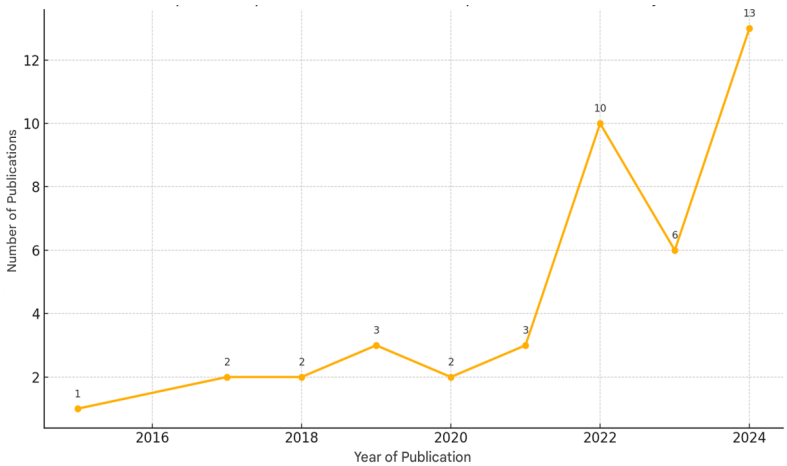
The first automated filter was based on titles, abstracts, and keywords, which resulted in 138 publications. Subsequently, a second manual filter was applied to refine the selection, excluding studies focused on urban, political, or non-agricultural contexts, as well as research in developed countries. Priority was given to research conducted in Latin America and other regions with high rurality, focusing on women farmers, with explicit educational interventions (workshops, training programs, participatory methodologies, or pedagogical theories). An additional 187 studies were excluded, resulting in 42 articles that met all the criteria (Figure 1).

In the second phase, the methodological guide was designed, structured into four sequential stages that integrated training objectives, participatory activities, and contextualised didactic strategies. The third phase involved a structural analysis of the workshop, through which relationships were established between the training stages, the theoretical frameworks used, and the pedagogical decisions adopted regarding language, materials, group dynamics, and timing.

What are the trends in the scientific literature on the empowerment of rural women in agriculture through capacity-building in training processes?

The analysis of the 42 studies selected identified sustained growth in scientific output between 2018 and 2024, especially in research focused on empowering rural women through training programs, capacity building, and participatory strategies (Figure 1).

Figure 1. *Temporal Distribution of Publications on Empowerment, Capacities, and Training Processes.*



Although the early years of the period (2015-2017) showed limited output, from 2022 onwards

there was greater visibility of the topic in scientific literature, particularly in developing countries. The research analyzed was mainly conducted in rural contexts in Africa, Asia, and Latin America. Some authors, such as Baah-Boateng *et al.* (2022) in Ghana, Kenya, and Nigeria, Bhattacharya *et al.* (2024) in India, and Nazari *et al.* (2024) in Pakistan and Iran, have worked on job training, agricultural leadership, and women's autonomy. In Latin America, notable studies include those by Sousa *et al.* (2024), with community interventions and rural policies, and Zegarra *et al.* (2018) in Peru, focusing on peer training.

The analysis reveals several authors who address multiple dimensions of rural women's empowerment: personal, relational, economic, educational, and community. Bandiera *et al.* (2020), Tandon & Srinivasan (2024), and Zegarra *et al.* (2018) show that each initiative responds to specific training needs for empowerment. Likewise, authors such as Thorne (2021), Sinclair *et al.* (2022), Venis *et al.* (2022), Wood *et al.* (2020) document experiences in technical, vocational, and life skills training, which strengthen personal, economic, educational, and community empowerment. In turn, studies such as those by Gichungi *et al.* (2023), Jaiswal *et al.* (2024), and Kaki *et al.* (2023) highlight strategies focused on mentoring, leadership, and training promoted by community organizations, with a significant impact on relational empowerment. However, some studies, such as those by Njogu *et al.* (2024), prioritize indicators of participation or inclusion.

What educational approaches or theories are employed in studies focused on the empowerment of rural women?

The analysis of the studies allowed us to identify educational approaches for the three levels of empowerment: personal, relational, and community. Five approaches stand out: (1) Paulo Freire's pedagogy of consciousness (Campos & Oliveira, 2020; Marin Gonzáles, 2021; Ramos-Pardo *et al.*, 2021; Tandon & Srinivasan, 2024); (2) Naila Kabeer's theory of empowerment (Bageant *et al.*, 2024); (3) Feminist pedagogies with an emphasis on the individual (Elwell & Buchanan, 2019); (4) Amartya Sen's theory of capabilities (Bageant *et al.*, 2024); and (5) Kolb and Freire's human capital approach (Van den Berg *et al.*, 2020). At the relational level, focused on building bonds, solidarity, participation, leadership, and shared decision-making, approaches such as Lidia Puigvert and Ramon Flecha's dialogical feminism emerge (Ruiz-Eugenio *et al.*, 2024). Feminist pedagogies with an emphasis on the interpersonal and group are also explored in depth (Elwell & Buchanan, 2019). Finally, at the structural or community level, aimed at transforming norms, institutions, and power structures, Freire's pedagogy of consciousness-raising or liberating education is once again integrated (Bageant *et al.*, 2024; Campos & Oliveira, 2020; Ramos-Pardo *et al.*, 2021). Critical feminist and decolonial pedagogies are particularly relevant here (Mahecha Montañez & Collado Castellanos, 2024).

What educational approaches or theories are employed in studies focused on the empowerment of rural women?

The training strategies documented in the studies reviewed are characterized by their participatory, dialogical, and community-based approach, aimed at strengthening the individual and collective power of rural women. Zegarra *et al.* (2018) describe peer learning processes, where previously trained women replicate knowledge in their communities, generating networks of support and belonging. Ragasa *et al.* (2023) report women's circles and community mentoring as key spaces for collective planning and autonomous decision-making.

Along the same lines, Rouhani (2019) and Sinclair *et al*. (2022) highlight the use of visual and digital narratives as tools to make silenced experiences visible and foster critical awareness. Strategies such as role-playing, dramatizations, and introspection exercises, analyzed by Shankar *et al*. (2015), allow for the exploration of identities, power relations, and personal aspirations from a transformative perspective. For their part, authors such as Lorist (2024) and Kalibwani *et al*. (2021) incorporate information technologies and digital platforms as means to expand access to educational resources and promote autonomy. Together, these practices seek to educate critical individuals who are aware of their context and capable of acting upon it, integrating principles of popular education and feminist pedagogy, as emphasized by Valerio *et al*. (2024), with the aim of promoting social change from the local and collective context.

Conclusions

The main objective of this chapter was to systematise the design and conceptual validation process of a methodological guide aimed at empowering rural women in agricultural contexts, grounded in participatory methodologies, theories, and pedagogical approaches. To achieve this objective, a mapping review was conducted, which enabled the identification of key trends related to the empowerment of rural women in agriculture through training processes, methodologies, and instructional techniques in the field, as well as the identification of gaps in the pedagogical foundations of many interventions. The findings revealed a substantial body of academic work on the empowerment of women in rural contexts, although many of the documented experiences lack an explicit educational structure that would enable their systematisation and replication in other contexts. Despite this, participatory training practices with strong transformative potential were identified, framed within dynamics of dialogue, critical reflection, and collective construction. Qualitative approaches predominated methodologically among the studies analysed, reaffirming the importance of recognising women's subjectivities and narratives in their local contexts as central elements for the design of training proposals with real impact.

As a result of the research process, a methodological guide was designed that articulates theoretical frameworks with contextualised pedagogical practices, grounded in the principles of feminist popular education, critical pedagogy, and empowerment approaches. This tool offers a flexible and situated approach, recognising women as agents of social change. Through its implementation, it seeks to strengthen autonomy and decision-making, enhance community leadership, and facilitate collective processes of social transformation with a gender and territorial perspective. This proposal represents both a conceptual and practical contribution to the improvement of rural educational programmes focused on empowering women in agriculture and serves as a concrete working tool for facilitators and educational agents committed to equity and social change. When employing this methodological guide, it is important to remember that empowerment does not mean "giving power" from the outside but rather creating the conditions for each woman to recognise the power already within her, to develop it, and to exercise it in solidarity with others. Each workshop represents a shared learning experience - both for the rural women who advance towards transformative change in their lives and territories, and for those facilitating the process, who also grow and are enriched through each intervention.

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Training and creativity: integration of human capital and human talent in organizational management

Dustin Tahisin Gómez Rodríguez
Corporación Universitaria de Asturias (Colombia), Dustin.tgr@gmail.com,
https://orcid.org/0000-0001-5359-2300

Introduction

The current business environment places its focus on people, emphasizing Human Capital (HC)—knowledge and skills developed through education and experience—and Human Talent (HT)—innate abilities such as creativity and adaptability—as key pillars of organizational performance (Gómez et al., 2025; Rodríguez, 2024). However, challenges in their integration persist, exacerbated by inequalities in access to educational and professional opportunities, which limit human potential and demand a strategic analysis of their convergence and divergence (Martínez et al., 2024).

Effective management of HC and HT is crucial due to their strategic complementarity in facing 21st-century challenges. Deliberately aligning accumulated knowledge (HC) with innate creativity (HT) has become imperative to optimize performance and maintain competitiveness. This requires integrated approaches that overcome current barriers and foster sustainable organizational development.

Subsequently, in the second phase, a documentary review was conducted using the PRISMA method (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). This approach consists of a standardized set of guidelines designed to ensure methodological quality and transparency in the execution of systematic reviews and meta-analyses. Its primary objective is to guarantee rigor in the identification, selection, and synthesis of studies, thereby promoting a precise and comprehensive presentation of results (López et al., 2025).

As a result of the selection process, 236 documents were identified, from which those showing a direct relationship with the analytical categories of interest were chosen. From this selection, relevant data were extracted and systematized from 172 research articles, 64 institutional documents, and 2 reviews (Aguilera et al., 2020). The combination of search-equation techniques for bibliometric analysis with the application of the PRISMA method in the documentary review provided a solid methodological foundation for the presentation and synthesis of findings, strengthening both the validity and relevance of the research (Castro et al., 2024).

Similarities: convergences between education and creativity

Despite the conceptual distinctions between Human Capital (HC) and Human Talent (HT), a fundamental link exists, grounded in education and training—both crucial for the development of these constructs. The literature confirms that the acquisition of knowledge and skills directly enhances HC, while Human Capital Theory has elevated the value of workforce training, recognizing the positive impact of skilled employees on organizational competitiveness

(Gómez & Velasco, 2024). In parallel, creativitythe core of HT, can be cultivated through educational programs and innovative work environments (Laverde et al., 2020), demonstrating the interdependence between both concepts.

This convergence underscores the need for an integrated approach that combines educational development with creative stimulation, transcending the mere attraction and retention of qualified personnel. Effective HT management requires the creation of organizational conditions that foster innovation and knowledge generation (Rosero & Gómez, 2025), strategically integrating both dimensions to optimize institutional performance and build solid foundations for future challenges.

The simultaneous management of HC and HT thus emerges as a key strategic factor for adaptation and evolution in dynamic business environments. Organizations that successfully articulate these elements not only maximize their current effectiveness but also strengthen their resilience and capacity for innovation (Rodríguez, 2025). Understanding and managing these links become critical determinants for sustainability and competitive advantage in the 21st century.

Differences and synergies between human capital and human

An essential distinction between Human Capital and Human Talent lies in their nature and development. HC refers to the set of knowledge, skills, and competencies that individuals acquire and refine over time through formal education, continuous training, and professional experience. This concept emphasizes the ability of individuals to increase their value and productivity through investments in professional development (Vesga & García, 2020).

Conversely, HT is often associated with innate aptitudes or intrinsic characteristics that distinguish certain individuals, such as creativity, leadership, or emotional intelligence. Traditionally, these qualities have been perceived as traits difficult to cultivate artificially. However, recent research suggests that, through personalized development programs and targeted talent management strategies, it is possible to identify, enhance, and leverage the latent potential within individuals—thus challenging the notion that talent is a fixed and immutable quality (Rodríguez & Pérez, 2025).

The findings confirm that strategic human resource management is fundamental to optimizing the synergy between Human Capital (HC) and Human Talent (HT). This requires an integrated model encompassing the systematic identification of key competencies, capability development through structured programs, and strategic talent retention via stimulating work environments (Barbosa et al., 2021; Rincón et al., 2017). Methodologies such as reverse mentoring and upskilling programs using microlearning emerge as effective tools (Gaspar, 2021), while digital transformation enhances this integration through People Analytics tools that map connections between quantifiable competencies and innovative potential (Gómez & Buitrago, 2024).

The evidence reaffirms the strategic nature of HC-HT integration amid accelerated digital transformation. The future of organizational management will depend on developing analytical frameworks that integrate measurable HC variables with the intangible dimensions of creative talent (Chavarro et al., 2022). Emerging challenges—such as the impact of generative AI on the redefinition of competencies—demand interdisciplinary approaches combining strategic

management, data science, and organizational psychology, thereby defining new frontiers for research in this field (Rincón & Gómez, 2023).

Conclusions

The strategic integration of Human Capital (HC) and Human Talent (HT) stands as a fundamental pillar for ensuring financial sustainability and organizational competitiveness in the 21st century. Specialized literature confirms that HC—built through the accumulation of technical competencies and continuous education—and HT—focused on innate abilities such as creativity and adaptability—are complementary elements. Their articulation through ethical and planned human resource management not only optimizes institutional performance but also contributes significantly to human and social development.

Implementing integrated strategies that simultaneously promote lifelong learning and the identification and development of talent enables organizations to effectively address the challenges posed by globalized and constantly changing environments. This dual approach, supported by empirical evidence, consolidates itself as a robust pathway to strengthen organizational resilience, drive innovation processes, and build sustainable competitive advantages through the comprehensive valorization of human capabilities.

Nevertheless, it is essential to acknowledge this study's limitations to guide future research. The analysis relied predominantly on Anglo-Saxon literature (75% of the sources), which may restrict the applicability of findings in culturally diverse contexts—particularly in emerging economies. Additionally, the scarcity of longitudinal studies measuring the return on investment (ROI) of integrated HC-HT programs hinders the precise quantification of their long-term impact, highlighting the need for further exploration through broader and more diverse methodological approaches.

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Identification and Classification of Variables for Defining Social Innovation in Design Projects

Ariel Alonso de la Torre Ramos
Autonomous University of Ciudad Juárez (Mexico), ariel.delatorre@uacj.mx, https://orcid.org/0000-0003-0812-7391
David Cortés Sáenz
Autonomous University of Ciudad Juárez (Mexico), david.cortes@uacj.mx, https://orcid.org/0000-0003-1459-6127
Fausto Enrique Aguirre Escárcega
Autonomous University of Ciudad Juárez (Mexico), fausto.aguirre@uacj.mx, https://orcid.org/0000-0001-9564-261X
María Alicia Herrera Hernández
Autonomous University of Ciudad Juárez (Mexico), alicia.herrera@uacj.mx, https://orcid.org/0000-0003-2045-4467

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Introduction

Social Innovation (SI) has emerged in recent years as a key concept for addressing the economic and environmental challenges facing society. This is due to the need to generate comprehensive solutions to social problems that transcend traditional approaches, especially in contexts where conventional responses have proven insufficient. Therefore, the concept of SI has been developed from a holistic and multidisciplinary methodological standpoint, which has given rise to a wide variety of definitions and approaches. Such conceptual diversity has hindered the consolidation of a theoretical framework that unifies the theoretical framework (Mulgan, 2006; Scupola *et al.*, 2021).

In response to this situation, several literature reviews on the definition of SI have been conducted. These have analyzed the evolution of the concept from the late 19th century to the present day, identifying multiple definitions that reflect different approaches over time (Agostini *et al.*, 2017; Ayob *et al.*, 2016; Jaillier-Castrillón *et al.*, 2020; Teasdale *et al.*, 2023). Despite the lack of a consensus definition, this remains a significant barrier to the design of methodologies for rigorous evaluation and impact measurement in social projects. In this regard, consolidating a coherent theoretical framework is essential to strengthen the capacity for action of researchers and professionals in the field of SI in diverse socioeconomic and environmental contexts (COTEC, 2018; Jaillier-Castrillón et al., 2020).

In this scenario, design emerges as a key discipline for implementing SI principles in concrete, contextualized solutions. Unlike traditional approaches, design for IS seeks to address complex problems related to social, cultural, economic, and environmental factors, which cannot be solved in isolation or through conventional responses (Angelucci, 2017; Manzini, 2015). Achieving a positive impact in projects through design for IS depends largely on an understanding of the environment in which the solution is implemented (Franzato, 2020). Therefore, in order for projects to be relevant, designers must clearly understand what social innovation entails and what elements must be considered for the project's solution and development.

This study is to identify the variables that have a direct relationship with IS and that will serve to structure a conceptual framework to guide the development of the design project. To this end, a qualitative approach based on conceptual co-occurrence analysis is adopted, exploring

various definitions of social innovation drawn from academic and documentary sources. The objective of the study was to identify thematic focus patterns, key abstractions, and conceptual relationships that facilitate a comprehensive understanding of the complexity of the concept and deriving significant variables for its evaluation.

The first phase of the study consists of reviewing and coding different definitions of social innovation using an inductive method, which allows for the classification and grouping of key concepts. To conduct this phase, the guidelines of Bossuyt *et al*. (2013) were followed, which emphasize the need to implement a protocol of inclusion and exclusion criteria to ensure consistency and objectivity in the data collection process. Accordingly, the criteria applied in this study focused on the relevance, clarity, and academic rigor of the sources, while excluding definitions that were vague, redundant, or lacked empirical grounding.

The time frame considered for this study is from January 2019 to September 2024, covering a period of five years and nine months. This delimitation allowed us to capture recent and updated research in the field of SI, ensuring the relevance and contemporaneity of the findings.

To guarantee the accessibility and transparency of knowledge, only *open access* documents were included. This decision favors the reproducibility of the study and makes the results available to a wider audience, including researchers, academics, and professionals interested in the subject.

The research focused solely on the area of design, arts, and humanities. This choice reflects the intention to explore the social, cultural, and human dimensions of innovation, offering a perspective that complements predominantly technical or economic approaches. From this perspective, the study seeks to highlight the role of cultural practices, critical thinking, and creativity in generating innovative processes with social impact. Finally, English and Spanish were established as the main languages for the documentary search.

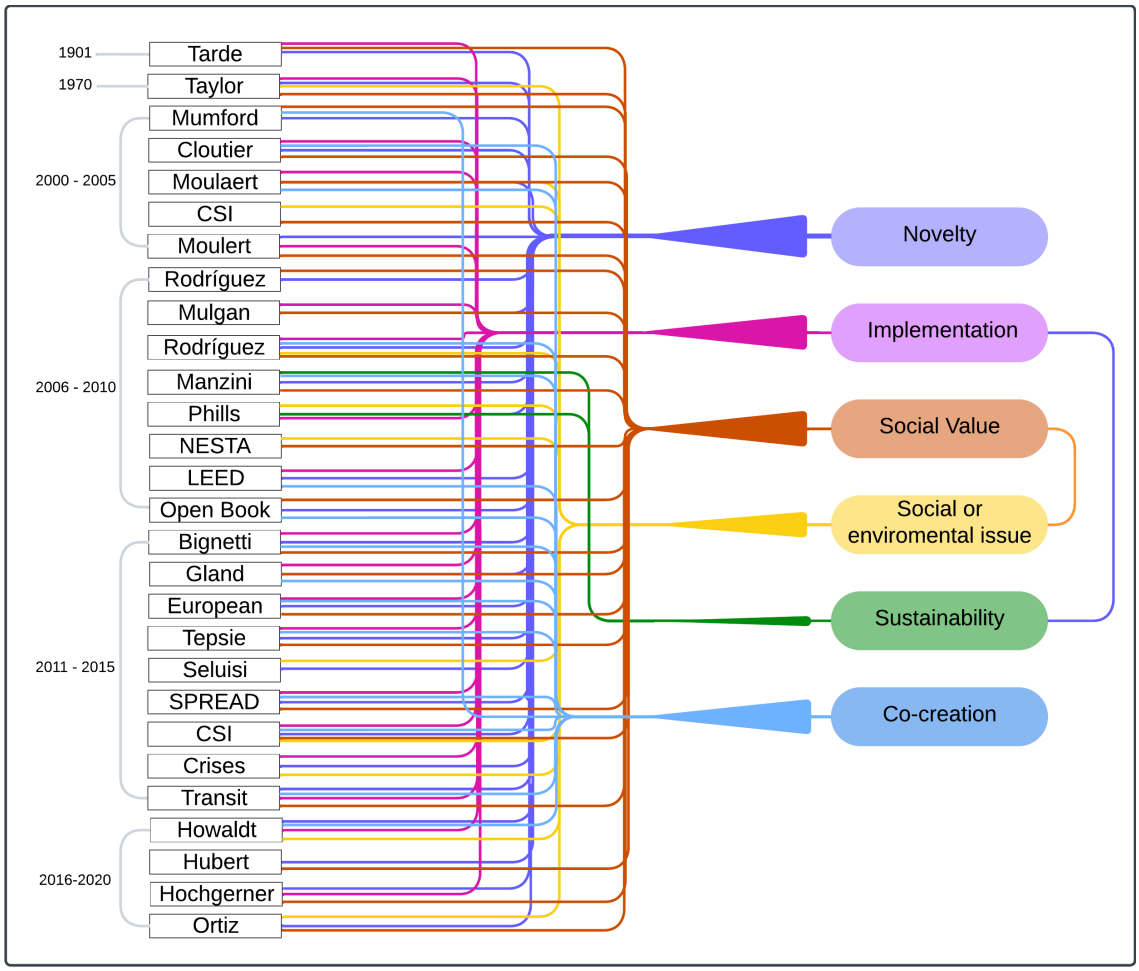
In the second phase, *the* qualitative analysis *software* ATLAS.ti was used to explore the relationships between the resulting codes. This tool facilitated the creation of a co-occurrence matrix showing frequent combinations of codes and their hierarchical relationships.

Visualizing this connection enables the identification of conceptual integration, that is, the thematic areas that define each variable, providing a deep understanding of the conceptual structure of social innovation.

In the third phase, a categorical refinement process was carried out, which involved grouping six related variables and redefining them to increase clarity and applicability.

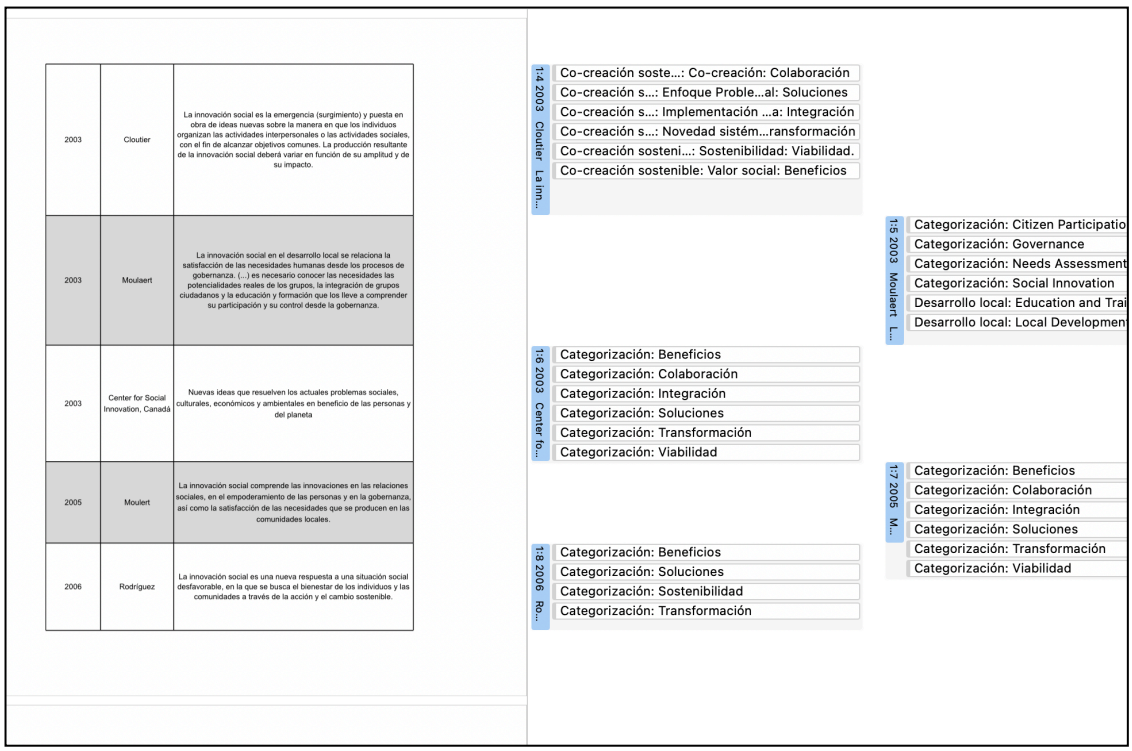
As a result of phase one, six preliminary categories were identified that reflect the most recurring elements in the definitions analyzed. These categories are: (1) Novelty, (2) Implementation, (3) Social Value, (4) Social and/or Environmental Problem, (5) Sustainability, and (6) Co-creation. These categories are systematized in a conceptual matrix (Figure 1), which allows us to visualize the key dimensions of social innovation and their relationship with each definition studied.

Figure 1. Diagram of the definitions of social innovation.



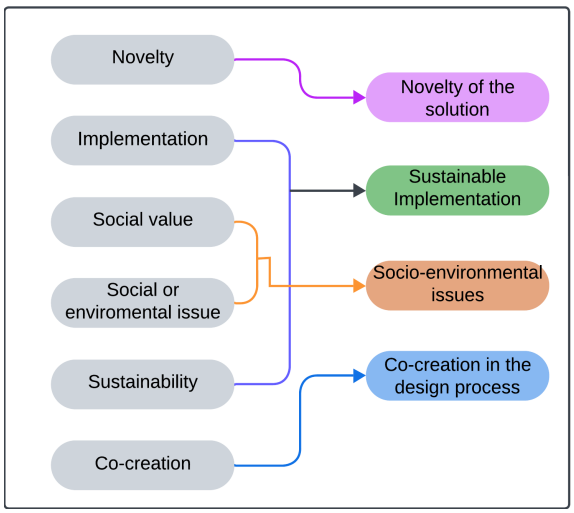
In the second stage, based on the description of keywords and categorization of definitions, spatial relationships were used, using advanced *software* tools such as those found in ATLAS.ti. This tool displays a matrix that refers to all the segments coded in a project, highlighting cases where two or more codes appear linked in the data, as can be seen in the following image (Figure 2).

Figure 2. Matrix of codes generated using Atlas.ti software.



In the third phase, similar categories were merged, while infrequent ones were grouped to create more coherent and representative clusters. They were also reclassified, changing the way the categories were defined or labeled to improve clarity or relevance. This reduced the number of categories from six to four, which are: novelty of the solution, implementation and sustainable, socio-environmental issues, and co-creation in the design process. This refinement is shown in Figure 3.

Figure 3. Refinement of social innovation categories. Source: Own elaboration.

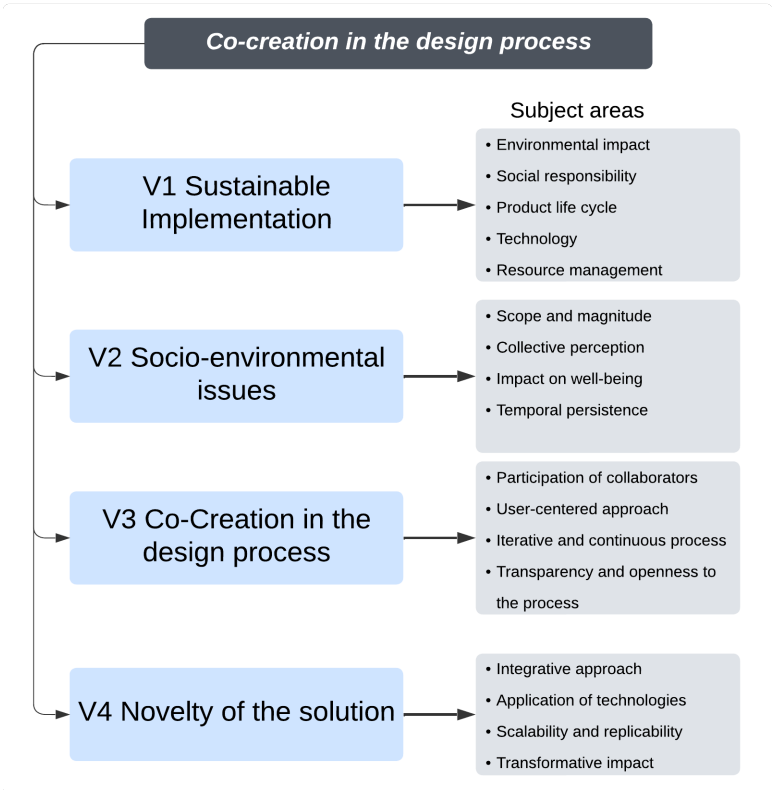


Based on this refinement, the categories of social innovation were obtained. Subsequently, a list of these categories was generated, in which each category was defined as a variable for the

definition of social innovation. Each variable is made up of thematic areas and the main factors that must be considered for compliance, as described in the theory found in the literature review.

The result was that social innovation is characterized by four main variables that integrate various thematic areas. *V1 Sustainable Implementation* considers aspects such as environmental impact, social responsibility, product life cycle, technology, and resource management. *V2 Socio-environmental Issues* covers the scope and magnitude of problems, collective perception, impact on well-being, and the temporal persistence of solutions. *V3 Co-Creation in the Design Process* focuses on the participation of collaborators, the user-centered approach, the development of an iterative and continuous process, as well as transparency and openness to the process. Finally, *V4 Novelty of the solution* addresses the integrative approach, the application of technologies, the scalability and replicability of the proposals, and their transformative impact. Figure 4 shows the diagram of the variables and their thematic areas for the definition of social innovation in design projects.

Figure 4. Diagram of variables and their thematic areas for defining social innovation in design projects.



Conclusion

The study presented here proposes a conceptual contribution to the field of design for social innovation. By establishing a set of variables that define social innovation in design, this facilitates a clear, relevant, and contextually grounded understanding and implementation of the approach. The integration of dimensions such as novelty, sustainability, co-creation, and

attention to socio-environmental issues reinforces the role of design as a transformative agent capable of positively influencing solutions to complex problems.

Beyond definitions, this work highlights the importance of building a common language that facilitates the evaluation, teaching, and implementation of projects with social impact. In this sense, the proposal presented here provides a solid foundation for the development of tools that strengthen a conceptual theoretical framework, allowing designers to act with a more critical approach and commitment to social innovation.

Finally, this study not only defines a set of key variables for understanding social innovation in design, but also highlights the need to build solid theoretical frameworks to guide this practice from more comprehensive perspectives. Throughout the study, it was shown how social innovation has been conceptualized in diverse and fragmented ways, which hinders its consistent application in real projects. In response to this, design is presented as a discipline capable of articulating these disparate dimensions, thanks to its ability to integrate social, environmental, and collaborative aspects into viable solutions.

Building on these findings, it is essential to encourage further research focused on validating these variables and developing methodologies, indicators, and tools that enable the effective implementation and evaluation of social innovation through design across different contexts.

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Women's leadership in business organizations in Colombia: beyond quotas towards real equity

Ruby Lorena Carrillo Barbosa
Corporación Universitaria de Asturias (Colombia),
lorena.carrillo@asturias.edu.co, https://orcid.org/0000-0003-1032-5792

Introduction

Women's leadership in organizations has emerged as a key issue on the agenda for economic development and institutional transformation, especially in Latin America, where gender gaps persist in both access to positions of power and the distribution of labor opportunities (Economic Commission for Latin America and the Caribbean [ECLAC], 2022). In Colombia, despite legislative and regulatory progress aimed at gender equity, women continue to face multiple structural barriers that limit their advancement to leadership positions, including occupational segregation, the glass ceiling, unconscious bias, and the unequal distribution of unpaid domestic work (Departamento Administrativo Nacional de Estadística [DANE], 2021; World Economic Forum, 2023).

In this context, gender quotas have been an important tool to address the underrepresentation of women in decision-making spaces; however, various studies have pointed out that the formal fulfillment of quotas does not necessarily lead to a substantive transformation of organizational structures nor guarantee the real empowerment of women in the corporate environment (Krook & Zetterberg, 2014). This raises a key question: What strategies are business organizations in Latin America adopting to promote women's leadership beyond quotas?

International literature has shown that women's leadership not only holds intrinsic value associated with principles of justice and equality, but also contributes to organizational performance, innovation, workplace climate improvement, and business sustainability (Catalyst, 2020; Eagly & Carli, 2007). In particular, studies in the Latin American context highlight that organizations that adopt inclusive leadership models experience higher levels of engagement and productivity (Leon et al., 2023). However, there is a knowledge gap regarding how these practices are implemented in specific business contexts such as Colombia, which is characterized by sectoral heterogeneity, a still-traditional organizational culture in many sectors, and weak articulation between public policy and private management.

For example, various studies in Colombia have begun to document business initiatives that go beyond quota logic and aim to transform organizational culture, create professional development programs, establish mentoring networks, and adapt internal policies to facilitate female participation (García-Solarte, González-Miranda, & Saavedra-Hernández, 2018; Villarroel Jácome & Santillán Marroquín, 2021). However, these efforts remain scattered, lack systematization, and their impact is still little known. In this regard, it is necessary to conduct a review that critically and systematically identifies the organizational strategies that have effectively contributed to women's leadership in the corporate environment in Colombia.

Therefore, the aim of this chapter is to analyze, based on a rapid literature review, how

business organizations in Colombia have implemented leadership strategies aimed at promoting women's leadership beyond the fulfillment of gender quotas. To achieve this, empirical studies documenting organizational experiences in different sectors are examined, considering both qualitative and quantitative approaches. This review seeks to address a theoretical and practical gap in the literature on organizational studies and leadership from a gender perspective in Colombia.

Accordingly, the central question guiding this review is: How have organizational leadership strategies aimed at strengthening women's participation in decision-making positions in Colombia been designed, implemented, and evaluated beyond gender quotas? To address this question, the main strategic lines used by organizations are identified, success factors and barriers are analyzed, and recommendations for their sustainability and replicability are presented.

This chapter is structured into five sections. Following the introduction, the methodology section describes the design of the systematic review, the study selection criteria, and the thematic analysis procedure. The results section presents the findings grouped into four categories: organizational cultural transformation, development and training programs, mentoring and networking, and structural reforms in organizational policies. The discussion section analyzes the findings in dialogue with international and regional literature. Finally, the chapter presents the conclusions, practical implications, and suggestions for future research.

This study was conducted using a rapid review approach to academic literature. As a method for evidence synthesis, rapid reviews enable researchers to address specific research questions within a limited timeframe while maintaining methodological rigor through streamlined and transparent procedures compared to traditional systematic reviews (Tricco et al., 2015). Elements of thematic and systematic reviews were combined to generate a comprehensive mapping of relevant empirical evidence (Booth, Sutton, & Papaioannou, 2016).

The literature search was carried out using the digital repository Semantic Scholar, selected for its open access to a broad base of academic documents. Keyword combinations were used in both Spanish and English, including: "female leadership," "business organizations," "Colombia," and "organizational strategies". This initial search yielded a total of 500 potentially relevant articles (Hernández, Fernández, & Baptista, 2018).

The inclusion criteria considered studies conducted in Colombia and focused on public and private organizations within the business sector. Studies had to address leadership strategies for promoting women beyond quota mechanisms, present evidence of implementation through examples or case studies, and analyze structural or cultural organizational transformations related to women's leadership. Empirical studies (qualitative, quantitative, or mixed methods), as well as systematic reviews or meta-analyses focused on organizational practices, were accepted (Hernández et al., 2018).

Excluded were studies limited to analyzing legal compliance with quotas without exploring additional strategies, those that lacked empirical evidence or examples of organizational implementation, that did not focus on the Colombian context, or that belonged exclusively to non-business sectors such as politics or academia (Jesson, Matheson, & Lacey, 2011).

The evaluation and selection of articles was supported by a large language model (LLM), which extracted key elements from each study based on predefined analytical instructions. The

inclusion or exclusion of articles was determined through the application of multiple criteria assessed holistically. As a result of the final screening, 32 studies were selected as relevant (Whittemore & Knafl, 2005).

From the selected studies, data were extracted on the type of research methodology used (qualitative, quantitative, or mixed), data collection techniques employed (interviews, surveys, focus groups, document analysis, among others), participant profiles (with emphasis on gender, professional roles, and economic sectors), as well as key leadership strategies, barriers and challenges to women's leadership, and the competitive advantages associated with its promotion (Snyder, 2019).

Finally, the findings were thematically organized into four analytical categories: transformation of organizational culture; leadership development and training programs; mentoring and networking initiatives; and changes in organizational policies. This categorization enabled the identification of common patterns, differentiated approaches, and cross-cutting success factors in the initiatives analyzed (Fink, 2014).

In recent years, business organizations in Colombia have made progress toward implementing deeper and more inclusive leadership strategies, moving beyond the limited focus on gender quotas. This systematic review analyzed 32 empirical studies focused on organizational practices aimed at enhancing women's participation in leadership roles. Through thematic classification, four main strategies were identified: organizational cultural transformation, development and training programs, mentoring and networking, and reforms in organizational policies.

Table 1. *Findings by type of strategy*

Strategy	Number of studies reporting it	Key results
Organizational cultural transformation	9	Reduction of the glass ceiling, participative leadership, greater collaboration
Development and training programs	6	Professional growth, empowerment, innovation, responsible practices
Mentoring and networking	3	Increased confidence, expanded networks, soft skills development
Reforms in organizational policies	4	Work-life balance improvements, inclusion, structural representation

Organizational Cultural Transformation

The most frequently addressed strategy in the reviewed studies was the transformation of organizational culture (9 studies). It was observed that organizations implementing structural and symbolic changes in their work environments reported significant impacts on women's participation in leadership positions. Associated practices include the promotion of participative leadership styles, the reduction of rigid hierarchical structures, and the creation of more collaborative environments.

For instance, studies such as García-Solarte et al. (2018, 2022) and Santamaría and Consuelo (2007) report that the adoption of transformational and participative leadership has helped

break down invisible barriers such as the glass ceiling, facilitating the inclusion of women in decision-making spaces. Furthermore, promoting a less hierarchical culture contributes to more flexible and inclusive work environments.

These cultural transformations have also been facilitated by top management commitment and alignment between gender equity policies and organizational identity. This alignment allows inclusion to become part of the corporate DNA rather than just an external mandate.

Leadership Development and Training Programs

Six studies highlighted the impact of training and professional development programs designed for women. These initiatives included mentoring, training sessions, coaching, and instruction in managerial and strategic skills. Unlike symbolic interventions, these programs are directly linked to strengthening female human capital in business environments.

The most representative cases were found in sectors such as agriculture (women coffee growers), oil (STEM programs), and entrepreneurship. For example, Díaz et al. (2019) reported significant improvements in social responsibility practices and transformational leadership in women's coffee-growing associations. Similarly, Jaramillo et al. (2020) found that training interventions increased women's participation in traditionally male-dominated sectors such as oil and gas.

Another important finding was the association between these programs and the development of innovation capacities. The studies showed that women exposed to structured training improved not only in terms of employability but also in their ability to generate added value within their organizations.

Mentoring and Networking

Although only three studies directly addressed this strategy, the findings show that professional support networks are essential mechanisms for promoting women's leadership. Mentoring initiatives between women leaders and emerging professionals allow for knowledge transfer, confidence building, and broader access to strategic networks.

In sectors such as real estate and energy, these spaces have been structured through mentoring workshops and networking programs that foster the development of soft skills while also offering access to role models (Ríos & Vásconez, 2019). However, a cross-cutting finding was that the sustainability of these networks depends on organizational resources and explicit institutional commitment. A lack of continuity and follow-up weakens their long-term impact.

Reforms in Organizational Policies

Four studies analyzed changes in internal policies as a catalyst for gender equity. These reforms included the adoption of work-life balance policies, measures against structural discrimination, implementation of extended parental leave, and systematic analysis of wage and representation gaps.

The studies suggest that such reforms are fundamental for creating enabling and sustainable conditions for women's leadership. Unlike symbolic or training-based interventions, institutionalized policies have the potential to endure over time and consolidate a more equitable organizational culture.

One of the most relevant studies in this area was conducted by Villarroel Jácome and Santillán Marroquín (2021), who showed how the adoption of gender-focused regulatory frameworks enables the integration of women at all organizational levels, thereby increasing motivation and competitive advantage.

Common Success Factors

The analysis of the reviewed studies allowed the identification of a series of common factors that have facilitated the success of leadership strategies aimed at promoting women's participation beyond compliance with gender quotas.

First, the visible commitment of top management to gender equity emerged as a fundamental element for legitimizing and driving organizational change. It was also evident that the most effective strategies are those that are coherently integrated with organizational values and culture, avoiding isolated or purely symbolic approaches. Another key factor was the strengthening of mechanisms to balance work and personal life, which supports the retention of female talent at all hierarchical levels.

Similarly, the formalization of mentoring spaces and professional networks emerged as a recurring practice to foster leadership skill development, access to opportunities, and the creation of role models. Lastly, the existence of clear and sustainable regulatory frameworks that go beyond legal compliance was positioned as a structural enabler of organizational change.

Organizational Outcomes

The strategies analyzed produced positive impacts at various organizational levels. Companies that adopted these initiatives reported increased motivation and commitment among human talent, which translated into a better organizational climate and higher employee retention.

An increase in the diversity of perspectives in decision-making processes was also observed, promoting more inclusive and innovative solutions. Another noteworthy effect was the improvement in corporate social responsibility indicators and in the implementation of ethical practices, which strengthened institutional reputation.

In highly dynamic contexts, the active inclusion of women in leadership roles also contributed to greater innovation and organizational adaptability. Finally, several organizations—especially small and medium-sized enterprises (SMEs) and those located in rural sectors—showed increased productivity and competitiveness associated with these inclusive practices.

Nevertheless, the studies also highlighted the persistence of important challenges. These include the underrepresentation of women in top executive roles, unresolved wage gaps, and the discontinuation of gender equity strategies when not institutionalized within the organizational structure. These findings suggest the need to strengthen mechanisms for monitoring, evaluation, and sustainability of inclusive leadership policies in Colombian companies.

Conclusions

The findings show that women's leadership in Colombia is being consolidated through multi-causal and cross-sectoral strategies that go beyond the quota-based approach. Organizations

that have committed to cultural change, structured training, mentoring networks, and sustainable policies have achieved significant progress in terms of inclusion, productivity, and innovation. However, the path toward full structural equity still requires institutional strengthening and continuous monitoring of these practices to ensure their long-term impact and replicability.

The results of this systematic review lead to the conclusion that business organizations in Colombia have begun to implement women's leadership strategies that transcend the limited focus on gender quotas. Through the analysis of 32 studies, four predominant strategic lines were identified: organizational cultural transformation, development and training programs, mentoring and networking, and structural reforms in institutional policies. Each of these strategies corresponds to different levels of cultural, individual, and structural intervention and reflects a progressive evolution toward more inclusive and sustainable models for managing female talent.

First, the transformation of organizational culture stands out as a cross-cutting axis for the success of any gender equity initiative. The adoption of participative, transformational, and less hierarchical leadership models has enabled the opening of decision-making spaces for women, as well as the reduction of symbolic barriers such as the glass ceiling (García-Solarte et al., 2018; Santamaría & Consuelo, 2007). This transformation not only translates into improved internal conditions but also into greater organizational adaptability and resilience.

Second, professional development and leadership programs—such as mentoring, training, and instruction in management skills—have proven to be effective tools for strengthening women's human capital (Díaz et al., 2019; Jaramillo et al., 2020). These initiatives contribute to women's empowerment, increase their participation in traditionally male-dominated sectors, and stimulate organizational innovation. However, their success largely depends on alignment with organizational strategy and explicit commitment from top management.

Third, mentoring and networking initiatives constitute essential mechanisms for supporting women's professional positioning and knowledge transfer within the business environment (Ríos & Vásconez Yulán, 2019). Although their implementation is still in early stages, they are recognized as valuable spaces for developing soft skills and building sustainable leadership trajectories. Nonetheless, challenges remain in terms of sustainability and resource availability for their long-term institutionalization.

On the other hand, reforms in organizational policies—such as parental leave, work-life balance, and structural gap assessments—are necessary conditions for the sustainability of gender equity progress (Villarroel Jácome & Santillán Marroquín, 2021). These policies allow for the institutionalization of cultural change and ensure that women's access, retention, and promotion are not dependent solely on individual efforts or isolated initiatives but on formal structures and regulations.

Cross-cutting factors that enhance the success of these strategies include: visible commitment from top management, integration of women's leadership policies into organizational culture, formalization of support networks, and adoption of normative frameworks that go beyond legal compliance. Organizations that have adopted more comprehensive strategies report benefits not only in terms of equity but also in performance, employee motivation, innovation, and social responsibility.

However, it is important to recognize that significant structural barriers still persist, such as the underrepresentation of women in senior positions, wage gaps, gender biases, and the lack of systematic monitoring of implemented policies. These findings suggest that the progress achieved is neither homogeneous nor irreversible, and that greater coordination between sectors, companies, and public policies is needed to consolidate truly equitable organizational ecosystems.

This review supports the conclusion that Colombia is advancing toward a more sophisticated model of women's leadership in the business sector, grounded in cultural transformations, training initiatives, collaborative networks, and structural changes. Nevertheless, the sustainability and expansion of these strategies will depend on institutional strengthening, accountability, investment in gender equity as a strategic pillar, and the political and business will to keep the issue high on the agenda.

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At the height of childhood: Critical analysis of body posture in the pedagogical practices of early childhood educators

Camila Aqueveque Muñoz
Universidad Bernardo O'Higgins- Universidad Finís Terrae,CIPEF
cqueveque@uft.cl https://orcid.org/0009-0003-4389-7639

Introduction

In preschool education, the body is a fundamental tool for building affective bonds and promoting the integral development of children (Mineduc, 2018). The preschool educator not only teaches content, but also, through her body presence, tone of voice and gestures, transmits containment, confidence and security (Figueroa & Céspedes, 2013). However, in recent years it has been observed that many educators have lost contact with looking into the eyes of children, bending down at their height and connecting physically with them, which has generated a growing emotional and affective distance in pedagogical interactions (Mendiaras, 2008). This loss of bodily closeness has affected both the professional practice of educators and the well-being of the preschoolers, weakening the bonds of attachment and the sense of belonging in the classroom (Bowlby 1988).

The body is language, it is a bond and it is a mediator of learning. Understanding it as a means of affective, cognitive, and social expression allows us to recognize that movement is not limited to physical motor skills, but involves emotional, symbolic, and relational dimensions (Villar *et al.*, 2024). When the educator maintains a distant or technically-focused stance, children perceive this disconnection. On the other hand, when they bend down, look into the eyes, touch respectfully and listen with their body, they transmit a message of validation, closeness and recognition that has a profound impact on children's self-esteem and emotional security (Céspedes, 2013).

Psychomotor development and body play are spaces where preschoolers explore and build their identity, autonomy, and creativity (Serrabona, 2023; Schojed-Ortiz, 2021). However, these experiences only flourish in warm pedagogical environments, where the educator understands her body as part of the educational process. Motor skills integrate the physiological, cognitive, and emotional systems, enabling voluntary action and meaningful learning (Pellegrino, 2025; Chihuailaf *et al.*, 2023; Trigueros Cervantes *et al.*, 2022). Recovering these forms of contact not only humanizes teaching practice, but also returns to the classroom the essential value of tenderness, encounter, and the child's educational presence (López, 2022).

Study development

The questionnaire applied to 80 students of the Pedagogy in Early Childhood Education career aimed to know their perceptions about the use of body posture by educators, in particular the physical disposition at the height of the children as an expression of the pedagogical bond. A Likert-type scale was used to evaluate different levels of frequency or agreement, allowing the identification of trends in the observed practices and their coherence with the initial training received.

The early childhood educator is the first professional agent who significantly influences the affective, identity and cognitive development of children in early childhood. An essential way to promote respectful and close treatment is verbal and non-verbal interactions, including body language and physical posture.

This study sought to understand the pedagogical reasons why educators limit the use of close bodily interactions and to analyze the factors associated with the resistance to placing themselves at the child's height, according to the perceptions of students who attend from first to fifth grade. The research was developed under a quantitative, non-experimental and longitudinal approach, using a structured questionnaire with dimensions on the role of the educator, the pedagogical perceptions of the students and the incorporation of practices of body approach.

Frame of reference

The importance of corporeality in preschool education

In preschool education, the body is an essential tool for the integral development of the child and the construction of affective bonds. The Curricular Bases of Early Childhood Education (MINEDUC, 2018) emphasize that the school must promote learning experiences based on principles such as well-being, play, relationship and significance, allowing children to develop integrally. Motor skills and psychomotor skills not only refer to physical skills, but also involve affective, cognitive, and social dimensions (Villar & Faúndez, 2022).

The postural system facilitates the integration of learning, freeing attention for new cognitive processes (Berruezo, 2004). Thus, educational practice that considers movement and body exploration allows children to discover their body, their environment and enhance their autonomy. However, when the educator stops bending down to look into the child's eyes or interactúa desde una posición jerárquica, se genera una distancia afectiva que puede afectar el desarrollo de vínculos seguros (Bowlby, 1988).

Eye and body contact as a foundation for learning

Eye and body contact not only strengthens the affective relationship, but also impacts the child's learning and identity construction. According to Mendiaras (2008), a safe environment where affections such as love and understanding prevail allows the neurological, social and psychic maturation of children, promoting adequate psychomotor skills. The lack of placing oneself at the child's height can limit the personalization of the "I" and the "not-I", decreasing the awareness of space and interaction with the environment.

The close interaction between educator and child also influences attachment, an affective bond that integrates cognitive, emotional and behavioral components. López-Cassá (2005) highlights that the presence and security of the attachment figure generate emotional stability, while its absence can cause anxiety or fear. Therefore, the practice of looking into each other's eyes and maintaining body contact is not only a pedagogical gesture, but a central element for the construction of safe and meaningful relationships (Santana & Martínez, 2021).

Factors that affect the loss of bodily closeness

Despite its relevance, a growing body distance has been observed in pedagogical interactions. This phenomenon can be explained by multiple factors: seniority, years of service, age in practice, lack of specific training and demanding working conditions. Early childhood

educators face high emotional and physical burdens, as well as long working hours, which directly impacts their willingness to maintain close contact with children (Serrabona, 2016; Schojed-Ortiz, 2021).

Distancing can also be related to the educational tradition that prioritizes the teaching of intellectual content over bodily practices, relegating play, movement, and exploration to a secondary role (Aucouturier, 2004). This shows the need to transform teaching strategies towards models focused on the integral development of the child, considering their physical and emotional well-being, as well as the importance of body expression as a learning tool (Anasi, 2022).

Movement and exploration as pedagogical strategies

Movement and exploration are fundamental pillars for the integral development of children, since through them cognitive, affective and social skills are strengthened. According to Huaiquián-Billeke (2016), all voluntary action is inscribed in a social and historical context, which reinforces the idea that motor skills must be understood as an integral phenomenon, in constant interaction with the adult mediator. In this sense, education, especially in early childhood, assumes a key responsibility, not only from pedagogical accompaniment, but also from a socio-emotional role shared between the family and the educator (Durán-Chiappe & Cruz-Velásquez, 2024).

For their part, Murcio and Corvetto (2021) argue that the relationship between body, mind, and movement should constitute the core of physical education in childhood, promoting meaningful learning experiences based on play, expression, and body exploration. Along the same lines, Villar (2020) highlights that movement is an essential form of communication and knowledge construction, where children learn to understand the world through their bodies and interaction with others.

This comprehensive approach requires educators to intentionally plan pedagogical experiences that integrate spaces and times for physical, visual, and affective contact, guaranteeing opportunities for exploration, discovery, and free expression (Molero *et al.*, 2011). In this way, movement-based pedagogy not only strengthens motor skills, but also enhances creativity, autonomy, and emotional well-being, essential aspects for meaningful and balanced learning (Undersecretary of Early Childhood Education, 2019).

Challenges and opportunities from the practice of early childhood educators

Innovating in early childhood education implies a process of profound transformation that goes beyond modifying methodologies or didactic strategies (Céspedes Carreño, 2024). It is to be able to move from traditional models to pedagogical approaches focused on the integral development of the child, where play, movement, creativity and emotional well-being are prioritized (Palomera *et al.*, 2019). In this scenario, the role of the educator becomes fundamental, since through her practice she not only provides pedagogical tools, but also projects her identity and way of understanding teaching (Siso-Pavón & Pérez, 2025).

Early childhood education has been conditioned by adult-centric structures that conceive of children as passive recipients of knowledge. This approach, based on authority and dependence, limits children's autonomy and reduces active participation in learning processes (Gutiérrez, 2011, cited in Torres, 2011). The educator, from an innovative perspective, must break with these schemes and position herself as a mediator between the child and his

environment, promoting spaces for dialogue, respect and reciprocity.

The importance of the educator being at the level of the children transcends the symbolic: it represents an act of recognition and equity. By establishing eye contact, actively listening and maintaining close and respectful body communication, an affective bond is created that strengthens the child's emotional security and confidence in the educational space. These types of interactions are not minor gestures, but essential practices that reflect pedagogical sensitivity and a deep understanding of child development.

A positive emotional climate, built from empathy and affective contact, has a direct impact on the well-being of the educator and the children. When practices are based on listening and conscious presence, the mechanization of routines is avoided and an environment of containment is fostered, preventing children from feeling neglect or emotional absence (Núñez, 2017). The resignification of the body and the affective bond as pedagogical tools allows us to move towards a more inclusive and respectful education of children. Placing oneself at the child's level, attending to their emotional needs, and recognizing corporeality as a means of learning strengthens the educational relationship and enhances integral development (Bowlby, 1988; Mendiaras, 2008).

The results show a high valuation of the body approach as a significant pedagogical practice.

62.5% of the students indicated that the educator does not bend down or stand at the height of the children, while 28.8% indicated that she does so sometimes, which reflects a clear trend towards a closer and more respectful interaction.

Regarding facial and body expression, 71.3% observed eye contact and warm expressions, which is associated with positive affective communication. Meanwhile, 68.8% considered that the educator's body posture favors horizontal treatment, promoting an environment of trust and respect.

In relation to pedagogical coherence, 60% of the participants perceive that the practice of bending or getting at the child's level is consistent with the educational approach of the level, while 27.5% consider it partially coherent. This suggests a generalized perception of consistency between body practices and the educational principles of the kindergarten level. Finally, with respect to initial training, 55% of the students report that during the degree work on eye contact and body posture is intended, while 31.3% say that these topics are partially addressed. This reflects a growing but still unequal presence in university education.

In relation to reliability, the Cronbach's alpha coefficient obtained was $\alpha = 0.87$, which indicates a high level of internal consistency. This result shows that the questionnaire items have an adequate internal correlation and consistently measure the underlying construct linked to the pedagogical link mediated by body posture. In psychometric terms, an alpha value greater than 0.80 is considered excellent, which supports the internal validity of the instrument and its relevance for future research in the field of teacher training and pedagogical practices (Cronbach, 1951).

Table 1.*Reliability Statistics*

Estadísticas de fiabilidad
Alfa de Cronbach 0.87
N de elementos 20

Data analysis

The analysis of the data collected through the questionnaire applied to 80 students of the Pedagogy in Early Childhood Education career focused on understanding how the body posture of the educators influences the pedagogical interaction with the children. Special attention was paid to the physical disposition of the educator at the child's height, considered a key manifestation of the pedagogical bond and respectful and horizontal communication.

Table 2. *Year studied by students of the Pedagogy in Early Childhood Education Career*

Año que cursa	Frecuencia (n)	Porcentaje (%)
1° año	19	23,8 %
2° año	25	31,3 %
3° año	19	23,8 %
4° año	9	11,3 %
5° año	8	10,0 %
Total	80	100,0 %

Most of the students are in their second year (31.3%), followed by those in the first and third years (23.8% each). This shows a balanced participation in the first levels of education, with less representation of fourth and fifth year students.

Table 3. *Administrative unit of the house of studies*

Tipo de institución	Frecuencia (n)	Porcentaje (%)
Universidad estatal	65	81,3 %
Universidad privada	15	18,7 %
Instituto profesional	0	0,0 %
Total	80	100,0 %

The majority of participants (81.3%) come from state universities, while 18.7% belong to private universities. No responses from professional institutes were recorded, evidencing a predominance of public university education in the sample.

Table 4. *Administrative unit of the practice centre*

Dependencia	Frecuencia (n)	Porcentaje (%)
Privado	22	27,5 %
Convenios de administración delegada (CAD)	15	18,8 %
Administración directa (VTF)	25	31,3 %

Fundación Integra	9	11,3 %
JUNJI	9	11,3 %
Total	80	100,0 %

Directly administered practice centres (VTFs) represent the largest group (31.3%), followed by private kindergartens (27.5%). The presence of JUNJI and Integra establishments reaches a combined 22.6%, reflecting diversity in the contexts of professional practice

Table 5. *Observation of the interaction of the educator with the children According to the students*

Variable	Category	Frequency (n)	Percentage (%)
Bends down or stands at the child's height	Siempre	28	35,0 %
	A veces	6	7,5 %
	Casi nunca	16	20,0 %
	Nunca	30	37,5 %
Situations observed in which the educator bends down (multiple choice)	Para saludar o despedirse	36	45,0 %
	Al dar instrucciones	27	33,8 %
	Al consolar o contener emocionalmente	53	66,3 %
	Durante el juego	27	33,8 %
	Al corregir una conducta	53	66,3 %
	No observé que lo hiciera	14	17,5 %
Occasions when you crouch	Cuando un niño/a llora o está molesto/a	54	67,5 %
	Se agacha o se arrodilla con frecuencia	16	20,0 %
	Durante el juego libre o dirigido	22	27,5 %
	Para dar indicaciones claras y personalizadas	37	46,3 %
	Para escuchar lo que un niño/a quiere decir	46	57,5 %
	No se agacha en ninguna situación observada	16	20,0 %
Facial and body attitude when bending over	Muestra contacto visual y expresión cálida	61	76,3 %
	Tiene el rostro serio o distante	6	7,5 %
	Sonríe y utiliza gestos acogedores	34	42,5 %
	Evita el contacto visual	5	6,3 %
	No observé claramente estas expresiones	15	18,8 %
Promotes respectful and horizontal communication	Siempre	16	20,0 %
	A veces	42	52,5 %
	Casi nunca	22	27,5 %
	Nunca	0	0,0 %
Body posture when interacting	De pie, la mayoría del tiempo	40	50,0 %
	Se agacha o se arrodilla con frecuencia	21	26,3 %
	Se sienta junto a ellos/as	39	48,8 %
	Se inclina, pero no se agacha	29	36,3 %

	completamente		
	Se sienta ella y sienta a los niños/as sobre sus piernas	36	45,0 %
	Varía su postura según la situación	29	36,3 %
Effects observed in children	Mayor atención	47	58,8 %
	El/la niño/a se calmó	40	50,0 %
	Disposición al diálogo	47	58,8 %
	Mayor disposición del niño/a hacia el adulto	38	47,5 %
	Al corregir una conducta	17	21,3 %
	No observé que se colocara a la altura de los niños/as	9	11,3 %

Regarding the educator, the most frequent experience is between 2 and 4 years of service (41.3%), and most work at NT1-NT2 transition levels (68.7%). Regarding interaction with the children, 35% of the observations indicate that the educator always places herself at the child's level, while 37.5% never does so, evidencing heterogeneity in practice. The most common situations for bending over were when comforting or emotionally containing and correcting behaviors (66.3%), and the perceived effects include greater attention and willingness to dialogue (58.8%) and calmness in children (50%). In terms of posture and body attitude, 50% of the educators stand most of the time, while 26.3% frequently bend or kneel, and between 36% and 48.8% use other strategies such as sitting next to the children or placing them on their legs. Warm facial expression and eye contact are observed in 76.3% of cases, complementing physical posture to favor respectful and horizontal communication, although only 20% are perceived as constant.

Conclusions

The adoption of postures that consider the height and closeness of the children favors attention, calmness and willingness to dialogue, strengthening horizontal communication and the pedagogical bond. However, the practice of educators is heterogeneous: while some bend down and use eye contact and warm expressions constantly, others remain standing with less frequent close interaction. These findings show the need for training strategies that promote coherence in the use of corporeality as a pedagogical tool, ensuring affective and effective interactions in all contexts.

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Sustainability, Supply Chains, and Sectoral Management

Business Internationalization and the Supply Chain in Mexico

López Torres, Virginia Guadalupe
Autonomous University of Baja California, Mexico, virginia.lopez@uabc.edu.mx
https://orcid.org/0000-0002-2795-8951
Moreno Moreno, Luis Ramón
Autonomous University of Baja California, Mexico, lmoreno@uabc.edu.mx
https://orcid.org/0000-0003-2544-6562
Gámez Gámez, Karina
Autonomous University of Baja California, Mexico, gamezka@uabc.edu.mx
https://orcid.org/0000-0003-0777-4247

Introduction

Sustainability in the food system has become an increasingly critical global issue (Lohano et al., 2025; Stein & Santini, 2022). Companies must adapt to market dynamics, rely on international suppliers to optimize delivery times, meet financial metrics, improve regulatory compliance, and optimize business continuity through market analysis, process optimization, and efficiency improvements (Aldokhi et al., 2025; Eyo-Udo, 2024).

Every organization is part of a complex supply chain system, where any disruption fragments the chain and affects the entire structure (Baldah et al., 2025; Shahbaz et al., 2019). Food supply chains are considered more complex systems than other types of chains; their complexity stems from the continuous changes that occur to ensure the quality of food products throughout the entire chain, from cultivation, resource procurement, production, and inventory management to distribution to the end consumer (Peng et al., 2025; Haji et al., 2020).

Recently, attention has focused on voluntary mechanisms such as labeling and certification, administered by independent bodies that provide written assurance that a product or company meets defined sustainability standards (Lohano et al., 2025); for example, an innovative smartphone-based labeling system offers a practical solution for monitoring freshness in real time throughout the cold chain, while meeting critical consumer needs for food safety, quality control, and transparency in perishable products (Zhang et al., 2026).

Strawberries, *berries* (blackberries, strawberries, raspberries, and blueberries) are crops whose production must overcome significant barriers to entry, such as substantial capital investments and high requirements for skilled labor; yet they are also crops with great potential due to their high profitability, rapid return on investment, versatility in producing fruit for consumption, and viable export opportunities (Lagunes et al., 2020).

Globally, the strawberry market offers opportunities stemming from a shift in consumer habits toward healthy, convenient, and quick food options, such as snacks. Additionally, new emerging markets provide ample room for growth. Given the distances between production areas and major markets, the supply chain—particularly the frozen food industry—is a priority (Pefaur, 2014).

In recent years, Mexico has increased its domestic berry production; in 2023, 1.15 million tons were harvested from 42,975 hectares, with Michoacán, Jalisco, and Baja California standing out as leading states (Ministry of Agriculture and Rural Development, 2024). Given the structure of

the berry production chain, its nodes can bring these products to new markets; in particular, production companies have the global focus needed to enter and compete successfully. Considering these topics, this chapter aims to characterize the strawberry supply chain in the state of Baja California and reflect on the challenges of its internationalization—transitioning from a domestic business to a global one.

To this end, a two-phase study was conducted. In the first phase, official statistics on production and exports were reviewed to illustrate patterns and trends. The second phase consisted of a quantitative, empirical, non-experimental, and cross-sectional study, using a non-probabilistic sample of business owners located in the San Quintín Valley, Baja California (northern Mexico). Initially, the available academic literature was reviewed and analyzed to identify the type of supply chain and the challenges posed by global markets; based on this, a data collection instrument was designed. Data collection took place from April to August 2025, resulting in a sample of 181 valid surveys. Descriptive statistics were applied to analyze the data.

Since the variables measured were adapted to the context, they were assessed using ordinal Likert-type items with a five-point response scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Business Internationalization

Internationalization is a decision to expand foreign trade following an analysis of the political climate of the target country, such as assessing political stability, corruption, R&D spending, government support, and legal procedures (Dayan et al., 2023). It is a process that takes operational activities to foreign markets, selling or purchasing products and services outside the domestic market, which offers numerous opportunities and increases sales revenue (Anwar et al., 2024).

The literature offers various definitions of internationalization; for Ochoa et al. (2011), it refers to the set of decisions and processes within a company that enable it to target markets geographically outside its country of origin, in order to establish productive links that facilitate its growth. Internationalization is the result of a search for new alternatives that allow companies to grow and consolidate their position by conquering new markets (Puerto, 2010).

To access international markets, companies and their products must comply with the standards established by the destination country and/or region, which often involves changing processes and operating methods to align with those standards, standardizing tasks through tactical strategies that enable their products to enter new markets; therefore, companies require human capital with skills and competencies that facilitate internationalization (Tosic et al., 2025).

Internationalization is a strategy that most family businesses approach with great caution (primarily those that originated as necessity-driven ventures); they tend to be conservative due to the inherent risks, while the minority (those born from a business plan) seek to build a sustained competitive advantage through it (Ding, 2025).

The internationalization process is a strategy to increase market share, expand into other territories, access tax benefits, benefit from logistics, reduce costs, and take advantage of outsourcing their processes, among other factors, which together enable companies to be

competitive (Vieira and Morandi, 2021; Ochoa et al., 2011). At the forefront is the figure of the executive, who, with their experience and perspectives on globalization, as well as access to technology and information, makes more assertive decisions for the company's growth. This enables them to choose the best internationalization strategies—those most suited to the company's reality and the market context—ensuring its long-term effectiveness and competitiveness (Jiménez-Castillo et al., 2022).

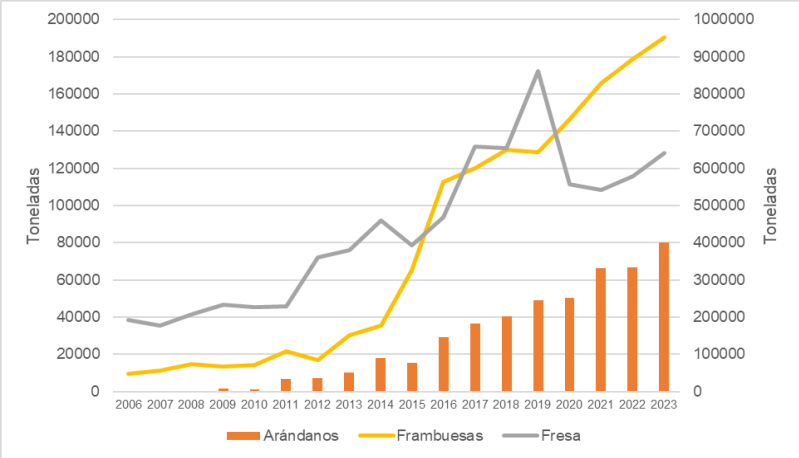
Licensing or franchising is an internationalization strategy of great value for international expansion; it generates additional revenue and reinforces the parent company's image as a key player (das Neves & Gomes, 2021); other forms include exporting, importing, and outsourcing (Benabed, 2024).

For small and medium-sized enterprises, internationalization is a challenge; they must overcome a series of internal and external export barriers, one of which is the financial culture of the owner-manager (Molina-García et a al., 2025), business and political connections, and product innovation favor their internationalization in emerging economies such as Mexico (Dayan et al., 2023). Ideally, governments should use public policies to promote their internationalization and the innovation of business models through digital capabilities, as this would allow them to enter more stable and advanced markets in the global economy to maximize profitability (Anwar et al., 2024).

An example of internationalization is the strawberry agribusiness operating in the San Quintín Valley, Baja California, in northwestern Mexico. It consists mainly of family-owned businesses that began producing blueberries, raspberries, and strawberries at the start of the 21st century. Data from the Food and Agriculture Organization of the United Nations (FAO) for the period 2006 to 2023 (Figure 1) show that in 2006, blueberry production was negligible, reaching just 264 tons, but over the years it increased to 80,133.49 tons in 2023, representing exponential growth. Raspberry cultivation has also seen positive growth during this period, starting at 9,351 tons and ending at 190,411.55 tons; strawberries were the most widely grown crop in 2006, with a harvest of 191,853 tons, which has also grown to reach 641,552.22 tons in 2023. The data show the successful internationalization of companies in the region that are competitive in foreign markets.

One of the benefits of internationalization through exports is the inflow of foreign currency into the home country (headquarters); in the case of Mexico, Rodríguez and Venegas (2011) demonstrated that exporting is necessary for growth, there is a causal relationship, hence the relevance of a policy of trade liberalization and export promotion, which are based on the competitive and comparative advantages of the regions (Cruz et al., 2022).

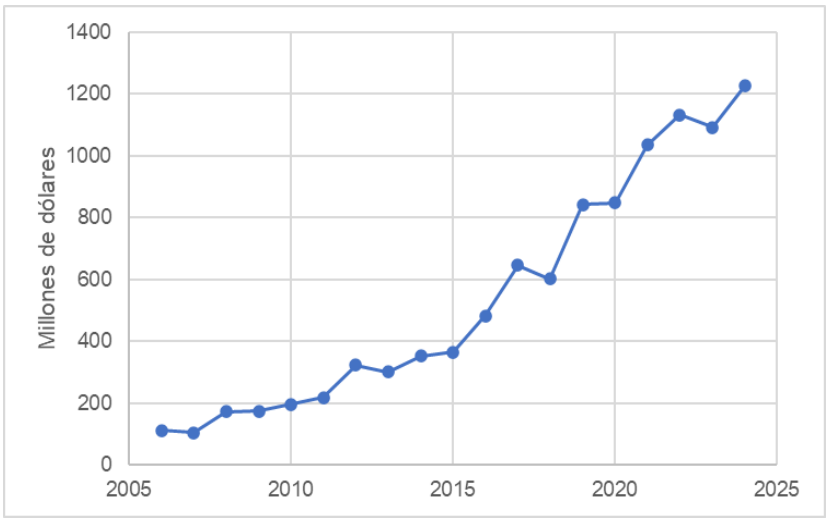
Figure 1. *Blueberry, Raspberry, and Strawberry Production in Mexico*



It should be noted that, according to the Government of Mexico (2025), only approximately 30% of strawberry production is exported; Figure 2 shows the trend in exports for the period from 2006 to 2024. Initially, the value was $112 million, experiencing dynamic growth to reach $1.225 billion in 2024. Four states stand out for their leadership in international sales: Jalisco (466 million USD), Baja California (367 million USD), Michoacán (330 million USD), and Guanajuato (18.5 million USD). As can be seen, the example cited as a success story in internationalization ranks second in exports measured in millions of USD.

Most exports are distributed among five destinations; the two main ones correspond to the partners of the United States-Mexico-Canada Agreement (USMCA): the United States ($1.177 billion), Canada ($1.65 billion); the other three are Asian countries: Saudi Arabia (US$975,000), Kuwait (US$593,000), and the United Arab Emirates (US$569,000).

Figure 2. *Strawberry Exports*



A company's internationalization is managed collaboratively with its supply chain; this is what makes it possible to produce what international markets demand and to transport the product efficiently and safely without compromising its quality, safety, or other attributes and variables.

Supply Chain

For agricultural supply chains (ASC), internationalization is a major challenge; the 2030 Agenda, and in particular Sustainable Development Goal (SDG) number two, are the strategic focal points for addressing hunger and food insecurity. Although their internationalization is driven by population growth, natural disasters, climate change, the decline in arable land, and rising inflation (Kumari et al., 2025), achieving harmonious collaboration and coordination among all companies to source inputs, produce, harvest, package, and transport products to points of sale is chaotic and complex.

It is worth noting that, since NAFTA, transnational food value chains have been adopted in Mexico, as the treaty provided opportunities to access the international market provided that its standards were met, and has contributed to generating strong growth in exports, including fresh produce (McDermott and Avendaño, 2024).

In the context of sustainability, internationalization faces barriers, government regulations, and customer demands to achieve environmental collaboration throughout the supply chain so that sustainable management of greenhouse gas emissions, energy, food waste, food safety, and the water footprint is exercised (Barbosa and Cansino, 2024). Despite these barriers, internationalization is imperative for many countries that must import food to meet the demand of their populations.

The internationalization of food supply chains involves structured processes ranging from food sourcing in natural environments to delivery to consumers—complex tasks in emerging economies, including meeting requirements for documentation, certifications, customs procedures, foreign exchange, and international logistics (Cislaghi et al., 2025).

Since food (meat, fruits, and vegetables) is perishable, its shelf life without preservatives is limited (7 days) after initial processing or harvest; given the saturation of the domestic market, export markets are the destination for achieving viability, the success of which depends on the export supply chain and, in particular, on air transport (Rahman et al., 2020).

In the process of internationalization, and particularly in the context of supply chain management, the exercise of leadership ceases to be an exclusively hierarchical function and becomes a collective capacity that permeates the entire organizational structure; in this regard, leaders with soft skills are required who are capable of efficiently managing internal work teams and nodes in the supply chain, resolving conflicts, and stimulating creativity—the "how it can be done" (Acosta et al., 2023).

It is also important to understand the process of deglobalization, which has driven the internationalization of global supply chains through next-shoring—a strategy that promotes their relocation to meet market demands for flexibility, customization, and fast delivery. Its main strategies include " " product positioning, and the digitization of the supply chain (Amico et al., 2025).

In supply chain management, various theories are adopted to build sustainable competitive advantages, notably the resource-based view and the theory of transaction cost economies. The former emphasizes the need for all nodes in the supply chain to be integrated, while the latter posits that transactions must be completed at minimal cost (Rahman et al., 2020).

Processing and transportation are two of the most critical links in the supply chain for the export of perishable goods; to operate efficiently, it requires transportation infrastructure—the critical node—whether by land (roads, rail network) or air (airports with cargo flights) (Rahman et al., 2020).

Food safety must be guaranteed throughout all nodes of the supply chain. In Mexico, there are laws and agencies that regulate and monitor processes and products; these should have the capacity to help companies improve their practices and access learning communities to obtain and maintain certification that allows them to continue exporting products to various international markets (McDermott and Avendaño, 2024).

In Mexico, the coordination of nodes in the supply chain faces an initial barrier in its culture, as the population focuses on competing rather than collaborating. To illustrate the complexity of agricultural supply chains, we will again use the example of the strawberry agroindustry mentioned earlier, based on a study that included 181 entrepreneurs—16% women and 84% men—with an average age of 45.8 years, all professionals with the knowledge and capabilities to address the challenges of global markets. By economic activity, 57% are producers, 35% engage in 3PL (Third-Party Logistics: including warehousing and inventory management, picking and packing: order fulfillment, transportation, reverse logistics, and other services), and 8% in packaging. These strategic sectors facilitate access to international markets.

Business leaders note that entering international markets requires a strategic approach on their part; they must integrate labor and reliable partners throughout the supply chain—both upstream and downstream—where information, materials, and money flow.

Furthermore, because this is a global business dealing with perishable goods, a modern supply chain must be designed with a multi-stakeholder, multi-level structure—one robust enough to manage any disruption that may arise in Mexico or in the countries to which goods are exported. The weakest link is the cold chain; Baja California has limited infrastructure, and few suppliers have the equipment and quality and safety certifications demanded by customers and government policies, particularly those of the United States through the Food and Drug Administration (FDA: Food and Drug Administration). In general, international markets require new traceability protocols to ensure the safety and efficacy of strawberries and all food products.

Strawberry processing involves *chilling, refrigeration, or freezing*; this is a Critical Control Point (CCP), which includes the HACCP (Hazard Analysis and Critical Control Points), a system that 100% of businesses in the strawberry supply chain have implemented in order to identify, evaluate, and control biological, chemical, and physical hazards throughout the strawberry production chain to ensure their safety and, consequently, increase the confidence of consumers and international buyers.

Strawberries are typically stored under cold conditions to limit the growth of microbiological pathogens and halt enzymatic degradation; maintaining temperature control is key, as it helps gain and maintain consumer confidence. However, business owners agree on the need to manage the costs of the cold chain, whether related to electricity or diesel consumption.

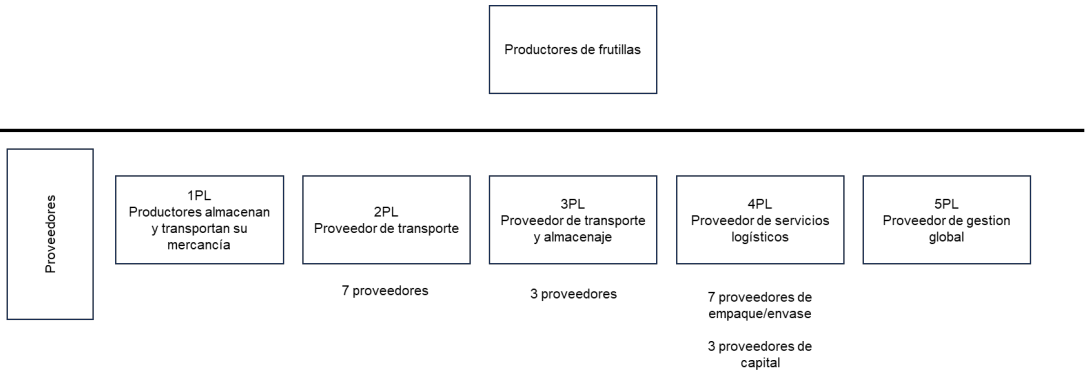
They are concerned about the tariffs imposed by the U.S. government, which is why they are seeking to enter new markets; however, distance and transportation remain unresolved issues. Given the low per capita consumption in Mexico, the domestic market is not an option;

instead, the focus must be on expanding the international reach of individual companies and the supply chain as a whole.

They are currently studying the European Union's import policies and have been in contact with potential customers; understanding the regulations governing the stages of production, transportation, and storage, as well as wholesale and retail sales, would allow them to develop short-term action plans to enter the European market.

Figure 3 illustrates the structure of the Baja California strawberry supply chain. It shows a short chain with few suppliers, a fact that reduces producers' bargaining power when setting prices, quality standards, and delivery terms. In Porter's Five Forces model of competitive analysis, Force 3 (Suppliers' Bargaining Power) and Force 4 (Buyers' Bargaining Power) stand out. In the first case, given that the number of suppliers is limited, there are no substitute inputs, and they are essential to the business, the supplier, aware of these conditions, imposes its will on producers, while input suppliers exercise their power to negotiate prices to their advantage and thus increase their company's profitability; this scenario puts companies' costs at risk.

Table 3. *Baja California Strawberry Supply Chain*



The supply chain is of the information-sharing type, featuring a decentralized logistics structure where members place orders independently, have access to information, and use it to make decisions. It can also be classified as a synchronized supply chain due to its centralized logistics structure, in which all member com s place orders in a coordinated manner and also transmit real-time information on their inventory levels, products in transit, and consumer sales data.

Challenges: A Look to the Future

Companies handling perishable goods must address all types of risks according to their sources: (i) internal to the company, (ii) external to the company but internal to the supply chain, and (iii) external to the supply chain (Shahbaz et al., 2019); adopting a proactive approach allows for the timely identification and management of risks. One example of risk is diseases caused by soil-borne pathogens, which exert greater economic pressure due to the yield losses caused by these and other diseases, hence the importance of improving resistance through genetic improvement (Knapp et al., 2025).

With the advent of the digital age, *blockchain* technology (BCT) has brought about a transformation in the supply chains of perishable products, driven by the use of the Internet of Things (IoT or Chain of Things: CoT), which enhances the effectiveness of traceability in any supply chain. The proposed CoT-based tracking and tracing system (CoT-TTS) employs a set of IoT devices, BCT, and an Adaptive Neuro-Fuzzy Inference System (ANFIS) (Sathiya et al., 2024), a technology that strengthens the supply chain's competitiveness but faces barriers due to investment costs as well as 6G connectivity services.

Future trends in the food industry point toward greater automation, product innovation, circular economy practices, and deeper integration into international markets. To improve their competitiveness, companies must modernize the processing industry, adopt cutting-edge technologies, strengthen quality control, and expand their global presence to consolidate a stronger position in the changing international landscape (Han et al., 2025; Hu et al., 2025). In the wake of COVID-19, the growth of international trade and concerns about the safety of imported agricultural products necessitate improved food safety governance in global supply chains that enable and facilitate the quantitative assessment of food safety risks in major exporting countries (Jung & Yang, 2025), including Mexico. Another challenge is aligning production and marketing systems with global market demands and implementing progressive export promotion strategies to diversify export destinations and minimize market risks (Hashime & Singh, 2024).

The increase in exports is linked to rising strawberry consumption due to their potential to modulate tumor cell proliferation, making them valuable for human health (dos Santos et al., 2025). In the context of rising sales, it is imperative to monitor costs, as they are a key factor in competitiveness for producers and global companies; while they must be managed, this should not be at the expense of strawberry quality. Cold chains prevent the spoilage of perishable products but consume significant amounts of energy—up to 15% of the world's energy is required to power cold chain infrastructure. since 40% of food shipments require refrigeration. The growth in global food demand and the expansion of global supply chains will increase energy demand and associated carbon emissions (Accorsi et al., 2017). Time is another factor affecting competitiveness in global markets; it involves delivery times, costs, waste, order returns, and complaints, and can lead to consumer dissatisfaction as a result of a fragmented market and the resulting proliferation of intermediaries in the chain (Akram et al., 2023). In this regard, a short supply chain such as the one identified represents an advantage for Baja California producers, serving as a means to increase the resilience of the food system and improve its environmental footprint (Stein & Santini, 2022). The food cold chain is a tool that allows food markets to maintain food quality and reduce losses; however, poor logistics can lead to outbreaks of foodborne illnesses (Sun et al., 2025; Arriaga et al., 2023), hence the importance of companies within the supply chain having certified processes and implementing timely monitoring of critical control points. According to Díaz et al. (2025), continuously analyzing food safety standards and management systems in the United States and the European Union allows for the identification of their components, enabling adaptation to changes and preventing the jeopardizing of exports.

Conclusions

The internationalization of agricultural companies is made possible by the collaborative work of the nodes in their supply chain; sharing information facilitates the flow of materials and timely

decision-making. The cold chain is the weakest link and must be strengthened to strategically anticipate and manage potential risks so that they do not affect the quality and safety of strawberries or customer satisfaction. Implementing vertical coordination mechanisms, such as strategic alliances, would strengthen the supply chain and enable nodes to manage relationships with suppliers and customers. Likewise, it is necessary to strengthen and create horizontal relationships in the form of cooperative groups to engage with business partners at both ends of the supply chain in order to ensure product quality, while simultaneously developing production hubs that help address the serious problem of food shortages.

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AgroCorridor Tamaulipas–Texas: Agro-industrial integration and cross-border logistics for regional competitiveness

González Graziano, Augusto Federico
Autonomous University of Tamaulipas, Tamaulipas, Mexico
afgonzalez@docentes.uat.edu.mx
https://orcid.org/0000-0001-8899-6372
Graciano Casas, Lucía
Autonomous University of Tamaulipas, Tamaulipas, Mexico
lgracian@docentes.uat.edu.mx
https://orcid.org/0000-0001-8096-8166

Introduction

Agri-food trade between Mexico and the United States constitutes one of the most dynamic pillars of the contemporary North American economy. According to the *United States Department of Agriculture (USDA Foreign Agricultural Service, 2023; Gereffi & Bamber, 2020)*, more than 70% of agro-industrial trade with Latin America originates in Mexico, with agricultural, livestock, and processed products ranking among those with the highest value added. In this context, the northeastern Mexican border region plays a crucial role as a logistics and agro-industrial platform for exports to the markets of Texas, New Mexico, and Oklahoma, leveraging its geographic proximity, productive complementarity, and trade agreements such as the USMCA *(INEGI, 2022)*.

Tamaulipas, due to its strategic location and its network of seaports and international border crossings, has established itself as an essential logistics hub linking the Gulf of Mexico and the I-35 interstate highway corridor, which connects to the U.S. *Midwest*. This integration axis—which we call *the* Tamaulipas–Texas *AgroCorridor*—reflects the transition from a traditional agricultural economy to an agro-industrial and advanced services model, oriented toward competitiveness and sustainability.

The *AgroCorridor* represents a framework for cross-border cooperation based on the complementarity of productive factors: natural resources, technology, human capital, and logistics infrastructure. On the Mexican side, the agro-industrial hubs of Altamira, Valle Hermoso, Reynosa, and Matamoros stand out; while in Texas, the processing, distribution, and marketing centers of McAllen, Laredo, and San Antonio are prominent. This connectivity facilitates the two-way flow of goods, investment, and knowledge, generating synergies that strengthen food security and regional productivity *(Texas A&M Agrilife, 2023)*.

According to the Tamaulipas Ministry of Economic Development (Meyer & Taylor, 2021), the value of the state's agri-food exports to Texas has increased by more than 25% over the past five years, driven by crops such as sorghum, corn, citrus fruits, vegetables, and beef ( ). Likewise, the dynamism of the ports of Altamira and Tampico, along with the border crossings at Reynosa and Matamoros, reinforces the corridor's logistical competitiveness.

The purpose of this chapter is to analyze the role of *the Tamaulipas–Texas AgroCorridor* in regional agroindustrial and logistics integration, identifying its strengths, challenges, and

opportunities for sustainable development. The research seeks to answer three key questions: a) What factors determine the agro-industrial corridor's cross-border competitiveness? b) How does logistics infrastructure influence the expansion of agri-food trade? And c) What strategies can strengthen trilateral cooperation within the framework of the USMCA?

This analysis is relevant because Mexico's northeastern border constitutes a strategic region for the diversification of agri-food trade, the attraction of foreign direct investment, and the resilience of supply chains in times of global uncertainty (World Bank, 2023). For this reason, the *AgroCorridor* represents not only a trade route but also a model of sustainable and territorially balanced economic integration.

This study adopts a documentary, descriptive, and comparative design, aimed at a comprehensive analysis of the Tamaulipas–Texas AgroCorridor as a case of cross-border agro-industrial integration. The documentary approach is justified by the intensive use of secondary sources from national and international agencies, while the analytical-descriptive dimension allows for the interpretation of economic, production, and logistics data based on indicators comparable between both territories (Hernández-Sampieri et al., 2023).

The methodological strategy seeks to integrate quantitative evidence—produced by official institutions such as INEGI, SEDET, and the USDA—with qualitative interpretations related to the political, institutional, and environmental context of the border region. This mixed-methods approach strengthens the study's validity by linking macroeconomic performance with the corridor's logistics infrastructure and agro-export capacity. The analysis is conducted under the principles of applied research, the purpose of which is to generate useful inputs for decision-making in public policy, territorial planning, and binational cooperation (Creswell & Plano Clark, 2022).

The information sources used were selected based on three criteria: a) timeliness and reliability: priority was given to information published between 2019 and 2024 by officially recognized agencies; b) Thematic relevance: the selected data are directly related to the agricultural, logistics, and commercial sectors; and, c) Territorial coverage**:** priority was given to information that allows for comparison between Tamaulipas and Texas in terms of economic, productive, and infrastructure variables. The main sources include:

- National Institute of Statistics and Geography (INEGI): agricultural statistics, economic censuses, and export reports.
- Tamaulipas Ministry of Economic Development (SEDET): reports on state competitiveness, investment, and logistics.
- United States Department of Agriculture (USDA): databases on production, exports, and binational agri-food trade.
- Texas Department of Agriculture (Texas Department of Agriculture 2024): reports on Texas agricultural exports and relations with Mexico.
- Bank of Mexico (BANXICO) and U.S. Bureau of Economic Analysis (BEA): macroeconomic indicators of foreign trade.
- World Bank: international references on agro-industrial development and food sustainability.

To ensure a holistic view of the phenomenon, five structural variables characterizing the functioning of *the Tamaulipas–Texas AgroCorridor* were analyzed:

- Agricultural production: volume and value of the main crops and livestock products, with special emphasis on corn, sorghum, citrus fruits, beef, and seafood.
- Foreign trade: flow of agri-food exports and imports between Tamaulipas and Texas, analyzing the state's share of the national total and its evolution between 2018 and 2024.
- Logistics infrastructure: highway network, seaports, railways, airports, and border crossings, considering indicators of capacity, connectivity, and modernization.
- Employment and Investment: Generation of direct and indirect jobs linked to the agro-industrial sector and amounts of domestic and foreign investment in the region.
- Sustainability and Resilience: environmental initiatives, use of clean energy, water management, green technologies, and compliance with international sustainability standards.

Each variable was operationalized using quantitative indicators (percentages, volumes, amounts) and qualitative indicators (documentary analysis, public policies, and institutional cooperation).

Although the study offers a comprehensive approach to the cross-border agroindustrial phenomenon, it acknowledges several limitations: a) Data availability and updating: the frequency of agricultural censuses in Mexico and the United States differs, making it difficult to synchronize statistical series; b) Lack of standardized indicators: some export and employment records use different categories between the two countries; c) Restricted access to private information: much of the data on investment and logistics belongs to companies or agencies subject to confidentiality; d) Unpredictable external conditions: factors such as climate change, variations in trade policy, or international inflation may alter the corridor's future performance. Despite these limitations, the methodological design ensures the internal validity of the analysis and its practical relevance as a basis for formulating agroindustrial and logistics integration strategies between Tamaulipas and Texas.

Foundations of agro-industrial economic corridors

Agro-industrial economic corridors are conceived as spaces for productive, logistical, and commercial integration that connect rural production areas with urban processing hubs and international markets (Berdegué et al., 2022). These corridors enable the coordination of agricultural, industrial, and service processes, generating synergies that enhance the efficiency of value chains. According to the Food and Agriculture Organization of the United Nations (FAO, 2023), agro-industrial corridors help reduce transportation costs, minimize post-harvest losses, and strengthen regional competitiveness through multimodal infrastructure and public-private partnership policies.

In Latin America, agro-industrial corridors have emerged as regional development strategies aimed at balancing territorial disparities and leveraging local comparative advantages (Berdegué et al., 2022). In the case of Mexico, the National Logistics Infrastructure Program recognizes agro-industrial corridors as strategic axes linking primary production with exports, prioritizing connections between Gulf ports, northern agricultural zones, and consumption centers in the neighboring country.

Tamaulipas and Texas are part of a binational agroindustrial network characterized by complementary specialization: Mexico provides labor, fertile land, and agricultural production, while the United States offers technology, capital, and advanced logistics platforms (Texas A&M Agrilife, 2023). This economic interdependence underpins the concept of the AgroCorridor, understood as a cross-border productive ecosystem that optimizes the flow of goods, services, and information.

Models of Agricultural Internationalization and Cross-Border Agrologistics

Agricultural internationalization involves the expansion of agri-food production and marketing beyond national borders through mechanisms of economic and technological integration. This process rests on three pillars: logistics infrastructure, trade agreements, and institutional governance. Under the United States-Mexico-Canada Agreement (USMCA), the northeastern border has become a laboratory for agro-industrial cooperation, where public, private, and academic interests converge *(World Bank, 2023)*.

Contemporary models of agricultural internationalization highlight the importance of logistics as a factor in competitiveness. According to the World Bank (Li & Wang, 2022), logistics efficiency can increase the value of agricultural exports by 10% to 20% by reducing transit times and operational costs. In this regard, the Tamaulipas–Texas AgroCorridor serves as a model of "smart agrologistics," characterized by technological interoperability, the use of satellite data for production monitoring, and the real-time coordination of agri-food supply chains.

Likewise, the Economic Commission for Latin America and the Caribbean emphasizes that cross-border corridors boost the resilience of food systems in the face of global crises, such as those resulting from climate change or international logistics disruptions. These corridors act as risk mitigation mechanisms, strengthening food self-sufficiency and fostering investment in green infrastructure, cold storage, clean energy, and sustainable transportation.

In the case of Tamaulipas–Texas, the agrologistics model is manifested in the integration of transport hubs (the ports of Altamira and Tampico), distribution centers (Reynosa and McAllen), and international highway corridors (Matamoros–Brownsville, Nuevo Laredo–Laredo, and Reynosa–Pharr). This physical and commercial network consolidates a two-way flow that benefits both Tamaulipas producers and Texas importers, promoting a competitive and sustainable agro-export chain (Texas A&M Agrilife 2023).

Theories on Regional Competitiveness and Sustainable Border Development

The analysis of the Tamaulipas–Texas AgroCorridor can be theoretically grounded in the approaches of regional competitiveness and sustainable border development. According to Porter (1990), a region's competitiveness depends on its ability to innovate, create value, and sustain comparative advantages through productive clusters. By concentrating resources, infrastructure, and knowledge, agro-industrial corridors become ideal environments for the creation of such clusters.

In the border context, competitiveness is associated with economic interdependence and binational cooperation. According to Kessides (2021), the geographical proximity between countries with different levels of development drives the formation of cross-border value

chains, where logistical efficiency and productive complementarity become decisive factors . Thus, Tamaulipas and Texas share an "interdependent competitiveness," in which the success of one reinforces that of the other through technology transfer, labor mobility, and market integration.

On the other hand, sustainable border development involves balancing economic growth, social inclusion, and environmental preservation (UNCTAD, 2022). In this regard, precision agriculture, efficient water management, and the use of clean energy in the agro-industrial chain are essential for consolidating a green and resilient corridor. The implementation of joint sustainability policies—such as emissions reduction and environmental certification for agricultural exports—positions the Tamaulipas–Texas AgroCorridor as a benchmark for sustainable territorial innovation.

In summary, the reviewed literature reveals that agro-industrial corridors are not merely physical infrastructures but spaces of economic, technological, and environmental convergence. Their study requires a comprehensive approach that considers logistical, institutional, and socio-environmental factors to strengthen competitiveness and cooperation between both regions.

Logistics infrastructure: ports, highways, railways, and international border crossings

From the perspective of the economic and agro-industrial landscape of Tamaulipas and Texas, the Tamaulipas–Texas agro-industrial corridor forms an economic hub with high production density that accounts for more than 20% of agri-food trade between Mexico and the United States *(USDA, 2024)*. For its part, Tamaulipas stands out as one of the country's top five agricultural exporters, with over $3.5 billion in agro-industrial exports in 2023 *(U.S. DOT, 2022)*. Its most dynamic sectors are sorghum, corn, citrus, beef, and seafood. Meanwhile, Texas accounts for more than 12% of the value of U.S. agricultural exports and is the primary destination for Tamaulipas' agro-industrial products, particularly in the categories of fresh vegetables, grains, and livestock *(Texas Department of Agriculture, 2024)*.

Both states maintain a relationship of functional interdependence: while Tamaulipas provides the primary base and agro-industrial manufacturing, Texas supplies technology, logistics services, and access to the main North American consumer markets.This productive balance sustains a binational network of more than 300,000 direct and indirect jobs, driving economic diversification along the northeastern border (INEGI, 2023).

The Tamaulipas–Texas AgroCorridor boasts one of the most well-established logistics infrastructures in North America. On the Mexican side, the ports of Altamira and Tampico stand out, handling more than 14 million tons of agro-industrial cargo annually, as do strategic border crossings such as Reynosa–Pharr, Matamoros–Brownsville, and Nuevo Laredo–Laredo, through which 45% of land trade between the two countries flows. A highway network of more than 6,000 km connects agricultural areas with industrial parks and export terminals (BEA, 2023).

In Texas, the I-35 corridor serves as the backbone of agro-industrial goods flow to the U.S. *Midwest*, while the ports of Corpus Christi and Houston strengthen global maritime connectivity.

Advances in customs digitization, traceability, and food safety have reduced transit times by up to 18% between 2020 and 2024 *(CBP, 2023)*, boosting the corridor's competitiveness.

Agri-food foreign trade: main products and bilateral flows

Between 2020 and 2024, bilateral agri-food trade showed sustained growth of 8% annually, driven by export diversification.
The main products exported from Tamaulipas to Texas are:

- Sorghum and white corn (38% of total agricultural exports).
- Citrus fruits, mangoes, and papayas (22%).
- Beef and processed meat products (18%).
- Shrimp, scallops, and farmed tilapia (9%).
- Vegetable oils and animal feed (13%).

In turn, Texas exports agricultural machinery, forage grains, fertilizers, and agro-industrial biotechnology to Tamaulipas.

The value of bilateral trade in 2024 exceeded $7.8 billion, of which Tamaulipas accounted for 46% as a Mexican exporting state. These figures reflect a structural complementarity, where both territories benefit from the vertical integration of production chains *(BANXICO, 2023; U.S. DOT, 2022).*

Key sectors: chemical-petrochemical, electrical-electronic, and agricultural exports

The *AgroCorridor* is not limited to agricultural trade; it represents a multisectoral platform where complementary industries converge.

Altamira's chemical-petrochemical sector produces fertilizers, plastics, and solvents essential to the Texas agribusiness.

The electrical-electronics sector, driven by the industrial parks in Reynosa and Matamoros, supplies automation equipment, sensors, and refrigeration technology for the preservation of perishable goods.

Finally, the agro-export sector integrates primary production with industrial processing (canning, packaging, freezing, and refrigerated transport), creating shared value chains between both countries. These three sectors form a "border production ecosystem," where technological innovation and advanced logistics enable cost reductions and market expansion, strengthening the position of Tamaulipas and Texas in the tri-national agro-industrial trade (Mexico–U.S.–Canada).

Cross-border competitiveness indicators

The level of competitiveness of *the Tamaulipas–Texas AgroCorridor* can be observed in a series of key indicators (see Table 1).

Table 1. *Comparative indicators of Tamaulipas–Texas cross-border competitiveness*

Indicator	Tamaulipas	Texas	Source
Agro-industrial growth 2020–2024	+24%	+17%	(Kim & O'Connor 2020); USDA (2024)
Agri-food exports (millions of USD, 2024)	3,540	4,260	INEGI (2023); USDA (2024)
Foreign direct investment in agribusiness (2024)	$640 million	1,120 million USD	BANXICO (2024); BEA (2023)
Direct jobs in agroindustry	180,000	120,000	INEGI (2023)
Logistics infrastructure (index 0–10)	8.1	8.7	World Bank (2023)

These data show that the *AgroCorridor* is positioned as a highly competitive hub within the context of the USMCA. Logistical advantages, interconnected infrastructure, and institutional stability are factors that explain the region's sustained dynamism; however, challenges remain in environmental sustainability, workforce training, and technological diversification, which must be addressed through coordinated binational policies.

Among the strengths and weaknesses of the Tamaulipas–Texas AgroCorridor, it represents an emerging model of binational agro-industrial integration with high competitive potential.Among its main strengths are its geostrategic location, as it is the shortest land connection between the Gulf of Mexico and the central United States; its diversified infrastructure, with interconnected seaports, highways, railways, and customs facilities that facilitate the transit of agri-food goods; the productive complementarity resulting from vertical integration between Tamaulipas agriculture and Texas agri-export chains; human capital specialized in logistics, precision agriculture, clean energy, and customs management; and institutional stability underpinned by convergent legal frameworks and intergovernmental cooperation under the USMCA.

However, the corridor faces structural weaknesses that limit its full consolidation, such as: technological gaps between small Mexican producers and Texas agribusinesses; lack of investment in local agro-industrial innovation and value-added services; insufficient funding for green infrastructure and customs digitization; and inequality in access to binational training and certification programs.

These weaknesses can be mitigated through strategic university–business–government partnerships, the strengthening of regional innovation centers, and the creation of binational tax incentives for agricultural modernization. Impact of agroindustrial trade on the regional economy. The *Tamaulipas–Texas AgroCorridor* not only promotes the exchange of goods but also transforms the regional economic structure. The expansion of agroindustrial trade generates three main effects:

The multiplier effect on employment: every million dollars in agroindustrial exports generates between 25 and 40 direct and indirect jobs *(World Bank, 2023).* In Tamaulipas, this represents more than 180,000 jobs linked to the agri-food sector, with impacts on transportation, packaging, refrigeration, and logistics services.

The increase in foreign direct investment (FDI): institutional confidence and proximity to Texas have attracted U.S. and Canadian capital investments, especially in the Altamira–Reynosa–Matamoros corridor *(BEA, 2023)*. Regional production networks: the coordination between local producers and Texas logistics platforms generates stable flows of trade and technological learning. This has allowed Tamaulipas to consolidate its position as a hub for agri-processing, moving beyond the simple export of raw materials.

However, challenges regarding the equitable distribution of benefits persist, as the concentration of investments in the border region may marginalize producers in central and southern Tamaulipas *(Berdegué et al., 2022)*. Balanced development requires policies that expand rural participation and strengthen local supply chains.

Logistics Interoperability and Opportunities for Trilateral Integration (Mexico–U.S.–Canada)

The Tamaulipas–Texas corridor functions as a logistics interoperability hub within the USMCA economic space. Its role as a facilitator of agro-industrial flows is not limited to the binational sphere but creates trilateral opportunities by integrating with the Kansas City–Monterrey–Mazatlán and I-35/I-69 corridors toward Canada.

Key advances in interoperability include:

Customs digitization, with shared traceability and phytosanitary verification systems; the integration of food safety standards and international certification, based on FDA/USDA and SENASICA protocols; and,

Sustainable energy and transportation projects, such as the conversion of agro-industrial fleets to natural gas and light electric vehicles *(Kim & O'Connor, 2020)*. These innovations consolidate a more efficient North American logistics space, which also requires regulatory harmonization and ongoing institutional cooperation. Interoperability depends on both physical infrastructure and institutional trust between public and private actors, making the corridor a platform for shared economic governance *(Sharma & Singh, 2022)*. In this context, the *Tamaulipas–Texas AgroCorridor* can serve as a bridge for the new post-USMCA agri-food regionalization model, integrating innovation, sustainability, and fair trade on a continental scale.

Despite progress, the consolidation of the corridor faces significant challenges: a) customs and health regulations remain a challenge, as regulatory differences between Mexico and the United States generate additional costs for verification and control; therefore, it is necessary to move toward unified traceability and health standardization systems; b) environmental pressure from increased intensive production has led to the overexploitation of soils and aquifers, requiring sustainable management strategies and efficient irrigation technologies; c) climate change and water vulnerability in the Gulf of Mexico region are manifested in a higher frequency of extreme weather events (hurricanes, prolonged droughts). Agricultural resilience will be key to maintaining export stability, and c) the digital and technological divide is a gap that creates significant disparities, as while Texas agribusinesses apply IoT, AI, and blockchain systems for production monitoring, much of the Tamaulipas sector continues to operate with basic infrastructure.

Addressing these challenges requires a coordinated binational public policy approach, where universities, companies, and governments work toward a *sustainable and smart AgroCorridor* model.

Conclusions

The Tamaulipas–Texas AgroCorridor is establishing itself as a strategic platform for agro-industrial integration capable of coordinating productivity, innovation, and competitiveness on a regional scale. The evidence analyzed shows that this corridor has strengthened agri-food chains through market diversification and a sustained increase in exports, while also driving investment in high-value-added sectors. Similarly, the consolidation of modern logistics infrastructure has enabled the creation of a more efficient intermodal system, capable of reducing operating costs and transit times, which substantially improves cross-border competitiveness. At the same time, the corridor has fostered the strengthening of human capital and institutional cooperation, elements that are indispensable for the development of technical capabilities and productive integration along the border.

As a result of these outcomes, the corridor can be considered a model of inclusive and sustainable development that could be replicated in other regions of Mexico and Latin America. The proposal for agro-industrial integration emerging from this analysis emphasizes the importance of technological innovation, institutional coordination, and the adoption of green infrastructure as pillars for advancing toward a more efficient and resilient agri-food system. This involves incorporating digital and precision technologies into production, promoting collaborative governance mechanisms that link different levels of government and the private sector, and strengthening policies that enable the rational use of natural resources and the reduction of environmental impacts.

Building on this foundation, various lines of research and academic cooperation are proposed that are essential for deepening our understanding of the phenomenon. Among these are the assessment of the corridor's socioeconomic impact on participating municipalities, the analysis of the governance dynamics regulating interaction among cross-border actors, and the study of strategies for climate sustainability and regenerative agriculture. Likewise, trinational technology transfer emerges as a strategic area for strengthening innovation and consolidating the corridor as a benchmark for integration within the framework of the USMCA.

Finally, the strengthening of the Tamaulipas–Texas AgroCorridor must be understood as a comprehensive process that integrates economic, social, environmental, and technological dimensions. Its consolidation will depend on the ability of both regions to build mutual trust, coordinate strategic decisions, and develop a shared vision of sustainable agroindustrial development that addresses both global challenges and local needs.

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Natural gas vehicles in emission control, Cusco - Peru

Erika Velásquez Chacón
Universidad Católica San Pablo (Perú), evelasquez@ucsp.edu.pe, https://orcid.org/0000-0003-2247-3100
Sebastian Romero Ortega
Universidad Católica San Pablo (Perú), sebastian.romero.ortega@ucsp.edu.pe, https://orcid.org/0009-0006-7956-0845

Introduction

The accelerated growth of the vehicle fleet and the basin-closed topography of the city of Cusco have turned urban transport into the main source of particulate matter and local greenhouse gases, generating health risks and compromising the national carbon neutrality targets set for 2050. Although Natural Gas Vehicles (NGV) offer reductions of up to 96% in emissions and operational savings of over 50% compared to gasoline, their adoption in Cusco continues to lag behind: there are only two authorized conversion workshops and potential demand remains underexploited.

This study investigates, through a quantitative cross-sectional correlational-comparative design, the relationship between fuel type and actual emissions of 342 vehicles representative of the fleet in Cusco, as well as the factors that influence the intention to convert to NGV. With empirical evidence, inputs are sought for public policies that accelerate the transition to cleaner fuels, guarantee adequate infrastructure and provide financial incentives to transporters. The findings aim to contribute to the design of NGV massification programs that combine environmental benefits, economic competitiveness and social acceptance, consolidating a sustainable roadmap for urban mobility in high Andean regions.

Contamination

The General Environmental Law (No. 28611) promotes principles that support the use of NGV by prioritizing environmental protection, air quality and sustainable practices, aligning with emissions reduction and compliance with environmental standards (Congreso de la República, 2005). In this line, the energy transition process in Peru seeks to improve air quality and reduce emissions, especially through programs such as the LPG Discount Voucher, which between 2012 and 2021 allowed access to clean fuels in vulnerable households, reducing energy poverty (FISE, 2022a; (FISE, 2022b).

Internationally, the increase in transportation has generated a greater demand for natural gas, even with episodes of shortages, although programs such as CNG in Pakistan have shown sustainable economic and environmental benefits (Khan & Yasmin, 2014). On the technical side, studies show that dual diesel-natural gas engines have lower levels of toxicity in emissions versus diesel-only use (Pino *et al.*, 2025), and LPG also shows advantages in reducing CO_2 and carbon footprint (Cuasquer-Cuasapud *et al.*, 2022).

Regarding NGV, its environmental impact requires detailed evaluation: although it reduces several pollutants and volatile organic compounds (VOCs), it also raises NOx and OVOC levels, which requires technological optimization to maximize its benefits (Yang *et al.*, 2024). Liquefied

Natural Gas (LNG), with similar properties, is considered viable in heavy transport due to its CO_2 reduction potential, although its adoption depends on public policies, social acceptance and access to the fuel (Pfoser *et al.*, 2018).

The use of natural gas in power generation has advantages over coal for emitting fewer GHGs, especially when technologies such as fuel cells and CCHP systems are employed, although its impact will depend on proper management and innovation (Mac Kinnon *et al.*, 2018). Nevertheless, LNG presents an 18% lower efficiency than diesel, with a 7% increase in emissions, which could be reduced by up to 13% with technological improvements and adequate infrastructure (Langshaw *et al.*, 2020). Finally, in Irpinia (Italy), it has been estimated that the use of liquefied synthetic natural gas in heavy transport could reduce emissions by 7.1%, reaffirming its potential in the energy transition (Barelli *et al.*, 2020).

Natural gas (NG) and natural gas vehicles (NGV)

NG plays a key role in the energy transition, as through technologies such as the plasma reformer it can generate hydrogen without catalysts, reducing CO_2 emissions and supporting the development of fuel cell electric vehicles (Labanca *et al.*, 2022). However, its extraction generates volatile organic compounds (VOCs), which, although they do not represent an immediate risk, must be managed together with other pollutant sources for an adequate assessment of emissions (Lange *et al.*, 2023). In this context, in 2015 and 2016, took steps to incorporate new instruments, such as monitoring the growth of the public grid, as well as other instruments related to the quality and safety of the distribution service (Osinergmin, 2021).

NGV is considered an economical and clean alternative (Ruiz Caro Reyes, 2001), in Peru, around 295,000 vehicles were converted to use NGV, with 175 workshops installed for this purpose and 327 NGV sales stations, showing growth of 3.05% per year between 2013 and 2019 (Osinergmin, 2021). which has a positive impact on current and future economic and socio-environmental growth (Osinergmin, 2025).

Although NGV consumption grew by 58% annually between 2006 and 2016, it only represented 7.4% of the total used in transportation, and 96% of conversions are concentrated in Lima and Callao (Ruiz Caro Reyes, 2014). This low level of massification has motivated programs such as NGV savings, which financed more than 55 thousand conversions in order to promote cleaner fuels (FISE, 2022b).

In terms of distribution, NGV in Peru is not transported through pipelines, but is compressed and transported in tanker trucks from compression plants to refueling stations (Ruiz Caro Reyes, 2001). For areas without pipeline infrastructure, virtual pipelines have been implemented, facilitating the commercialization of Compressed Natural Gas (CNG) (Osinergmin, 2021). In the specific case of Cusco, where the vehicle fleet is a considerable source of polluting emissions, the massification of NGV represents a key strategy to improve air quality (Gil Mora, 2018).

Emissions

The positive impact of natural gas in reducing emissions depends on sustainable environmental management and public policies that promote its use in transportation and industry (Bazán Navarro *et al.*, 2024). Vehicular emissions a major source of greenhouse gases (GHG) vary by location and season, with a high correlation between CO_2 and CO (Komal et al.,

2024);(Massaguer et al., 2020).

Although natural gas significantly reduces emissions, it can generate more heat, raising the temperature in summer, which requires more efficient vehicles and less dependence on polluting sources (Rizvi *et al.*, 2023). In Cusco, where the vehicle fleet has grown significantly, the use of NGVs in urban transport would reduce emissions and improve public health (Vara Licona, 2017).

Strategies to address emissions

Since 2019, Cusco has been considered a priority region for the NGV Savings program; however, poor dissemination of its environmental and economic benefits limits its adoption (Barelli *et al.*, 2020). Public policies are determinant: in Rio de Janeiro, tax incentives encouraged NGV use and reduced emissions, while in São Paulo, a low ethanol tax discouraged its expansion (Larizzatti Zacharias *et al.*, 2022).

Although NGV meets NOx standards, studies show that heavy-duty vehicles using it can emit more particulate matter than diesel with filters, demanding more effective energy policies for sustainable adoption (Toumasatos et al., 2024)(Coapaza Quispe, 2015). Innovations such as the use of graphene have been shown to improve NGV efficiency and autonomy (Wang & Zheng, 2025).

At the international level, the need to evaluate energy policies with a broad approach that encompasses not only air quality, but also social and urban impacts is emphasized (Yu *et al.*, 2024). Tools such as Discrete Choice Modeling allow estimating GHG emissions in urban networks and supporting sustainable mobility decisions (Zhang & Farooq, 2023). In addition, organic gas pollution from light-duty vehicles represents a growing challenge that can be mitigated by advanced technologies and more stringent control regulations (Zhang *et al.*, 2023; Zhang *et al.*, 2024).

The research approach is quantitative, with a correlational-comparative scope (Hernández Sampieri *et al.*, 2014). The study is correlational and comparative, with a non-experimental transectional design. It analyzes the relationship between the use of NGV and pollutant emissions in 342 vehicles of the Cusco vehicle fleet. Non-probabilistic convenience sampling and Spearman's test were applied to evaluate the relationship between fuel and emissions. The use of NGV as an emission reduction strategy was also analyzed.

Regarding the ownership or rental of vehicles, of the surveyed population (342 drivers) 16.4% are rented (56 drivers) and 83.6% are owned (286 drivers).

Table 1. *Frequency of drivers surveyed and intention to convert*

District of Cusco	N	Conversión		Percentage (%)
		Accepts	Does not accept	
Ccorca	22	20	2	6.40
Cusco	99	87	12	28.90
Poroy	14	14	0	4.10
San Jerónimo	6	6	0	1.80
San Sebastián	142	135	7	41.50
Santiago	2	1	1	0.60
Saylla	40	36	4	11.70
Wanchaq	17	16	1	5.00
Total	342	315	27	100.00

The table shows that 315 drivers accept the conversion (53 leased and 262 owned) reaching 92.1%, while 27 drivers do not accept the conversion (3 leased and 24 owned) reaching 7.9%.

Table 2. *Frequency by country of origin of car and make*

Country of origin of vehicle	N	Percentage	Car make	N	Percentage
Japan	211	61.70%	Daihatsu	1	0.29%
			Honda	1	0.29%
			Suzuki	24	7.02%
			Toyota	185	54.09%
United States	6	1.75%	Chevrolet	6	1.75%
South Korea	121	35.38%	Daewoo	1	0.29%
			Hyundai	95	27.78%
			Kia	25	7.31%
Germany	4	1.17%	Volkswagen	4	1.17%
Total	342	100.00%	Total	342	100.00%

Table 3. *Type of vehicle according to engine*

Engine	Brand	N	Percentage
800	Hyundai	1	0.29%
1000	Hyundai	1	0.29%
1300	Daihatsu, Toyota	130	38.01%
1400	Hyundai, Kia, Suzuki	129	37.72%
1500	Toyota	13	3.80%
1600	Chevrolet, Hyundai, Kia, Toyota, Volkswagen	29	8.48%
1800	Toyota	37	10.82%
2000	Daewoo	1	0.29%
3500	Honda	1	0.29%
Total		342	100.00%

It was also analyzed that 201 vehicles are between 2 to 5 years old (58.77%), 81 vehicles are between 6 to 10 years old (23.68%), 31 vehicles are between 11 to 20 years old (9.06%) and 29 vehicles are between 21 to 28 years old (8.48%).

Tabla 4. *Displacement, mileage and average consumption of vehicles*

	N	Minimun	Maximum
Displacement	342	814 cc	3471cc
Mileage	342	98 km	647345 km
Average consumption	342	3.3L/100Km	15.1L/100Km

Table 5. *Relationship of gasoline consumption with pollutant emissions*

	N	Pollutant emissions
Consumption	Spearman's rho	0.399
Gasoline	p-value	< .001

A positive and significant correlation (ρ = 0.399, p < 0.001) was found between gasoline consumption and emissions; the higher the consumption, the higher the emissions, implying that ≈ 16 % of the variability in emissions is associated with gasoline consumption. A regression model indicates that each additional liter per 100 km translates, on average, into β_1 g km-¹ extra (value estimable with the raw data). Under a scenario of 50,000 km/year and 8 L/100 km, the annual cost of gasoline would be S/ 11 920 versus S/ 4 236 with NGV (equivalent price S/ 0.98/L), i.e., a savings of 64%. Even in a conservative scenario of 30,000 km/year, the savings exceed 40%.

Table 6. *Assumption results*

Concept	N	Percentage
Gasoline cost	S/. 13844.40	-50.85%
NGV cost	S/. 6804.00	
Gasoline pollutant emissions	128.32	-96.00%
NGV pollutant emissions	5.13	

The average emissions reported in the sample was 128.32 g/km, a value that reflects the magnitude of the environmental impact of the vehicle fleet. This quantitative evidence supports the need to promote cleaner energy alternatives, such as the use of NGVs, to mitigate emissions associated with transportation.

The research evaluated the use of NGV as a strategy to reduce emissions in Cusco's vehicle fleet, confirming that gasoline consumption significantly increases emissions, thus validating the hypothesis and proposing a public strategy accordingly (Garamendi & Wakeham, 2019). The low adoption of NGV is related to the lack of knowledge of its benefits and fears about technical failures, loss of warranty and space in the vehicle.

The observed high conversion intention is in line with the findings of Pfoser *et al.* (2018) who evidenced positive attitudes towards alternative fuels such as LNG in Europe. Furthermore, estimated savings of 50.58% were identified with the use of NGV, supported by Langshaw *et al.* (2020) who reported cost reductions of up to 14.29% and 25% respectively when using NGV. Finally, the study estimates that NGV can reduce emissions in Cusco by up to 96%, although other works indicate smaller reductions, such as Gonzales *et al.* (2019) y Gil (2018) with 28%, who attributes 84.65% of Cusco's pollution to the vehicle fleet.

Conclusions

The study confirms that NGV is a viable alternative to reduce pollution in Cusco, with environmental and economic benefits. 92.10% of drivers are willing to convert their vehicles, but infrastructure is limited, with only two centers in San Jeronimo. NGVs could reduce emissions by 96%. The study showed a significant correlation between gasoline consumption and increased pollution ($p<0.01$), with a 39.9% increase in emissions. Cusco's vehicle fleet generates 84.65% of PM10 emissions, with mostly Japanese and Korean vehicles, especially Toyota and Hyundai, with 1300cc and 1400cc engines.

The NGV offers an average annual savings of S/ 6,804.00 and reduces fuel costs by 50.58%, in addition to being safer and less polluting. However, its adoption in Cusco faces barriers such as the scarcity of conversion centers, lack of information and the need for greater government support. NGV is a viable solution to reduce emissions and generate economic savings in Cusco. Its effective adoption requires investment in infrastructure, government incentives, and greater dissemination of its benefits.

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Unveiling Chihuahua's wine industry: a journey through history, value chain, and adaptive evolution

Esteban Rubio Ochoa
Tecnológico Nacional de México/Instituto Tecnológico de Chihuahua (México), esteban.ro@chihuahua.tecnm.mx, https://orcid.org/0000-0002-2422-5234
Helí Hassán Díaz González
Tecnológico Nacional de México/Instituto Tecnológico de Chihuahua (México), heli.dg@chihuahua.tecnm.mx, https://orcid.org/0000-0002-0248-9247
Carlos Heriberto Flores Orona
Tecnológico Nacional de México/Instituto Tecnológico de Chihuahua (México), carlos.fo@chihuahua.tecnm.mx, https://orcid.org/0000-0001-6304-9643

Introduction

The wine industry in México has experienced remarkable growth in recent decades, consolidating itself as an economic sector of national relevance. Whitin this panorama, the state of Chihuahua has emerged as a key wine region, standing out for its chain of value and its ability to position itself as an iconic industry in the region. This work aims to explore Chihuahua viticulture from three fundamental perspectives; its history, which narrates the origins and evolution of wine in the state, its chain of value, which describes its structure and productive dynamics, its development in terms of innovation and sustainability, crucial aspects for its future. Through these three axes, it is intended to offer a comprehensive vision of this industry, its evolution and ability to adapt to both local and international challenges.

History

The oldest evidence of winemaking reported by Pecci *et al*. (2013) comes from ceramic vessels with wine residues, dates to about 7,000 years ago and was found in the Mediterranean area. They presented the results obtained from analysing different vessels´ materials which allowed for the identification of tartaric acid and other markers of wine.

In the Middle Ages, as an example, wine production gained significance in the geographical context of Aragón, Spain, during the period vineyards became a key element in the economic and social colonization of the land, urban growth and the demand of wine as a staple food product provided a decisive boost to vine cultivation in peri-urban areas (Rodrigo, 2007). Then, European settlers brought the vines to the New World. Spanish missionaries introduced viticulture to South America in the 16th century which subsequently spread to North America.

Díaz (2020) traces the history of wine in the Americas, including Mexico. It confirms that Spanish missionaries and conquistadors brought vines to colonial Mexico in the early 16th. In 1595, King Philip II of Spain banned wine production in Mexico to protect Spanish wine exports, leading to the destruction of many vineyards, although some survive by producing wine for the church. Wine production in Mexico arose in the 18th century, particularly in Baja California, where missionaries planted new vineyards. This region is still an important wine producing area in Mexico today.

After Mexico´s independence in 1821, wine production began to flourish again. European

immigrants brought new grape varieties and winemaking techniques. Casa Madero, founded in 1597 in Parras, Coahuila is the oldest winery in Mexico and played an important role in the resurgence of Mexican winemaking. The Mexican Revolution and the phylloxera epidemic in the early 20th century severely affected the wine industry. The industry began to recover in the 1920s. Since the 1980s, mexican wine production has been in the rise, with regions such as Baja California, Coahuila, and Querétaro leading the way. Mexican wines have gained international recognition for their quality (Uvas de México, n.a.).

The history wine in Chihuahua reflects the cultural and agricultural heritage of the region. From colonial times, when Jesuits and Franciscan missionaries established the first vineyards to produce sacramental wine (Gourmet de México, 2019). In the 20th century, viticulture in Chihuahua blossomed with the production of brandy and cognac in the 1930s. Italian immigrants, such Gastone Guglielmina, played an important role in reintroducing winemaking traditions to the region.

Chihuahua is recognized as an emerging wine region with great potential. High altitude vineyards and favourable climate contribute to the production of high-quality wines. Chihuahua wineries have gained recognition for their innovative winemaking techniques and their diverse grape varieties. Chihuahua wine industry continues to grow, and its wines are gaining recognition both nationally and internationally. The region unique terroir and dedication to quality make it an interesting area for wine enthusiasts (del Castillo García, 2022).

Porras (2025) presented some data indicating that there are 51 vineyards and 24 wineries that produced 549,854 litres of wine with 3,389 hectares of production. According to the Ministry of Rural Development, the main varieties planted in the state are Cabernet Sauvignon, Merlot, Malbec and Shiraz (Gobierno del Estado de Chihuahua, 2022). The vineyards are registered in 21 municipalities spread over five zones. The state ranks eighth nationally in industrial grape production volume, with the state capital alone concentrating the largest number of hectares of production owned by 14 wine houses.

This concludes the historical journey of the wine industry, a journey that has made it possible to understand its evolution and transformation over the centuries. With this historical context as a basis, the next step is to analyze the industry production chain, supported by the theory of global value chains proposed by Gereffi. This approach will allow us to delve into the current state of the local wine industry, identifying its strengths and its position within the market.

Value chain

Michael Porter (1985) defined a value chain as a series of activities that a company performs to create a product or service, from its initial design to delivery to the customer. Gereffi and Fernandez Stark (2016) expanded on this concept by describing the value chain as a complete set of activities that companies and workers carry out to take a product from its conception to its final use and beyond. These activities include research and development, design, production, marketing, distribution and end user support. The activities that make up a value chain can be carried out within the same company or divided between different companies.

Global Value Chain

In the context of globalization, the activities that make up a global value chain are generally carried out in intercompany networks on a global scale. This approach, found in the sequences

of tangible and intangible activities that generate value, from conception and production to final consumption, allows a comprehensive analysis of the industrial activities worldwide. Gereffi and Fernandez Stark (2016) identified fundamental dimensions in the methodology explored by the global value chain, which are divided by industry dynamics at a global level, the local dimensions described how each country integrates into and participates in the global value chain.

As for the wine industry, the elements of the global value chain, from Gereffi perspective, are identified as follows; the input-output structure involves the main activities and segments such as vine cultivation, wine production, bottling, distribution and retail. In terms of geographical scope, it could include regions where vines are grown, wine production facilities, and global markets where wine is sold. Governance involves the relationship between grape producers, wine industrialists, distributors and retailers. In the institutional context, for the wine industry, this could include local and international regulations on wine production, quality standards and trade policies. Scaling up includes the adoption of new technology, improving wine quality, and expanding into new markets.

Hawkins-Mofokeng *et al.* (2017) and Wines Uncovered (2024) provide examples of the application of the global value chain in some wine regions.

Bordeaux, France, has a well-established value chain that includes grape cultivation, wine production, aging, bottling, and global distribution. The region´s strong governance and institutional support have helped maintain its reputation and position in the market.

Napa Valley, California, has adopted technological advances and sustainable practices to improve its value chain. Napa Valley wine producers have focused on improving their quality by expanding into international markets and improving the quality of products.

Tuscany, Italy, the region has a well-integrated value chain that includes grape cultivation, wine production, and global distribution. Tuscan wine producers have leveraged their strong brand identity and quality standards to compete in the global marketplace.

Baja California, Mexico. Baja California´s wine industry has developed an integrated value chain that includes grape cultivation, wine production, and marketing. The region has focused on improving infrastructure, tackling water scarcity, and investing in human capital to improve competitiveness.

The Chihuahua wine industry is an excellent example of how a region can leverage its natural resources, institutional support, and strategic investments to create a thriving and competitive wine sector. From González (2021) article, the elements of the global value chain for Chihuahua can be identified. Chihuahua is known for its climatic and geographical; the high altitude and semi-arid climate of the region provide favorable conditions for grape cultivation. Chihuahua vineyards benefit from significant temperature variations between day and night, which contribute to the development of high-quality grapes.

Chihuahua value chain

Chihuahua wineries range from small family-owned businesses to large commercial producers. The wine production process includes fermentation, aging, and bottling. Some wineries in the region also focus on the production of artisanal and organic wines.

In terms of distribution, Chihuahua wines are distributed both nationally and internationally. The region has developed efficient logistics and transportation networks to ensure timely delivery to markets around the world. On retail and marketing, Chihuahua wines are marketed through various channels, including wine stores, restaurants, and online platforms. The region has also invested in wine tourism, attracting visitors to its vineyards and wineries. For governance, the wine industry has the support of various organizations and institutions that help regulate and promote the sector. Local government initiatives and industry associations play a crucial role in maintaining quality standards and supporting the growth of the wine industry. In the institutional context, the Chihuahua wine industry operates within a framework of local and international regulations. The region adheres to strict quality standards and labeling requirements to ensure the authenticity and traceability of its wines. Chihuahua wine producers have focused on modern winemaking practices and technologies, investing in technology, and improving product quality. The region has also expanded its market reach by participating in international wine competitions and fairs.

The identification of the global value chain elements in the Chihuahua wine industry remains imprecise, in some cases, it is difficult to assert whether it truly constitutes a global chain. It is identified as a value chain, as can be seen in Table 1.

Table 1. *Comparison between the value chain and global value chain*

	Value chain	Global value chain
Scope	Local or national	Global expands to several countries
Governance	It can be internal to a company or industry	It involves governance by multinational corporations, leading companies, or global buyers
Geographical distribution	Production is within a region or a country	Different stages of production are carried out in different countries
Coordination mechanisms	Companies coordinate their own activities	Leading companies coordinate activities across multiple vendors and regions
Main actors	Local businesses, domestic industry	Multinational corporations, suppliers, global institutions

Based on Gereffi and Fernandez-Stark (2016)

Value chains focus on the sequence of production activities; global value chains emphasize the international fragmentation of production and the global governance of supply chains. Gereffi framework has been widely used to study globalization, industrial development, and economic policy strategies. Given the above, it can be concluded that the wine industry of Chihuahua occurs in a value chain. Since practically the activities are carried out in the region and what could be an exemption in terms of the international context are the sales of retailers and restaurants and hotels.

Once the value chain of the Chihuahua wine industry has been established, it has been possible to describe its actual situation and its dynamics within the market. However, for this industry, iconic and deeply rooted in the history of the region, to continue to thrive, it is

essential to incorporate two fundamental pillars: innovation and sustainability. These concepts, in addition to being key to ensuring the winemaking tradition of Chihuahua, which remains alive and relevant in a world in constant evolution. Concrete examples will then be presented to illustrate how the industry is already adopting practices that will take in from the present to a promising and sustainable future.

Sustainable wine innovation

Innovation

For economist Joseph A. Schumpeter (1934) innovation is the process of making new combinations, this includes introducing new products, new production methods, opening new markets, new suppliers, restructuring the company; he stressed that innovation is not only inventing, but also the commercial application of new ideas and technologies. The Oslo Manual, which is the guide for collecting and interpreting data on innovation, defines innovation as the introduction of a new, or significantly improved, product or service, new method of marketing, or method of organization, into the company internal practices, workplace organization, or external relations (OECD/Eurostat, 2007).

Sustainability

For the California Sustainable Winegrowing Alliance (n.a.), sustainable viticulture and winemaking is a holistic approach that preserves natural resources, protects the environment, improves wine quality, enriches the lives of employees and communities, and safeguards vineyards and family businesses, today and for generations to come.

In the early to mid-1960s, the wine industry began to see a significant growth in development of mechanical harvesting, since then, mechanization has evolved and resulted in better machines. Winegrowers and researchers began looking for ways to refine and improve machinery and modify vineyards to make them more compatible with mechanization (Streingler & Jomes, 2019).

Ojeda-Barrios *et. al*. (2012) reported that in the 1970s some winegrowers began experimenting with organic methods, avoiding synthetic chemicals. Drip irrigation in the vineyards of Chihuahua began to be implemented at the end of the 20th century. Vineyards follow the global trend of adopting more efficient technologies in the use of water, this technique became popular due to its many advantages, such as saving water and improving the quality of the grapes (Hernández, 2024). Chihuahua wineries adopted practices and techniques to minimize their impact on the environment and promote the conservation of natural resources; they incorporate sustainable principles from the cultivation of grapes to the distribution of the wine. This involves a comprehensive approach to the well-being of the ecosystem, the local community, and the health of consumers (Remodify, 2025).

Conclusion

The wine industry of Chihuahua represents an emblematic case of how a region can overcome geographical and climatic adversities to consolidate itself in the global market. Throughout its history, it has demonstrated resilience and adaptability, while its integration into global value chains has allowed it to compete in an increasingly demanding international scenario. In

addition, its commitment to innovation and sustainability has laid the foundation for responsible and lasting development. To maintain this momentum and ensure its future growth, it is critical that key players – local producers, vineyards and wineries – reinforce their commitment to investing in technology, training personnel and implementing sustainable practices. The future of Chihuahua winemaking will depend largely on its ability to balance the demands of the global market with the preservation of its cultural identity and the care of its natural resources. Thus, Chihuahua will continue to be a benchmark in wine production and model of integral and sustainable wine development.

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Sustainable software development: impact and best practices of the last decade

Sergio Arley Puerto Moreno
Corporación Universitaria Minuto de Dios (Colombia),
sergio.puerto.m@uniminuto.edu, https://orcid.org/0000-0003-3119-0401

This paper arises from a bibliometric analysis based on the comparison of best practices applied to software development projects with a sustainable focus, conducted within the framework of the graduate program in Software Development at UNIMINUTO.

Introduction

In the past decade, software development has expanded beyond functionality to integrate environmental, social, economic, and technical sustainability. This shift prompts a central question: how can sustainable practices be embedded in the software life cycle without compromising quality? Scholars warn of risks tied to unregulated technological growth and advocate for sustainability from early design stages (Venters *et al.*, 2023). This study identifies approaches, frameworks, and best practices through a bibliometric review (2020–2025) and a graduate-level case study at UNIMINUTO. The analysis focuses on impact and implementation, addressing energy efficiency, accessibility, algorithmic ethics, and sustainable maintenance (Schneider & Betz, 2022; Guandalini, 2022; Bolón-Canedo *et al.*, 2024). It consolidates a technical-ethical catalog aligned with the Sustainable Development Goals (SDGs) and the United Nations Global Compact, promoting a fair, inclusive, and responsible digital transformation (Verdecchia *et al.*, 2022; Hariyani *et al.*, 2025).

The Context of Sustainable Software

Sustainable software has emerged as a strategic response to the negative impacts of technological development lacking ethical, social, and environmental considerations. Initially centered on energy efficiency, it has evolved into a holistic approach spanning all software life cycle phases (Venters *et al.*, 2023; Verdecchia *et al.*, 2022). Digital sustainability now implies not just efficient systems, but also ethical, inclusive, and responsible ones. As Schneider & Betz (2022) note, "sustainability in software engineering requires a dual transformation: of the technological system and of the cultural system that sustains it" (p. 4). This involves principles like accessibility, inclusion, and transparency (Moises de Souza *et al.*, 2025). Recent research links Artificial Intelligence (AI), big data, and green innovation to sustainable performance (Al Halbusi *et al.*, 2025; Zu *et al.*, 2025). Institutional frameworks also encourage digitalization aligned with green goals (China Council for International Cooperation on Environment and Development, 2025).

Standards like ISO/IEC 25010, the SDGs, and the Green Software Foundation (GSF) define software as a key enabler of sustainable transformation. Verdecchia *et al.* (2022) state that "software-based solutions represent a bridge between economic efficiency and environmental commitment" (p. 3). Sustainability is now a core principle of quality and ethics in both academia and industry. As Guandalini (2022) notes, "digitalization can be strategically designed to support the SDGs" (p. 11), while AI fosters green innovation (Bolón-Canedo *et al.*, 2024).

Sustainable Practices and the Software Life Cycle

Sustainable software development is now a cross-cutting principle that integrates ethical, social, environmental, and technical values across the entire lifecycle. From planning to maintenance, it enables resource optimization, anticipates impacts, and supports responsible digital transformation. The practices identified align with ISO/IEC 25010, the SDGs, and the United Nations Global Compact, reinforcing sustainability as a core element of software quality and innovation. These goals are embedded from the planning phase to foster inclusion and prevent design flaws (Guandalini, 2022). Design promotes efficiency via reusable patterns and decoupled structures (Venters *et al.*, 2023). Development emphasizes eco-coding, modularity, and version control (Bolón-Canedo *et al.*, 2024). Testing adopts automation and low-resource environments, since "tests should also be evaluated by their energy footprint" (Schneider & Betz, 2022, pp. 3–7). Deployment relies on lightweight containers and green cloud services aligned with SDGs (Hariyani *et al.*, 2025), while maintenance ensures sustainability through refactoring, energy tracking, and component cleanup (Heldal *et al.*, 2024).

Table 1. *Key Dimensions of Sustainable Software Practices (2020–2025)*

Dimension	% of Studies	Focus Areas
Environmental & Technical	90%–100%	Energy efficiency, eco-coding, automation, green infrastructure
Social & Ethical	70%–45%	Inclusion, accessibility, algorithmic transparency
Economic & Resource Use	55%	Cost reduction, optimization of infrastructure
SDG & Global Alignment	60%	SDGs 9, 11, 12, 13; ISO/IEC; Green Software Foundation
Lifecycle Integration	65%–85%	Sustainable design, clean code, testing, refactoring

Based on 20 peer-reviewed articles indexed in ScienceDirect, IEEE, Scopus, and Springer (2020–2025).

The data shows steady progress in sustainable software maturity. Table 1 highlights five key dimensions that reflect the integration of energy efficiency, inclusion, and ethics throughout the software life cycle. These practices, aligned with ISO/IEC and the GSF, outline a clear path toward globally responsible software development.

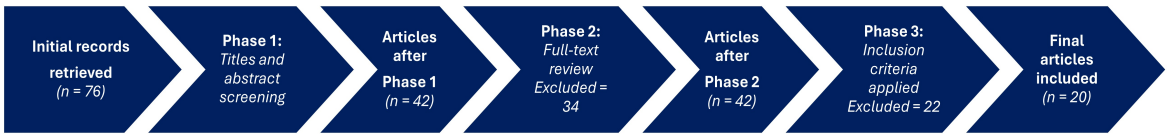
This study was based on a systematic review of scientific and technical literature, complemented by a bibliometric and thematic analysis that enabled the identification of key trends, approaches, and best practices associated with sustainable software development over the past decade. The specific objectives were: (1) To analyze the most relevant thematic lines published between 2020 and 2025 on sustainability applied to software; (2) To identify practices, approaches, and impacts associated with the software life cycle; and (3) To construct a structured classification of best practices supported by internationally recognized technical and ethical frameworks.

The analysis was based on 20 scientific articles published between 2020 and 2025 in ScienceDirect, IEEE, Springer, and Scopus, complemented by reports from the United Nations, the GSF, and ISO/IEC standards on technological sustainability.

Search and Validation Procedures of the Document Corpus

A systematic search was conducted from October 2024 to March 2025 using Boolean operators (AND, OR, NOT) and key terms such as "sustainable software development" and "eco-coding" across four databases: ScienceDirect, IEEE Xplore, Scopus, and SpringerLink. The initial retrieval yielded 76 articles. In Phase 1, titles and abstracts were screened. In Phase 2, full-text reviews excluded 34 articles, leaving 42. In Phase 3, strict inclusion criteria (peer-reviewed, focus on the software life cycle, mention of the SDGs, ISO, or GSF) led to 22 further exclusions, resulting in a final corpus of 20 articles. Each was classified by publication year, software life cycle phase, sustainability approach, and use of standards. A flow diagram (Figure 1) illustrates the selection process for greater clarity.

Figure 1. Selection Process of Scientific Articles for the Study



The systematic search retrieved 76 initial records. After title and abstract screening (Phase 1), 42 articles were retained. In Phase 2, 34 were excluded following full-text review. In Phase 3, 22 more were excluded based on inclusion criteria, resulting in a final corpus of 20 articles for analysis.

Methods of Analysis

This study used a mixed-methods approach combining bibliometric, thematic, and best-practice analyses. The bibliometric analysis identified trends, key terms, authors, and annual topic evolution. Thematic analysis classified articles by environmental, social, economic, and technical perspectives to map sustainability comprehensively. Best practices were manually extracted and organized across six software life cycle phases: Planning (accessibility, SDGs), Design (efficient architectures, reusable patterns), Coding (eco-coding, modularity), Testing (low-resource automation), Deployment (green cloud), and Maintenance (refactoring, energy tracking). This led to a structured reference framework that offers a critical and up-to-date synthesis of sustainable software development, integrating technical rigor with ethical and global standards.

The bibliometric analysis reveals sustained growth in scientific production on sustainable software development between 2020 and 2025. A conceptual evolution is observed, moving beyond energy efficiency toward a comprehensive vision that encompasses ethical, social, economic, and technical dimensions. In this way, sustainability is consolidated as a cross-cutting principle throughout the software life cycle.

Emerging Trends

Three macro-trends emerged from the analyzed corpus: (1) Integration of the SDGs: An increasing number of studies link software development with goals such as SDG 9 (industry and innovation), SDG 11 (sustainable cities), and SDG 13 (climate action). (2) Measurement of Environmental Impact: Indicators such as digital carbon footprint and software energy consumption are adopted as key metrics. (3) Sustainability as a Professional Competency: There is a growing emphasis on training developers with ethical awareness and mastery of

sustainable practices (Hossain *et al.*, 2024; Raihan, 2024). These trends are also aligned with emerging paradigms such as Industry 5.0, which emphasize human-centric and environmentally sustainable innovation (Rame *et al.*, 2024; Shao & Min, 2025).

Best Practices Applied to the Software Life Cycle

Thematic mapping enabled the consolidation of a best-practices catalog: Planning and Requirements: Early sustainability integration and SDG alignment (Guandalini, 2022); Design: Decoupled and efficient architectures (Venters *et al.*, 2023); Coding: Emphasis on eco-coding and modularity (Bolón-Canedo *et al.*, 2024); Testing: Resource-optimized automation (Schneider & Betz, 2022); Deployment and Maintenance: Green infrastructure and sustainable updates (Heldal *et al.*, 2024). This catalog functions as both a technical and ethical reference for sustainable digital development. Methods like eco-design and energy-aware testing gain ground in reviews (Atadoga *et al.*, 2024). Frameworks for measuring software sustainability (Noman *et al.*, 2024) and case studies in agile environments (Regona *et al.*, 2024) confirm the feasibility of these practices in real-world contexts.

Impact Indicators

The following key indicators were identified in relation to the implementation of these practices: *Carbon footprint:* Energy consumption reductions between 20% and 40% through eco-coding and green cloud adoption. *Operational efficiency:* Improvements of 15% to 30% in response times and scalability; 25% reduction in technical debt. *Technology adoption:* Increasing use of renewable-energy-powered cloud computing and edge computing (Valsan *et al.*, 2025).

Integration of Sustainability into Software Development

Recent studies propose expanding software quality models to include ethical and ecological dimensions. Atadoga *et al.* (2024) highlight trends like eco-design and energy-aware testing, while Bolón-Canedo *et al.* (2024) emphasize green AI for reducing environmental impact. Al Halbusi *et al.* (2025) show that AI and green innovation—mediated by big data—enhance sustainable performance. Additionally, Zahir Khan *et al.* (2025) identifies theoretical and practical pathways for integrating green growth into digital development, reinforcing sustainability as a strategic axis in software engineering.

Case Study: Sustainable Project in the UNIMINUTO Graduate Program: In the "Standards and Quality Metrics in Software Development" module, students at UNIMINUTO redesigned an academic system focused on digital sustainability. They incorporated energy efficiency, accessibility, modularity, and ethical traceability. Tools like Green Software Analyzer were used to estimate CO_2 emissions, optimize cyclomatic complexity, and apply GSF guidelines. The project achieved a 30% reduction in resource consumption, 18% improvement in performance, and full compliance with Web Content Accessibility Guidelines (WCAG). Evaluated through technical and ethical lenses, the project enhanced students' skills in sustainable development and demonstrated the feasibility of training professionals aligned with the SDGs, ISO/IEC 25010, and the United Nations Global Compact.

Overview of the Final Corpus

The final corpus analyzed in this study consists of 20 peer-reviewed scientific articles published between 2020 and 2025 across four academic databases (ScienceDirect, IEEE Xplore, Scopus, and SpringerLink). These works address various thematic axes related to sustainable software development, including energy efficiency, green cloud computing, algorithmic ethics, digital equity, and sustainable design. The objectives of the selected studies range from proposing conceptual frameworks to evaluating the impact of sustainable practices in real-world scenarios. The methodologies employed include systematic reviews, case studies, bibliometric analyses, empirical evaluations, and framework design. The main findings highlight the growing consensus on the need to integrate sustainability throughout the software life cycle, the positive correlation between green practices and technical performance, and the key role of developer competencies in driving ethical digital transformation.

Conclusions

Sustainable software development has become a strategic response to the ethical, social, and environmental challenges of the digital era. Through bibliometric and thematic analyses, this study demonstrated that sustainability has evolved from a complementary concept into a guiding principle throughout the entire software life cycle. As Heldal *et al.* (2024) state, "embedding sustainability requires a systemic shift that redefines not only how software is built, but also why and for whom" (p. 2). This led to the creation of a catalogue of best practices that integrate energy efficiency, inclusion, algorithmic ethics, and technical quality, in alignment with the SDGs, ISO standards, and the GSF. The study also demonstrated, through a case at UNIMINUTO, that sustainability can be successfully integrated into academic training. This supports Hossain *et al.* (2024), who affirm that "developing sustainability competencies among software engineers is no longer optional" (pp. 5–6). The study proposes a roadmap for ethical and sustainable software development.

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Analysis of the Behavior of New Housing Buyers in Bucaramanga (Colombia) in Response to Current Real Estate Offerings

Nelson Hernández-Bueno
Corporación Universitaria Minuto de Dios UNIMINUTO de Bucaramanga (Colombia),nelson.hernandez.bu@uniminuto.edu.co, https://orcid.org/0000-0003-3170-2497
Alexander Reyes-Jaimes
Universidad Autónoma de Bucaramanga (Colombia), areyes538@unab.edu.co, https://orcid.org/ 0009-0005-58371650

This text originates from a mirror class conducted between the Business Administration program at UNIMINUTO Bucaramanga University Center and the Marketing program at UNAB, within a research line focused on emerging markets and consumer behavior.

Introduction

In recent years, the real estate sector in Bucaramanga, Colombia, has undergone substantial changes in terms of design, pricing, and housing features. These shifts have affected consumer preferences, particularly regarding the trade-off between private space and social areas, and have raised questions about whether current housing projects align with actual buyer expectations (Bueno, 2016). Urban housing trends now emphasize functional design, strategic location, and affordability as critical decision-making factors (Ziemann *et al.*, 2023).

Studies show that in emerging economies, housing choice is increasingly influenced not only by income but also by perceived social mobility and lifestyle aspirations (Salinas, Smolka, & Veneri, 2021; Monkkonen, 2013). Additionally, buyer behavior reflects concerns about proximity to public services, access to credit, and long-term investment security. This context makes it essential to investigate how these factors play out in Bucaramanga, a city experiencing notable urban transformation.

This text originates from a mirror class conducted between the Business Administration program at UNIMINUTO Bucaramanga University Center and the Marketing program at UNAB, within a research line focused on emerging markets and consumer behavior. Understanding consumer behavior in this context is crucial for designing more effective and socially responsive marketing strategies.

Bucaramanga Housing Market Context

The housing market in Bucaramanga reflects broader urban and socioeconomic transformations typical of intermediate cities in Latin America. In recent years, developers have increasingly favored vertical housing projects with compact living spaces and shared amenities to reduce construction costs and maximize profitability (Rodríguez & Yepes, 2021). While this model is intended to appeal to middle-income buyers, particularly young professionals and small families, it often clashes with the expectations of consumers who value larger private spaces and neighborhood-based services (Flórez, 2025).

Moreover, public perception studies indicate a growing dissatisfaction with high-density residential projects that overlook functionality and family dynamics (Ruiz Perea, 2025).

Bucaramanga's urban expansion has intensified the need for integrated infrastructure planning that balances accessibility, green areas, and essential services (Alcaldía de Bucaramanga, 2025). Consequently, the city represents a compelling case study for understanding the evolving priorities of housing consumers in a regional Colombian context.

Context description

The housing sector in Bucaramanga operates within a landscape marked by urban densification, regional migration, and socioeconomic fragmentation. The concentration of construction activity in mid-rise apartment complexes and gated communities responds to profit-driven models rather than community-centered planning (Finca Raíz, 2025). This shift has prompted real estate firms to prioritize return on investment through uniformity and verticalization, often overlooking localized cultural and family dynamics (BluRadio, 2024).

Urban policies have not always kept pace with the accelerated growth, leading to challenges in mobility, public service coverage, and environmental management. Scholars note that such imbalances weaken the urban fabric and increase social segregation (Rodríguez, Delgado, & Botello, 2018). Additionally, the spatial mismatch between employment hubs and residential zones disproportionately affects low-income populations, reinforcing inequality in housing access (Cáceres-Manrique et al., 2018).

Innovation in housing is beginning to emerge through digital platforms, modular construction, and energy efficiency standards, but adoption remains limited. Strategic planning that integrates sustainability, inclusivity, and real-time data is critical for meeting the evolving needs of Bucaramanga's residents (Redacción Economía, 2022).

To support the contextual understanding of the population surveyed in this study, Table 1 presents a descriptive statistical summary based on variables such as age, income, housing preference, and market perception.

Table 1. *Summary of Descriptive Statistics of Survey Participants*

Variable	Most Frequent Category	Percentage
Age	18-25 years	43,2%
Marital Status	Single	70,6%
Housing Situation	Tenant	45,6%
Socioeconomic Stratum	3	37,5%
Preferred Housing Type	House	59,6%
Income Level	$1,000,000 - $3,000,000 COP	50,8%
Budget	Less than $100 million	54,9%
Preferred Size	50 - 100 m²	42,4%
Intention to Buy	Yes	58,5%
Market Perception	Not sure	39.9%
Metraje vs. Amenities	Larger area	65,3%

These characteristics provide a robust base for the analytical segments of this research and guide interpretation in light of Bucaramanga's current housing dynamics.

Theoretical Framework

The objectives of this research are as follows: (1) Analyze whether the current real estate offerings in Bucaramanga meet the expectations of new housing buyers. (2) Identify purchase habits and motivational factors among consumers. (3) Determine differences in preferences based on socioeconomic status and age. (4) Provide strategic marketing recommendations for real estate developers

The theoretical framework of this research draws from four key strands: classical housing choice theory, behavioral economics, real estate marketing, and digital innovation in housing.

Classical housing theories posit that location, income, household size, and proximity to services are the main determinants of residential choices (Clavijo, Janna, & Muñoz, 2005). In the Colombian context, these variables are compounded by informality, social stratification, and urban sprawl, which shape both access and desirability (Fique Pinto, 2008).

Behavioral economics offers tools to understand the deviations from rational models of decision-making. According to the theory of planned behavior (Ajzen, 1991), attitudes, subjective norms, and perceived behavioral control influence intention, a critical factor in home buying. In Latin America, young consumers display aspirational behavior linked to social mobility and long-term stability, sometimes purchasing beyond their immediate means (Monkkonen, 2011).

Marketing theory contributes by identifying value perception, brand positioning, segmentation, and buyer journey as central constructs in understanding the residential market (Kotler & Keller, 2016). Developers increasingly use psychographic segmentation to cater to lifestyle preferences rather than demographic variables alone (Rogal, 2018). Value proposition design in housing integrates functional benefits (space, location), emotional elements (sense of belonging), and social cues (prestige or status).

From a technological and innovation perspective, recent studies emphasize the impact of smart housing technologies, energy-efficient design, and platform-based real estate ecosystems in influencing buyer preferences (Qi *et al.*, 2023; Ratiu, 2020). Moreover, sustainability is emerging as a differentiator, particularly for projects targeting younger demographics aware of environmental concerns (Kuhlman & Farrington, 2010).

Urban planning frameworks such as Total Innovation Management (TIM) suggest that innovation is not only technological but also organizational and cultural (Xu *et al.,* 2007). Applying these frameworks helps explain the adoption lag in green or digital housing models in intermediate cities like Bucaramanga.

These overlapping theoretical domains enrich the analysis by linking micro-level consumer motivations with macro-level urban and market structures.

This research follows a quantitative approach using a field study based on survey methods. A structured questionnaire was administered to a probabilistic simple random sample of 384 individuals residing in Bucaramanga, with a confidence level of 95% and a margin of error of 5%, considering an estimated population of 625,000 (DANE, 2023).

The instrument included closed-ended questions with multiple-choice and Likert-scale items addressing housing preferences, decision-making criteria, information channels, and perceived adequacy of current offerings. The design and validation of the questionnaire followed the

principles outlined by Creswell (2014) and incorporated reliability indicators using Cronbach's Alpha where appropriate (Creswell, 2014).

Secondary data on housing sales and project characteristics were also reviewed using sources from local government statistics and real estate agencies. The analytical process included descriptive statistics and cross-tabulations to explore relationships among variables (Cohen & Manion, 2000). This triangulation between primary and secondary data strengthened the validity of the findings.

The analysis reveals that 65.3% of respondents preferred homes with greater square footage, even if it meant having fewer shared amenities. This finding underscores a strong preference for private, functional spaces over communal features. Interestingly, when asked about their willingness to purchase housing in the short term, 58.5% indicated they were open to the idea. However, only 23.5% believed that the current housing supply meets their expectations, suggesting a clear disconnect between supply and demand.

Further analysis by age and socioeconomic strata indicated that respondents between 18 and 25 years old, primarily from strata 2 and 3, emphasized location and price as the two most influential purchase drivers. When disaggregating the data, it becomes evident that younger respondents (ages 18–25) with lower incomes are more flexible about shared spaces but less tolerant of poor access to transportation and essential services.

Regarding the location, the most valued surrounding services were supermarkets (72%), public transport (64%), and health centers (59%), showing a distinct pattern of functional urban preferences. These findings reveal that consumers are less interested in luxury or aesthetic features and more concerned with practical advantages that align with their day-to-day lives.

Additionally, buyers with purchasing intentions but who were dissatisfied with the market tended to express openness to alternative ownership models such as cooperatives or leasing with purchase options. This suggests a need for financial and structural innovation in how housing projects are marketed and financed.

Overall, the results indicate that the housing market in Bucaramanga may be overly standardized, offering limited diversity in size and pricing schemes. A broader spectrum of housing options and greater transparency in the offerings could better match the segmented needs of various consumer profiles.

Conclusions

The housing market in Bucaramanga is facing a structural gap between consumer expectations and current offerings. The study finds that most buyers seek affordability, location benefits, and functionality rather than extensive social amenities. Developers and policymakers must integrate these insights to realign future housing projects with the socioeconomic realities and aspirations of target consumers.

To bridge the existing gap, strategic decisions should include: the redesign of apartment layouts with flexible spaces; diversified pricing options for different income levels; and enhanced transparency in advertising campaigns regarding size, services, and accessibility. The integration of data-driven decision-making tools and participatory planning processes can also strengthen trust and relevance in the market.

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Systemic analysis of the beef cattle production chain in Colombia: An innovative approach for strategic and sustainable decision-making

Marcela Guzmán Rincón
Corporación Universitaria de Asturias, marcela.guzman@asturias.edu.co
Germán Cordón Guayambuco
Corporación Universitaria de Asturias, german.cordon@asturias.edu.co

Introduction

Global livestock production plays a key role in food security, employment generation, and national development (Alzubi *et al.,* 2023; Houshyar et al., 2024); however, it faces significant sustainability challenges due to its environmental, social, and economic impacts (Houshyar *et al.,* 2024). Worldwide, the livestock sector contributes approximately 9.2% of greenhouse gas emissions (Nugrahaeningtyas *et al.,* 2024), occupies 70% of agricultural land, and uses 58% of harvested biomass, which puts pressure on ecosystems and natural resources (Van Zanten *et al.,* 2018; Krausmann *et al.,* 2008). In this context, the adoption of sustainable intensification practices and the multidimensional evaluation of supply chains have become priorities to ensure a balance between productivity, social equity, and environmental conservation (Godfray & Garnett, 2014).

That said, sustainability in livestock supply chains requires a systemic approach (Guzmán & Guzmán, 2024) that integrates economic, social, and environmental criteria, as proposed by Houshyar *et al.* (2024). Systems thinking, in this sense, allows livestock farming to be understood not as an isolated activity but as part of a complex and dynamic system in which multiple actors, information flows, resources, and interdependent decisions interact (Guzmán & Guzmán, 2024). This perspective supports the identification of circular causal relationships, feedback loops, and time delays, which are essential for anticipating unintended effects of policies or interventions, as well as for identifying leverage points that can transform the system sustainably.

Given the above, systems thinking is essential for understanding interactions within the production chain in complex contexts like Latin America, particularly Colombia, where economic growth, natural resource use, and social well-being intersect (Rodríguez *et al.,* 2016; Sluyter, 2023). In Colombia, structural issues—such as low productivity, informality, agricultural expansion, and deforestation—undermine the sustainability and resilience of the beef supply chain, while also constraining progress toward environmental goals and inclusive rural development (Fedegán, 2024; Sandoval *et al.,* 2022).

Within this framework, the use of system thinking-based models to analyze the livestock chain is still limited in national and international literature, especially in Latin American contexts. Although some studies have begun to integrate simulation and dynamic modeling tools in other agricultural sectors (Esteso *et al.*, 2023; Benavides *et al.,* 2024; Guzmán & Guzmán, 2024), there remains a significant gap in their application to the beef cattle production chain.

This gap prevents the development of comprehensive diagnoses to guide strategic decision-making regarding the system's sustainability.

Therefore, this study aimed to apply a systems thinking approach to analyze the beef cattle production chain in Colombia, by identifying its key components, interdependent relationships, and critical factors that affect its performance. By achieving this objective, from an academic perspective, this work helps close an existing gap in the literature on agri-food chains by applying systems modeling tools—traditionally used in industrial or energy sectors—to the analysis of complex agricultural systems. It also offers a novel theoretical and methodological approach that integrates multiple dimensions of analysis (economic, social, environmental, institutional), which can serve as a foundation for future research focused on sustainability assessment in other production systems in Latin America.

From a practical standpoint, the study's findings can support decision-makers, producers, trade associations, and public policy makers in identifying bottlenecks and leverage points within the livestock chain. The proposed systemic characterization allows for the visualization of interrelationships that would otherwise be invisible under conventional approaches, which is key to designing more effective, sustainable, and inclusive intervention strategies.

Current State of the Beef Cattle Supply Chain in Colombia

The beef cattle supply chain in Colombia encompasses activities from breeding and fattening to the processing, distribution, and marketing of meat and by-products. According to the Colombian Cattle Federation (FEDEGAN, 2023), the national cattle inventory amounts to approximately 29.5 million head, positioning Colombia as the fourth country with the largest cattle herd in Latin America (FEDEGAN, 2025). Production is concentrated in regions such as the Eastern Plains (35%), the Caribbean (25%), and Antioquia (15%) (DANE, 2023). In 2024, Colombia exported a total of 29,448 tons of beef and offal, registering a slight increase compared to the 29,273 tons exported the previous year, and generating revenues of USD 301 million. However, live animal exports showed a significant decline, dropping from 300,266 head in 2023 to 238,600 in 2024 (FEDEGAN, 2025). Nevertheless, the domestic market absorbs 95% of production, with a per capita consumption of 18.5 kg of beef per year (DANE, 2023). The supply chain is characterized by a predominantly extensive model, with an average of 0.6 head per hectare and limited adoption of advanced technologies (FEDEGAN, 2023).

The Colombian beef cattle production chain holds important competitive advantages due to its geography and tropical climate, which support year-round production on over 35 million hectares of pasture (IGAC, 2022). The sector also benefits from strong genetic diversity, with resilient crossbreeds such as Brahman, Angus, and Holstein (FEDEGAN, 2023). These factors, along with sanitary certifications that facilitate exports to over 20 countries (MinAgricultura, 2023), strengthen Colombia's position in global markets. Moreover, steady domestic demand—projected to grow 2% annually until 2030—continues to support sector growth (DANE, 2023).

Despite these strengths, the Colombian livestock sector faces serious environmental challenges, with deforestation being one of the most significant. Extensive cattle ranching, which expands over fragile ecosystems such as the Amazon, has been identified as the main cause of forest cover loss in the country. According to IDEAM (2020), between 2016 and 2020, this activity was responsible for 70% of deforestation, with an annual average of 171,685

hectares cleared. This process not only implies biodiversity loss but also a substantial increase in greenhouse gas (GHG) emissions, which account for 26% of emissions from the agricultural sector (Ministry of Environment and Sustainable Development, 2022). The growing international pressure for deforestation-free products poses a threat to the competitiveness of Colombian beef in markets with high environmental standards.

Another structural obstacle is the low productivity associated with extensive livestock practices. Compared to intensive models in other Latin American countries such as Brazil, Colombian livestock farming shows an average yield of only 180 kg/carcass per animal, while intensive systems reach 250 kg/carcass (FEDEGAN, 2023). Likewise, the Colombian production cycle is longer, with an estimated 36 months to slaughter, compared to 18–24 months in more efficient models. The low stocking density (0.6 heads/ha) not only reduces the profitability of the business but also increases pressure on natural resources, deepening ecological and economic impacts.

On the other hand, limited traceability and scarce adoption of international certifications also hinder access to premium markets. According to FEDEGAN (2023), only 30% of formal cattle ranchers implement individual animal identification systems, a requirement to meet the traceability standards demanded by trading partners such as the European Union. In 2022, only 10% of Colombian beef exports complied with sustainability certifications (MinAgricultura, 2023), which restricts the product's positioning in high-value segments and weakens the country's image as a reliable supplier of agri-food products. Logistics infrastructure represents another bottleneck for the sector's competitiveness. Poor rural road conditions increase transport costs, which in Colombia amount to 13.5% of GDP, compared to an average of 8% in OECD countries (DNP, 2022). Transporting cattle from production regions such as the Eastern Plains to slaughter or industrial processing centers can raise logistics costs by up to 20% (Bogotá Chamber of Commerce, 2022). This situation limits economies of scale, reduces producers' profit margins, and raises the final product price for consumers.

Finally, informality and climate change represent long-term structural risks. The persistence of illegal trade, including cattle smuggling from Venezuela, seriously affects sanitary traceability and the stability of the domestic market. It is estimated that 20% of the cattle slaughtered in Colombia comes from informal channels (FEDEGAN, 2023), generating annual losses of around 48 billion pesos (National Police, 2022). In turn, phenomena such as *El Niño,* a climatic pattern that develops in the tropical Pacific Ocean and influences the country's weather, typically associated with decreased rainfall relative to the historical monthly average and increased air temperatures, together with recurrent droughts, have reduced productivity by 15% in regions such as the Caribbean and the Eastern Plains over the past five years (IDEAM, 2023), causing losses of 1.2 trillion pesos in 2023 (MinAgricultura, 2023). These factors demand a structural transformation of the Colombian livestock model toward more sustainable, efficient, and climate-resilient practices.

This research adopts a qualitative, interpretive approach, grounded in systems thinking as a tool for understanding the structural and dynamic complexity of the beef cattle production chain in Colombia. Systems thinking enables the analysis of systems from a holistic perspective, identifying behavioral patterns, non-linear causal relationships, and feedback structures that shape their evolution (Sterman, 2000). A conceptual model of the bovine supply chain was developed based on a content analysis process applied to technical and economic reports issued by FEDEGAN between 2018 and 2024. These documents contain key information on

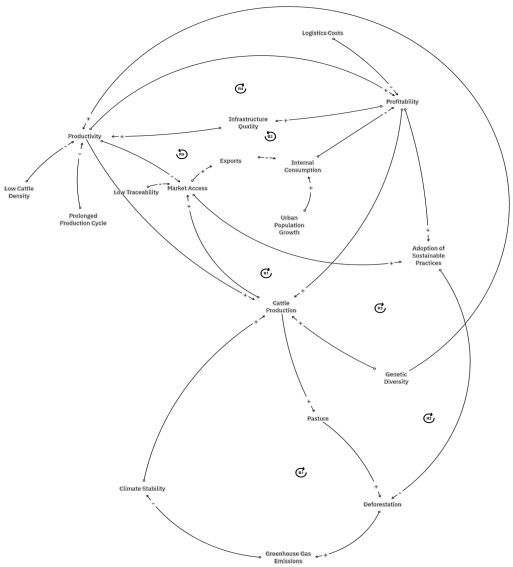
the productive structure, market dynamics, institutional factors, and environmental challenges faced by the sector. Through open coding, relevant categories were extracted related to system actors, material and financial flows, interactions among links, recurring bottlenecks, and structural tensions between productivity, sustainability, and regulation.

Based on this information, a causal loop diagram was constructed to represent the feedback cycles—both reinforcing and balancing—that shape the systemic behavior of the chain. This type of graphical representation is useful for mapping cause-effect relationships among variables, identifying critical dynamics, and strategically intervening at leverage points within the system (Bala *et al.*, 2017). For this purpose, the comodel.io software was used. The methodology employed aims not only to describe the current structure of the chain, but also to interpret the systemic reproduction logics that perpetuate inefficiencies, inequalities, and negative environmental impacts.

Regarding the current state of the supply chain, four reinforcing loops (R) and two balancing loops (B) were identified, as shown in Figure 1.

The first reinforcing loop (R1) identified in the causal model represents a growth dynamic based on the productive profitability of the cattle chain. In this cycle, an increase in cattle production enhances market access, which favors both exports and domestic consumption. These two factors, by increasing the system's profitability, incentivize further investment and a higher production volume, reinforcing the sector's growth. This structure follows a logic of self-sustained expansion. Reinforcing loop R2 describes an ecological-productive dynamic in which climate stability favors cattle production, which in turn improves market access and creates conditions to promote the adoption of sustainable practices in production systems. These practices, mainly aimed at mitigating deforestation, contribute to the reduction of greenhouse gas emissions, positively affecting climate stability. Thus, the system enters a positive feedback cycle where environmental and productive improvements mutually reinforce each other.

Figure 1. Causal loop diagram of the beef cattle supply chain in Colombia.



Reinforcing loop R3 represents an integrated dynamic linking cattle production with economic performance and environmental impacts, forming a complex but virtuous cycle. Climate

stability creates optimal conditions for livestock production, which enhances market access and encourages both exports and domestic consumption. This demand growth leads to higher profitability levels, which can be channeled into the adoption of sustainable practices in the production system. These practices, by reducing deforestation, contribute to a decrease in greenhouse gas emissions, once again reinforcing climate stability. The cycle reinforces the notion that profitability should not be understood as an isolated goal, but as a means that, if properly managed, can drive the transition toward sustainable agricultural models.

Reinforcing loop R4 illustrates an internal dynamic focused on productivity and its relationship with the quality of livestock infrastructure. Increased productivity generates higher profitability levels, which facilitates investment in quality infrastructure such as irrigation systems, rural roads, cold storage facilities, and traceability technology. This infrastructure improvement, in turn, helps optimize processes and reduce production inefficiencies, which again boosts productivity. Meanwhile, reinforcing loop R5 expands the logic of the previous loop by integrating the commercial dimension of the chain. An increase in productivity boosts livestock production, strengthening market access—both national and international—through higher levels of exports and domestic consumption. This demand, by generating higher income, increases profitability, which can be allocated to improve productive infrastructure, positively impacting initial productivity.

In the case of the two balancing loops, B1 and B2 represent self-regulation mechanisms that limit uncontrolled growth in the cattle production chain, acting as systemic brakes against reinforcing dynamics. Balancing loop B1 describes how the intensification of cattle production and the expansion of pastureland can lead to increased deforestation, which raises greenhouse gas emissions and undermines climate stability. As the climate becomes more unstable, the system's productive capacity is negatively affected. Meanwhile, balancing loop B2 describes an economic self-regulation dynamic within the cattle chain, in which productivity drives market access, thereby encouraging both exports and domestic consumption. However, as exports increase, availability for the domestic market decreases, creating tensions in meeting national demand. This redistribution contributes to increased profitability, as international markets typically offer higher prices. The profitability obtained is reinvested in improving productive infrastructure, which again reinforces productivity. Nevertheless, this dynamic is constrained by the system’s capacity to meet both domestic and external demand simultaneously, as well as by infrastructure availability, creating a negative feedback loop that prevents unlimited growth.

Within the cattle production system, certain structural variables act as key constraints that directly affect the sector’s efficiency, competitiveness, and sustainability. First, low stocking density is negatively correlated with productivity, as it implies extensive land use with low utilization levels. This factor also contributes to a prolonged production cycle, meaning more time is needed for an animal to reach slaughter weight, thereby reducing the system's overall efficiency. Second, low traceability constitutes a critical barrier to accessing international markets, as it hinders compliance with sanitary and regulatory requirements demanded by importing countries. This deficiency negatively impacts exports and, consequently, reduces the livestock sector’s global insertion opportunities. Finally, genetic diversity emerges as a positive structural variable: a higher level of genetic diversity in the herd enhances the system’s adaptive capacity to diseases, adverse climatic conditions, and environmental variability. Moreover, genetic diversity is positively related to cattle production, as it allows for better feed

conversion rates, hardiness, and resilience, thereby reinforcing the system's long-term sustainability.

Conclusions

The sustainability of Colombia's cattle production chain requires a comprehensive transformation that integrates economic, ecological, social, and institutional factors. This involves shifting from traditional models to more efficient and environmentally responsible systems through sustainable intensification practices. Implementing such changes, like silvopastoral systems, pasture rotation, and soil restoration, not only boosts productivity but also reduces deforestation and greenhouse gas emissions. Achieving this transition demands investment, technical support, and robust public policies, especially to support small and medium producers facing structural barriers.

Another fundamental strategy is related to strengthening the physical and technological infrastructure of the supply chain. The analysis showed that poor rural road quality, a deficit in cold chain infrastructure, and limited implementation of traceability technologies reduce the sector's competitiveness and constrain its ability to access demanding international markets. Bridging these gaps requires effective coordination between the state, the private sector, and territorial organizations.

In line with the above, traceability must occupy a central place in sustainability strategies. The ability to identify, record, and monitor each productive unit enables improved sanitary control, guarantees product quality, and opens access to more profitable marketing channels. Currently, low levels of traceability prevent most Colombian producers from meeting the requirements of high-value markets such as the European Union or East Asia. Therefore, it is necessary to strengthen individual livestock identification systems, promote the adoption of digital tools throughout the supply chain, and design differentiated incentives for those who meet higher standards of traceability and sustainability.

From an institutional perspective, sustainability strategies should consider the leverage points identified in the balancing loops. The first relates to the need to harmonize export growth with the assurance of domestic supply. As the cattle supply chain becomes oriented toward international markets, tensions may arise with national consumption, affecting food security or raising domestic prices. To avoid these effects, it is necessary to establish production planning mechanisms that allow for adjusting export volumes based on internal supply, without compromising system profitability. The second leverage point concerns the management of environmental impacts, especially deforestation. The analyzed data show that extensive livestock farming is responsible for a significant share of forest cover loss in the country, which not only threatens biodiversity and ecosystem services but also jeopardizes the international reputation of Colombian meat products. In this regard, it is urgent to adopt satellite monitoring strategies, farm georeferencing, and deforestation-free origin certifications to track the environmental impact of livestock activities and differentiate products based on their environmental performance.

The sustainability of the cattle supply chain requires strengthening sectoral governance and territorial participation in the formulation and implementation of policies. Given regional heterogeneity, differentiated approaches are proposed, involving participatory planning, public-private coordination, and decentralization of instruments, all tailored to local realities.

This study is limited by its reliance on secondary data and qualitative modeling, which, while appropriate for exploratory systemic analysis, may not capture all quantitative dynamics of the supply chain. Future research could incorporate simulation techniques (e.g., system dynamics modeling) with primary data from producers and policy actors to validate and quantify feedback loops identified. Additionally, comparative studies across Latin American countries could enrich the understanding of contextual factors that shape sustainable transitions in livestock systems.

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Digital transformation and sustainable export: The role of artificial intelligence in latin american brands

Marelby Amado Mateus
CENTRUM Católica Graduate Business School, Pontificia Universidad Católica del Perú (Peru), marelby.amado@pucp.edu.pe, https://orcid.org/0000-0002-2653-1251
Fredy Harbey Sáenz Guzmán
Corporación Universitaria de Asturias (Colombia), fredy.saenz@asturias.edu.co

Introduction

Developing economies are experiencing two intertwined transformations: accelerated digitalization and the need for structural change to achieve inclusive, sustainable growth. Recent studies show that digital transformation drives productivity and export diversification, but its benefits are unevenly distributed, depending on technological, institutional, and human capacities (Sayari *et al.*, 2025; CEPAL, 2024). In Latin America, digitalization has been key to resilience and export expansion; during the pandemic, firms that adopted digital tools maintained or even increased international market access, underscoring the importance of digitalization for competitiveness (CEPAL, 2024). Over the last decade, digitally driven progress has coincided with improved trade efficiency in leading countries such as Chile, Peru, and Colombia, while lagging countries risk falling further behind, making it crucial to close internal digital divides (CAF, 2023; CEPAL, 2025).

Despite this progress, Latin America faces structural challenges that limit digitalization's transformative impact. Persistent inequalities in infrastructure and digital skills restrict access to advanced technologies, particularly for SMEs. Regional investment in R&D and AI adoption remain low—less than 10% of companies use AI, and the region represents just 3.7% of global demand—highlighting the need for comprehensive strategies to close these gaps (CEPAL, 2025).

At the same time, digital transformation is central to achieving the Sustainable Development Goals, enabling business models that integrate economic growth, social inclusion, and environmental sustainability (CEPAL, 2025; Chen & Xing, 2025). Platforms and AI-based solutions have facilitated SME internationalization, reduced inequalities, and improved resource use across key sectors (CAF, 2023; Muhammad *et al.*, 2025). Realizing these benefits, however, requires investment, public–private collaboration, and robust capacity-building to overcome persistent divides.

From a management perspective, digital technologies and innovative organizational culture have become differentiators for Latin American exporters. The capacity to build strong digital narratives now serves as a key asset for global positioning and reputation (Feliciano-Cestero *et al.*, 2023). This chapter therefore analyzes how exporting firms recognized for innovation and sustainability in leading countries have incorporated artificial intelligence and digital transformation into their strategies and communications, identifying best practices, barriers, and opportunities to strengthen international competitiveness and sustainability.

This study adopts a qualitative-descriptive methodology, suitable for in-depth analysis of organizational processes and cultural dynamics in digital transformation and sustainable exports (Yin, 2018). The qualitative approach enables contextualized examination of complex strategies and meanings, while the descriptive orientation supports systematic, transparent cross-case comparison. A multiple-case study design was chosen to explore similarities and differences in strategies and outcomes across distinct organizational settings, thus increasing external validity and generalizability (Yin, 2018; Eisenhardt, 1989). Each company was treated as an analytical unit, allowing for both individual case analysis and identification of cross-case patterns.

Case selection was purposive and guided by three operationalized criteria: (1) formal recognition for innovation and sustainability—verified through national or international awards, certifications (e.g., B Corp), or inclusion in reputable industry rankings during 2021–2025; (2) clear evidence of international export activity—established via annual reports, press releases, or export records; and (3) public availability of documented digital transformation or AI strategies—confirmed through official websites, published case studies, or credible media coverage. These criteria ensured that the selected cases (Chocolates Luker, Nowports, Bioleather Lab, and NotCo) were relevant to the research objectives and provided sufficient diversity for robust comparative analysis.

Data were collected from secondary sources, including institutional reports, official websites, press releases, and corporate social media. The analysis was structured around three dimensions: (a) reconfiguration of business processes through technological innovation, (b) internalization of a digital organizational culture, and (c) construction of digital narratives for international markets. The authors conducted thematic coding manually to identify key patterns and contextual specificities, resolving discrepancies by consensus.

Chocolates Luker (Colombia)

Founded in 1906, Chocolates Luker has evolved into one of Colombia's leading cocoa exporters, now positioned as a B4B (business-for-business) supplier of premium chocolate and fine-flavor cocoa for international industrial and horeca markets. Its differentiation strategy is anchored in quality, sustainability, and ongoing innovation, establishing Luker as a Latin American reference in the sector (Luker Chocolate, 2024).

Reconfiguration of Processes through Technological Innovation

Luker integrates technological and social innovation through initiatives like "The Chocolate Dream" and "El Efecto Cacao" with USAID, training over 800 small producers in modern practices and boosting productivity by 75%. Digitalization accelerated during the pandemic with virtual training and tablet distribution. The Luker Trace platform, using blockchain and IoT, provides full traceability, faster audits, and international compliance, while AI supports quality control and reduces losses (Luker Chocolate, 2024; Amaya, 2023).

Internalization of a Digital Organizational Culture

Luker has fostered a participative and learning-oriented culture, moving beyond its traditional family business model. The company invests in continuous training for employees and producers, focusing on digital and environmental skills, with more than 1,200 producers and 300 employees trained in regenerative agriculture and technology use in 2023. This approach

has led to lower employee turnover (8%) and strengthened strategic alliances at both national and international levels (Luker Chocolate, 2024).

Construction of Digital Narratives Oriented toward International Markets

Luker's international brand narrative emphasizes authenticity, sustainability, and transparency. The company leverages digital storytelling, social media, and QR codes to communicate progress in traceability, women's empowerment, and carbon reduction. Supported by B Corp certification and industry recognition, Luker's transparent communication—including payments of up to 94% of the NYSE FOB price to producers—has reinforced its reputation and leadership in innovation and sustainability in global markets (Myers, 2024).

Nowports (México)

Founded in 2018, Nowports is Latin America's first digital freight forwarder, offering a cloud-based platform that leverages automation, AI, and data analytics to streamline international logistics across sea, air, and land (Nowports, n.d.). After raising $150 million in 2022, the company became a unicorn, expanded to seven countries in the region plus the U.S., and by 2025, operated ten offices with over 700 employees (Carraposo, 2022).

Reconfiguration of Processes through Technological Innovation

Nowports digitalizes the entire logistics chain, enabling instant freight quotes, real-time container tracking, and digital documentation that is up to 300% faster than manual processes (Mahoney, 2022). Its Smart ETA system uses machine learning to predict arrival times by analyzing routes and congestion, allowing clients to anticipate delays and optimize inventory (Y Combinator, n.d.). The platform also integrates insuretech solutions and customs automation, consolidating Nowports as a comprehensive digital logistics ecosystem.

Internalization of a Digital Organizational Culture

Nowports has an agile, scalable structure with distributed, multicultural teams coordinated via digital tools. Recognized by Employers for Youth as a top workplace for young professionals, the company prioritizes ongoing training in emerging technologies and agile practices (Juárez, 2022). Employees are encouraged to drive innovation and data-driven decisions, and the company shares its experience with other startups, strengthening the regional ecosystem. Remote, international teamwork is integral to its identity, supporting fast global expansion.

Construction of Digital Narratives Oriented toward International Markets

Nowports' narrative blends rapid growth with technological disruption, spotlighted in global media like Forbes and Wired (Carraposo, 2022). Strategic communications—such as the Miami office launch—reinforce its role as a bridge between Latin America and the U.S., aligning with nearshoring trends (Alfaro, 2022). The company positions itself as a key digitalization partner for exporting SMEs and traditional logistics operators, promoting regional impact and innovation.

Bioleather Lab (Perú)

Founded in 2020 by a multidisciplinary team of young scientists and entrepreneurs from Universidad Nacional Agraria La Molina, Bioleather Lab has positioned itself as a benchmark for innovation in Peru's leather industry by implementing a business model rooted in circular economy and sustainability (Bioleather Lab, n.d.; AgroPerú, 2024). Leveraging patented technology and agricultural waste—including avocado, mango, coffee, and purple corn residues—the company produces a flexible, durable bioleather that is free from plastics and toxic chemicals, generating a positive environmental impact through waste reduction and added value for local agricultural supply chains (Gonzales, 2025; ProInnóvate, 2024).

Reconfiguration of Processes through Technological Innovation

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Internalization of a Digital Organizational Culture

Bioleather Lab's organizational culture is defined by continuous innovation, interdisciplinary collaboration, and full adoption of digital tools. The team operates under a horizontal structure, which enables agile decision-making and fosters creativity (Bioleather Lab, n.d.). Open innovation platforms and digital networking have strengthened partnerships with universities, technology centers, and key stakeholders within Peru's entrepreneurial ecosystem. Ongoing learning is a core principle, supported by virtual training, participation in global hackathons, and international events such as South Summit Madrid (AgroPerú, 2024). This digital and global mindset allows Bioleather Lab to scale rapidly and adapt to challenges in sustainability, international demand, and co-creation with strategic partners.

Construction of Digital Narratives Targeted to International Markets

Bioleather Lab has strengthened its international profile through a transparent digital narrative focused on scientific impact and social purpose. Its website and social media share measurable results—over 99% water reduction and elimination of toxic waste—while highlighting rural integration and technological achievements (Bioleather Lab, n.d.; AgroPerú, 2024). Recognition in "Best Practices in Circular Economy" (Sjöstedt, 2025) and global media coverage (Gonzales, 2025) have boosted its reputation and attracted partnerships with ethical, sustainability-driven brands (ProInnóvate, 2024).

NotCo (Chile)

Founded in 2015, NotCo (The Not Company) is a leading Chilean foodtech recognized for its plant-based alternatives that replicate animal products, including NotMilk, NotMayo, and NotBurger. After reaching unicorn status in 2021 with a USD 1.5 billion valuation and securing

high-profile investors, NotCo expanded to major markets such as the U.S., Canada, Brazil, and Mexico, supported by its strategic joint venture with Kraft Heinz (Yu, 2022; Kraft Heinz, 2022).

Reconfiguration of Processes through Technological Innovation

At the heart of NotCo's innovation is "Giuseppe," an AI algorithm that uses machine learning to create plant-based foods closely mimicking animal products. Giuseppe's analysis of molecular and chemical data leads to unique recipes, like NotMilk made with pineapple and cabbage for authentic dairy taste (Ellis, 2024). This method accelerates product development and lowers environmental impact, achieving up to 92% less water use and 74% lower carbon emissions compared to traditional dairy. NotCo's approach has earned global recognition, such as the Roquette Innovation Challenge award in 2021 (Watson, 2022; Roquette, 2021).

Internalization of a Digital Organizational Culture

NotCo operates with the spirit of a tech startup: cross-disciplinary teams—data scientists, food engineers, chefs, and marketers—collaborate in agile cycles with Giuseppe. The company champions experimentation and rapid iteration under its "Why Not?" philosophy. Digital tools enable seamless collaboration across offices in Chile, Brazil, and the U.S., and its structure into own-brand and B2B units supports high-impact alliances like Kraft Heinz (Mridul, 2025).

Construction of Digital Narratives Oriented toward International Markets

NotCo's digital narrative is built on sustainability, innovation, and bold communication. The company transparently shares environmental metrics—such as reduced water and carbon use—on its website and social media. Creative campaigns, including viral ads featuring cows "resigning" from dairy, boost media coverage and international brand recognition (Watson, 2022). Strategic alliances, including the Kraft Heinz joint venture and features in Time, CNBC, and Bloomberg, amplify NotCo's reputation as a pioneer blending AI, sustainability, and creative entrepreneurship (Kraft Heinz, 2022).

Comparative Summary of Digital Transformation in Leading Latin American Exporters

Table 1 summarizes the four cases across three analytical dimensions: technological innovation in processes, digital organizational culture, and international digital narratives. This comparison clarifies both shared patterns—such as leveraging advanced technologies, fostering digital mindsets, and building strong international brand narratives—and notable differences in sector challenges, technological complexity, and B2B/B2C focus. The analysis highlights that, while each company follows a unique path, aligning innovation, culture, and communication is key for sustainable digital transformation and global competitiveness among Latin American exporters.

Table 1. *Comparative summary*

Company	Process Reconfiguration	Digital Culture & Organization	Digital Narrative & Global Positioning
Chocolates Luker **(Colombia)**	Implemented blockchain, IoT, and AI for traceability (Luker Trace); integrated digital training for cocoa producers; achieved B Corp certification.	Promotes sustainability, digital mindset, and ongoing training among employees and suppliers; horizontal structure; focus on community development.	Uses digital storytelling and certifications (B Corp, EUDR) to differentiate in premium markets; strong presence in B2B international forums and networks.
Nowports **(Mexico)**	Developed an AI-driven logistics platform; automated documentation and real-time cargo tracking; expanded to 10+ countries; offers digital financing (insuretech).	Digital-native startup culture; agile teams, international distributed workforce; recognized for young talent and tech-driven growth; early focus on internationalization.	Positions as Latin America's digital freight forwarder; leverages digital media and awards to project innovation; aligns narrative with nearshoring and global trade trends.
Bioleather Lab **(Peru)**	Pioneered biotech upcycling of agro-industrial waste into sustainable vegan leather; reduced water usage by >99%; achieved international recognition for process innovation.	Multidisciplinary team; open innovation model with universities and rural communities; promotes environmental values and science-driven entrepreneurship.	Communicates impact metrics and circular economy ethos; active on social media and innovation events; uses global awards and features to build credibility.
NotCo **(Chile)**	Created the "Giuseppe" AI algorithm for rapid plant-based R&D; patented tech; partnered with Kraft Heinz; reduced environmental footprint of alt-proteins.	Startup-like, agile culture; combines data science, culinary arts, and marketing; fosters experimentation and B2B co-creation; international, cross-functional teams.	Irreverent, viral storytelling in campaigns; global media coverage; leverages tech and sustainability to position as an industry disruptor; strong brand alliances.

This study underscores that digital transformation in Latin American exporting firms is a multidimensional process, integrating technology, organizational culture, and strategic communication. The comparative analysis of four leading cases reveals that technological adoption alone is insufficient; success depends on cultivating agile, learning-oriented cultures and building credible digital narratives. While the integration of advanced technologies such as AI and blockchain has driven competitiveness and export diversification, persistent barriers—

such as skills gaps, financial constraints, and regulatory hurdles—continue to shape outcomes. The evidence highlights the importance of internal capabilities, public–private collaboration, and context-specific adaptation, while also confirming that there is no one-size-fits-all path to transformation. Methodologically, the multi-case approach enabled the identification of both shared drivers and sectoral distinctions. The exclusive focus on successful cases signals a need for future research to examine less favorable experiences, deepening understanding of the risks and limits of digital transformation in the region.

Conclusions

The analysis of Chocolates Luker, Nowports, Bioleather Lab, and NotCo confirms that digital transformation and sustainability have become essential and differentiating pillars for Latin American companies aiming to compete globally. In each case, the adoption of advanced technologies—AI, blockchain, biotechnology, and digital platforms—has enabled organizational renewal, new business opportunities, and greater resilience against diverse challenges. However, success is not driven by technology alone: it also depends on deep cultural change, multidisciplinary collaboration, and strong internal and external value propositions.

These cases show that digitalization is most effective when supported by agile, learning-oriented cultures and reinforced through credible digital narratives and transparent impact metrics. Despite their achievements, all four companies faced persistent barriers such as skills gaps, financial and regulatory constraints, and cultural resistance, overcoming them through partnerships, talent investment, and adaptive strategies. Focusing solely on success stories may overstate the ease of transformation; future research should also consider partial and failed attempts to capture the region's real challenges. Taken together, the experiences of these leading firms illustrate how the strategic integration of technology, culture, and communication can position Latin American companies as emerging leaders, capable of driving differentiation, resilience, and legitimacy within increasingly sophisticated global markets.

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Academic Internationalization, University-Industry Partnerships, and the Healthcare Sector

Universities and internationalization processes: Synergies for business expansion

García Sandoval Jesús Roberto
Autonomous University of Tamaulipas, Mexico, jrgarcia@docentes.uat.edu.mx
https://orcid.org/0000-0003-3770-1620
Estrada Esquivel Claudia Rita
Autonomous University of Tamaulipas, Mexico, crestrada@docentes.uat.edu.mx
https://orcid.org/0009-0006-9459-7777
Castrellon Rodríguez Olga Ellinor
Autonomous University of Tamaulipas, Mexico, Ecastrel@docentes.uat.edu.mx
https://orcid.org/0009-0006-5958-2940

Introduction

The transformations and innovations that have emerged since the era of globalization—and particularly since the fourth scientific and technological revolution, known as the Fourth Industrial Revolution or Industry 4.0— mark a phase that combines advancements in various fields such as robotics, artificial intelligence, nanotechnology, biotechnology, quantum computing, the Internet of Things, 3D printing, and autonomous vehicles, among others. These advancements demand new knowledge and technically comprehensive training processes centered on the human being (Kipper et al., 2020).

Universities are becoming autonomous international platforms, essential for establishing collaborative relationships, inter-institutional cooperation, dialogues, and exchanges for the development of innovative ideas (Duart, 2007). Internationalization processes involve essential factors such as academic mobility for cultural purposes in the integration of social, scientific, and technological knowledge for education and the strengthening of research to develop entrepreneurial, digital, and social competencies that shape the values of students and academics, thereby connecting innovative processes and linking them to internationalization policy. This approach uses knowledge and society as its foundation, generating a model of sustainable development among universities, businesses, and government that is more beneficial for their regions (Macías et al., 2023).

Universities play a key role in internationalization processes that go beyond simple traditional academic mobility and present challenges in new partnership relationships, particularly in knowledge transfer, thereby impacting the consolidation of a sustainable business ecosystem. Both public and private universities They can also generate processes involving the development of comprehensive scientific policies to foster cooperation, which also opens possibilities for the functional distribution of power, supported by funding systems and academic networks for the production and dissemination of knowledge. This perspective seeks to ensure that internationalization is neither a hegemonic power nor a merely populist commercial force, but rather one capable of strengthening and establishing cooperative ties that can promote inclusive and sustainable development in the academic and scientific spheres (UNESCO, 2018), that is, it highlights the strategic role of universities as facilitators of innovation and the training of individuals with global talents to address the challenges of the globalized world by fostering collaborations grounded in the realities and needs that reveal the strengths and weaknesses of the business sector within a given region.

The Organization for Economic Cooperation and Development (OECD, 2016) states that a country's economy and its administrative model develop specific characteristics in the relationship established between them; business expansion requires advanced training that enables the transfer of knowledge from the university to the company, in order to create conditions for entry into and consolidation within international markets. Therefore, the integration between universities and businesses becomes a strategic agent for addressing the challenges of the global context. In this sense, entrepreneurs, as the entities responsible for the application and development of knowledge , are key to aligning internal marketing and innovation capabilities with external economic, political, and cultural factors to enter international markets; These relationships manifest in cross-border mergers and acquisitions, the formation of strategic alliances, exports, and foreign investment (Gallardo-Figueroa, et al., 2024).

In this regard, the university cannot be divorced from this cross-border perspective; it is essential for internationalization processes to foster synergies in the necessary expansion of business, so that the absence of national science policies, limitations in creating conditions for academic mobility, and lack of access to scientific dissemination channels do not become obstacles to the development of university internationalization. The existence of a multidimensional process that encompasses not only student and faculty mobility but also the creation of research lines and projects to foster research cooperation is urgent for the consolidation of a technological commitment that develops intercultural competencies within universities, as they play a decisive role.

This triad symbolically benefits regenerative innovation and business competitiveness, shaping new models of collaboration to enhance the global reach of businesses and their expansion in the international market; that is, the university redefines its strategic social role, emerging as a key actor in the international knowledge economy and becoming a strategic partner in internationalization processes, specifically with a direct impact on global business and corporate expansion. University-business integration is the result of a relationship, agreements, and negotiations that are developed with a high capacity for adaptation to address an increasingly connected society, one that is demanding in terms of capital and the market, where evolution enables innovation, the development of intercultural competencies, and knowledge transfer as potential factors in the expansion of companies into international markets (Barrientos-Oradini et al., 2022).

This research employed descriptive documentary analysis as its methodology, reviewing relevant literature to interpret the specific characteristics and necessary relationships between universities and internationalization in the business context. As a research field, the study drew upon digital journals indexed by Scopus, Emerald, JSTOR, EBSCO Hot, and digital books, which enabled the construction of the theoretical frameworks for the study. Critical thinking, rigor, and systematicity are employed as part of the method to achieve a valid and accepted scientific status.

The research is classified as exploratory, as it sought to analyze and understand the phenomena and describe the practices that promote international collaboration. The main technique was thematic analysis to identify patterns and significant relationships that demonstrate the influence of university internationalization on the expansion of the business sector today.

This chapter addresses the theoretical and practical analysis of the synergy between the university and the internationalization processes that stimulate the business sector and foster competitiveness in international markets, identifying benefits and challenges. The analysis of these mechanisms contributes to the development and implementation of scientific policies and business strategies that foster sustainable, efficient, and excellence-driven university internationalization, emphasizing the need for close ties between academia and the private sector for global economic development.

Factors Influencing University Internationalization

Currently, university internationalization is conceived as a multidimensional process encompassing scientific policy, student and faculty mobility, research collaboration, and the incorporation of an international dimension into the curriculum, with the aim of fostering excellence in education, research, and innovation (García et al., 2018). Internationalization fosters a culture of innovative encounters through experiences, case studies, and disciplinary topics for the development of products, services, and business models adapted to a global environment. The relationships and dynamics established with the business sector—both within the country and abroad—become a key strategy for competitiveness, international sustainability, and the comprehensive education of undergraduate and graduate students.

The institutionalization of the university's internationalization policy for programs and projects incorporates clear funding guidelines that integrate training processes in disciplines that are in high demand by businesses, as well as the definition of plans and projects for university management, which must be planned to ensure the allocation of resources (Gacel, 2023), meaning that the definition of an explicit policy on international funding and training must be accompanied by a planning process consistent with business realities and needs.

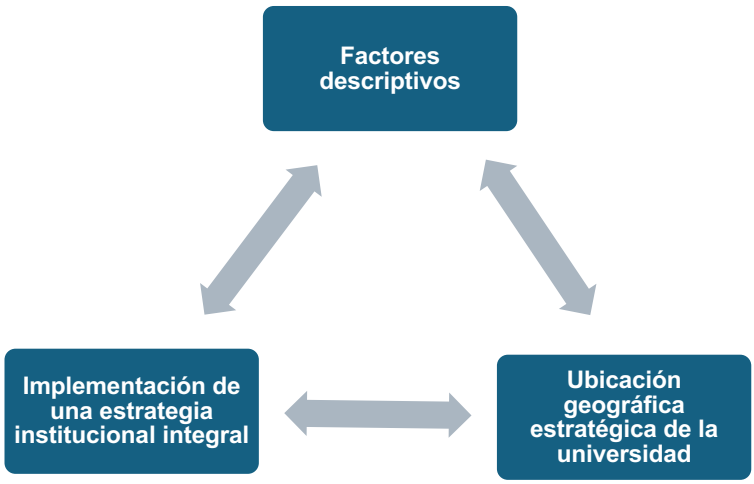
There are various theories regarding the interaction between the institutionalization of internationalization policy and human training policies; both are interrelated and subject to planning and innovation processes that must generate processes and outcomes of excellence in university management. This process of collaboration fosters the creation of global networks around common themes such as business development and the entire business ecosystem involved in driving global expansion. According to Knight (2004), internationalization driven by higher education has various implications, stemming from the intentional integration of a generalized technical dimension across all academic functions. This promotes the development of global competencies for understanding common themes and knowledge related to development, with a particular focus on creating conditions that foster business growth. This perspective emphasizes education as a driver of sustainable transformations in the international economy.

According to Gacel-Ávila (2012), comprehensive internationalization—a recent term—seeks to transcend basic conceptualizations of physical mobility to holistically incorporate the international dimension into governance, curricula, and teaching activities, thereby generating an ecosystem that drives innovation and global business collaboration. This approach positions the university as a strategic node in knowledge networks, where the capacity for innovation and technology transfer strengthens businesses in their global expansion processes. In this regard, two key factors are identified that, within the broader context of internationalization processes, influence the business sector:

a) Implementation of a comprehensive institutional strategy, which includes the creation of specific offices or units for the management and direction of internationalization, the establishment of agreements and partnerships with foreign institutions, and the integration of the international dimension into institutional development plans. This promotes student and academic mobility, as well as collaboration in research and technology transfer, resulting in the training of individuals with global competencies and a higher quality of education designed to drive transformation within the company (Rubio, 2006; Moctezuma, 2011); that is, the strategy aims to serve as a means of coordinating decision-making regarding which faculty and students may participate, the areas of exchange, the cultures involved, and the selection of universities by country and program type.

b) The strategic geographic location of universities—particularly those in border regions—is key to fostering exchanges and collaborations, as it facilitates cross-border cooperation. In the specific case of Mexico, this involves exchanges with the United States and with South American countries, which drive joint programs and academic networks that enhance mobility and cultural and scientific exchange. This interaction is also linked to the country's trade openness through international treaties, such as the North American Free Trade Agreement (NAFTA), a trade agreement signed between Mexico, the United States, and Canada, whose primary objective was to eliminate tariff barriers and facilitate trade among the three countries. specifically, this treaty opened up opportunities for universities to establish partnerships aimed at developing the skills and knowledge of students who will enter the business sector, making them competitive in the region (Albacht and Knight, 2006; ANUIES, 2002). From this perspective, both territorial factors and trade agreements influence the internationalization processes taking place in universities.

Figure 1. Descriptive factors that broadly define internationalization processes



Although each of the factors described in Figure 1 demonstrates its role within the comprehensive institutional strategy, these factors are interlinked. Generally speaking, the region and the university's strategic location will define the comprehensive institutional strategy that incorporates sustainable elements for the university's structure, as defined by three substantive elements that are explicitly considered:

Figure 2. Substantive Elements of the Comprehensive Institutional Strategy



Figure 2 highlights that in the comprehensive institutional strategy, the planning process carried out in the formulation of the internationalization policy is fundamental to the strategic plan, which is considered a means of dissemination that communicates and promotes the university's strategy. Through the integrated management of diverse fields of knowledge, clusters, themes, and perspectives, achieves disciplinary dynamism by reflecting the organizational culture defined by people's values, beliefs, and ethical behavior. In this sense, this triad leads to a synergy that, from within both public and private universities, drives the decisions and actions defined by public policy within the universities.

Figure 3. Key elements of strategic geographic location



In Figure 3, strategic geographic location is a key factor that facilitates integration into networks, mobility, and international academic cooperation; it highlights the proximity to academic, economic, and cultural hubs, which enables integration into international academic networks. This location impacts the university's ability to promote student and faculty mobility, establish strategic partnerships, and access international education markets—all essential elements of international academic cooperation and the institution's global reach.

On the other hand, studies on internationalization show that it is futile to establish a common roadmap for universities and businesses and confirm that this depends on the chosen funding policy strategy (Kelo, 2008); in this sense, funding policy becomes a cross-cutting axis of development; its definition and development determine the mechanisms necessary to generate sustainable internationalization processes that achieve a real, tangible impact on businesses. From the institutionalization of policy as a means to define a strategy—tailored to the specific characteristics of a given university—strategic geographic location plays a significant role in fostering cooperation and visibility in academic exchange and partnership

processes between universities. It is also crucial for the ability to transfer knowledge to the business sector and for organizational adaptability to global demands.

University Synergies and Internationalization Processes: A Path to Business Expansion: Results

University synergies are presented through the mode of study offered by the university; there are on-campus and online universities, which, amid the transformation processes currently taking place worldwide, are developing as strategies to find new ways of responding to the realities of specific regions.

On-campus universities are generally the traditional and preferred mode of study for students. However, online universities are becoming increasingly numerous and, over time, are improving their competitive position, increasingly eliminating the stigma associated with studying at these institutions by prioritizing the benefit of having no time constraints on study over the merit or prestige of studying at a university in this format due to societal prejudice. Table 1 includes the results presented on the synergies between universities and internationalization processes as a pathway for business expansion:

Table 1. *Results of the synergies between universities and internationalization processes as a pathway for business expansion*

	Synergies	Business Expansion	Inclusive Hubs
Comprehensive Institutional Strategy	Access to Innovation and Technology	Universities provide applied research, technological development, and educational solutions tailored to real business needs, which enhances business competitiveness and fosters continuous innovation	Technology platform Artificial Intelligence
	Training of qualified talent	These synergies facilitate the training of highly skilled professionals with practical experience and up-to-date knowledge that companies require for their growth.	Training Knowledge and subject areas
	Strengthening business capabilities	Collaboration enables specialized training, organizational improvement, and access to consulting services and joint projects that contribute to business growth.	Engagement Identifying issues and implementing corrective measures
Strategic Geographic Location	Market expansion and networking	International university partnerships open new opportunities for access to global markets, facilitating the internationalization of companies through strategic networks and alliances.	Mutually beneficial sustainability with lasting connections, proactive exchange of support, and long-term information sharing for the network.
	Generation of joint	These result in startups, patent	Innovation

	projects and technology transfer	development, and shared intellectual property, driving innovative and sustainable business development.	Entrepreneurship
	Social and economic impact	These synergies strengthen the local and regional economy by creating jobs, fostering sustainable development, and promoting a culture of open innovation between academia and business.	Social transformations Culture of innovation: defining new ideas with social value

The existence of concrete partnerships that demonstrate how university-business collaboration with an international scope contributes to solutions; among the most relevant findings, it is highlighted that comprehensive internationalization enhances companies' innovative and competitive capacity through the training of talent with intercultural skills and access to global knowledge networks. Furthermore, it was identified that research cooperation (Montes de Oca et al., 2022), which is grounded in and driven by technology transfer, is key to international business sustainability and growth, validating the theoretical propositions of Gacel-Ávila (2012) and Chesbrough (2003), who argue that internationalization must be comprehensive starting with higher education; these dynamics demonstrate a model for global competitiveness to create and capitalize on the use of technology.

In this case, open innovation seeks collaboration between universities and companies, which is essential for accelerating the innovation and technological development necessary in international markets (Chesbrough, 2003). These synergies allow businesses to access new knowledge, seek resources, and identify talent—all of which are essential elements for contemporary global competitiveness. Universities, therefore, not only develop human capital but are also active players in the creation and dissemination of innovation for internationalization (Oviedo-González, 2025).

The results indicate that universities are essential facilitators of knowledge, innovation, and specialized human capital, fostering the development and consolidation of international networks. In this context, a comprehensive institutional strategy makes access to innovation and technology fundamental pillars, as these require the identification and training of qualified human talent with the skills to identify the potential of scientific networks and the key actors for international collaboration—whether with other universities or with business leaders. in this regard, the strengthening of entrepreneurial capacities is driven by the conditions that companies present in their various sectors, such as agri-food, health, culture, food, and infrastructure, among others.

With its strategic geographic location, the university facilitates market expansion and networking. Given its position at the frontier among the various countries where the university operates, it can create systems that foster two-way engagement: in-person interaction within the region and the strategic practice of building, nurturing, and maintaining a sustainable network of professional and personal contacts under shared goals of achievement. this internationalization approach will facilitate the exchange of knowledge and experiences, promoting the creation of joint projects involving technology transfer for scientific purposes

that generate social and economic impact, translating into the university's growth and development alongside changes within businesses.

Finally, these synergies contribute significantly to the evaluation of the internationalization policy, and of the academic mobility of students and faculty researchers through bilateral programs and agreements offering academic courses in foreign languages, joint international degree programs, and internship programs across the agreed-upon range of disciplines and fields of knowledge. These learning processes acquired must be transferred to companies, their management, and employees so that they can modify and generate adaptability in their work processes. This is the true synergy: educating business training processes through an internationalization lens to foster development and growth in countries, thereby stimulating the business ecosystem by promoting competitiveness in international markets and identifying benefits and challenges.

Conclusion

The university needs to define, in a pluralistic and comprehensive manner, a sustainable university internationalization policy that incorporates diverse agents and scenarios and is not viewed purely as a technical matter. Its implementation involves direct engagement with reality—that is, with its performance—which plays a key role in development and competitiveness through standards of quality, efficiency, and excellence. In Latin America, many universities must address the internationalization policy, which in most cases is marked by university system reform with severe budget cuts, creating limitations on funding systems. This underscores the need for the definition of internationalization policy to reclaim its exclusive, sustainable nature, guided by the relationships and connections established among universities, faculty, and students to thereby avoid individual risks.

It is considered that the university has clearly embarked on a process of internationalizing education and research that goes beyond simple international mobility; its approach aims to position the university on the international stage with the technical, theoretical, and practical capabilities to transfer to the business community a set of knowledge and global competencies in research and innovation, as well as to create networks and alliances, and these transfers strengthen the visibility and export capacity of the business sector.

This research highlights the importance of seeking innovative ways to strengthen university internationalization policy, with a particular focus on institutional expansion, by considering efforts to promote it through the development of university-business partnerships and ensuring that the main elements of the internationalization policy are systematically integrated into the curriculum and joint research projects. In this regard, this research provides essential information for the implementation of future lines of research, under the development of systematized and established synergies, which gathered information on internationalization and universities and demonstrated their progress in the process of business development and growth.

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Internationalization of university health services: models for exporting community telemedicine

Llanes Castillo, Arturo
Autonomous University of Tamaulipas, Mexico , allanes@docentes.uat.edu.mx
https://orcid.org/0000-0003-2570-826X
Cruz Casados, Jaime
Autonomous University of Tamaulipas, Mexico jcruz@docentes.uat.edu.mx
https://orcid.org/ 0000-0002-8308-964X
Cruz Casados, Laura Nelly
Autonomous University of Tamaulipas, Mexico ccasados@docentes.uat.edu.mx
https://orcid.org/ 0009-0001-1295-8510

Introduction

The global expansion of digital health has rapidly transformed the delivery of healthcare services and the training of healthcare professionals, positioning higher education institutions (HEIs) not only as educators but also as providers and innovators of clinical services based on digital technologies (OECD, 2023). Recent evidence shows that innovations in telemedicine, remote monitoring, and digital clinical decision support systems have helped improve continuity of care, operational efficiency, and the resilience of health systems, particularly in contexts of high clinical pressure and human resource shortages (Ahmed et al., 2025; Kane, 2024; Shaffer et al., 2023).

In this context, community telemedicine—understood as the provision of remote care with an emphasis on local, rural, or vulnerable populations—is emerging as a strategic avenue for HEIs to export validated and scalable care models beyond their borders in partnership with international companies and consortia (Gao, Chen & Cui, 2022; Cui et al., 2021; Mahdavi, Mahdavi & Moghbeli, 2025).

Since 2020, international agendas have established frameworks and roadmaps that encourage this transition. The World Health Organization's Global Digital Health Strategy 2020–2025 promotes the sustainable adoption of technologies, capacity building, data governance, and transnational cooperation to accelerate equitable access (World Health Organization, 2024). In the European Union, the European Health Data Space (EHDS) Regulation, adopted in 2024–2025, establishes criteria for interoperability, security, and citizen control over data, creating regulatory conditions that foster telehealth, research, and international cooperation (Terzis & Santamaria, 2023; Deimel, Hentges & Thiel, 2025).

The internationalization of university health services faces structural challenges in technological, regulatory, and social areas. Gaps persist in semantic and technical interoperability, such as the heterogeneous adoption of HL7 FHIR, IHE, or ISO/IEEE 11073 standards, as well as in the secure integration of telemonitoring and clinical platforms (Duda et al., 2022; Kramer & Moesel, 2023; Martins et al., 2025; Kapitan et al., 2025). Legally, debates continue regarding transnational professional licensing, civil liability, and data protection (Campiglio, 2024; Lewerenz, Martins & Martins, 2024). Socially, digital technologies can expand coverage, but they can also exacerbate inequalities if they are not designed with digital justice, accessibility, and technological literacy in mind (Badr, Motulsky & Denis, 2024; Cervantes et al., 2025).

In the case of Latin America, the relevance of this analysis is reinforced by regional evidence. According to Lozano et al. (2020) and Kruk et al. (2022), more than 35% of rural areas lack regular access to basic health services, and in Mexico the ratio of doctors per 1,000 inhabitants is just 2.4, compared to an average of 3.8 in OECD countries. These gaps demonstrate the urgency of strengthening community telemedicine models with the capacity to scale internationally, not only as a technological strategy but as a policy of equity and social justice.

Despite these barriers, comparative evidence points to opportunities. The OECD documents that, following the pandemic's spread, telemedicine helped maintain continuity of care with positive effects on efficiency and performance, and that many countries are consolidating hybrid models incorporating artificial intelligence algorithms (OECD, 2023). In parallel, European initiatives recommend accelerating the adoption of the European Electronic Health Record Exchange Format for secure exchanges (Agarwal et al., 2021; Greenhalgh et al., 2025). Recent reviews caution that interoperability is not resolved by standards alone, but through ecosystem governance and trust frameworks (Kapitan et al., 2025). Likewise, analysis of cross-border telemedicine highlights the need to develop evidence on data exchange, clarify regulatory roles, and harmonize consent processes (Lewerenz, Martins & Martins, 2024).

In this landscape, HEIs possess comparative advantages that include research and clinical evaluation capabilities, links to communities and health systems, legitimacy in training digital talent, and international networks for technology transfer and co-creation (Badr, Motulsky & Denis, 2024; Zhang et al., 2023). University-industry collaboration is a critical lever for the export of community telemedicine models, whether through platform licensing, the creation of spin-offs, the co-management of regional hubs, or participation in consortia that integrate cybersecurity, regulation, and sustainability (Al-Alawy & Moonesar, 2023; Ahmed et al., 2025).

This chapter proposes to examine and classify the community telemedicine export models driven by HEIs, including the academic-care model, the technology transfer model, and the multilateral cooperation model, and to analyze their conditions for international scaling when they are coordinated with global companies. Three questions are posed: What organizational capabilities do HEIs require to internationalize community telemedicine services with quality and ethical standards? What regulatory arrangements facilitate cross-border delivery and university-business cooperation? And what public value metrics can demonstrate the sustainability and social legitimacy of these models?

Answering these questions will provide a framework to support universities and companies in designing exportable, interoperable, and socially just proposals aligned with global digital health strategies and international best practices (Kane, 2024; Borges do Nascimento, 2023). In this way, university-based community telemedicine can become a strategic asset for internationalization, enhancing academic soft power and contributing to improved coverage for historically underserved populations.

Community Telemedicine and Its Role in Public Health

Community telemedicine has established itself as a strategic pillar of public health policies, especially in contexts marked by inequalities in access to medical services. Unlike conventional telemedicine, which is oriented toward hospital or private settings, the community-based model focuses on vulnerable populations, rural areas, and marginalized sectors with limited

health infrastructure (Gao, Chen & Cui, 2022; Cui et al., 2021). The World Health Organization has noted that its integration into national systems not only strengthens universal coverage but also drives a shift toward preventive and participatory models (Mahdavi, Mahdavi & Moghbeli, 2025).

Various studies show that community telemedicine contributes to continuity of care for chronic diseases such as diabetes, hypertension, and asthma by facilitating remote monitoring, health education, and timely access to specialists (Ahmed et al., 2025; Martins et al., 2025). In Latin America, university programs have reduced wait times and improved metabolic control indicators in rural communities, while also providing practical settings for the training of medical and nursing students (OECD, 2023). Thus, this model has not only a clinical impact but also pedagogical and social ones.

A key aspect of community telemedicine is its ability to reduce health inequities. Badr, Motulsky & Denis (2024) highlight that digital technologies, when applied with a social justice approach, can bridge gaps in access to basic services. However, they caution that if digital literacy, technological accessibility, and connectivity are not taken into account, telemedicine can exacerbate inequalities. In this context, projects led by Higher Education Institutions (HEIs) take on special relevance, as they include educational and community-building components that reinforce their social impact.

Community telemedicine is also closely linked to the objectives of primary health care. According to the OECD, telehealth models integrated into these networks demonstrate greater cost-effectiveness and reduce hospital and emergency room overcrowding (OECD, 2023). In developing countries, HEIs have promoted digital health programs as extensions of university hospitals and community clinics, turning them into living laboratories of social and technological innovation. These programs exemplify how telemedicine simultaneously strengthens care, teaching, and research.

Recent literature also highlights the need for regulatory frameworks and data governance to consolidate these programs. Lewerenz, Martins & Martins (2024) note that the exchange of clinical information requires standards for interoperability, security, and privacy protection, especially in cross-border projects. The implementation of HL7 FHIR and the promotion of open infrastructures are among the most common proposals for ensuring the integration of telemedicine systems with national health platforms (Kapitan et al., 2025). These regulatory efforts are an indispensable condition for international scalability.

Finally, community telemedicine also serves a community empowerment function by promoting patients' active participation in self-care, health education, and monitoring of their conditions. This approach not only improves clinical outcomes but also strengthens social cohesion and trust in educational and healthcare institutions (World Health Organization, 2024). Thus, it emerges as a tool for healthcare delivery, social innovation, and university internationalization, capable of becoming an exportable model adaptable to different contexts.

This export potential does not emerge immediately, but rather results from an evolutionary process with clearly distinct stages in the consolidation of community telemedicine. To clarify this conceptual evolution, a comparative framework is proposed that articulates three phases: (1) initial adoption in university hospitals and community clinics; (2) consolidation in hybrid programs using mobile and interoperable technologies; and (3) international expansion through consortia and technology transfer. This framework allows us to visualize the transition

from local initiatives to international public goods and offers a roadmap to guide both researchers and policymakers. In the Latin American context, experiences in Brazil (the Telessaúde Brasil Redes Program) and Mexico (the Veracruz Telehealth Network) demonstrate positive impacts in reducing wait times and improving access to specialists in rural communities.

Internationalization of university health services

Community telemedicine has emerged in recent decades as a promising strategy for reducing inequalities in access to medical care. Unlike traditional hospital models, it targets rural, marginalized, or underserved communities, integrating clinical services, health education, and university outreach (Johanson & Vahlne, 2009). The World Health Organization has recognized that its integration into national systems is a key measure for advancing toward universal coverage, as it reduces geographical barriers, optimizes resources, and strengthens prevention (Borges do Nascimento, 2023). The COVID-19 pandemic confirmed their value by enabling continuity of care for chronic diseases and psychosocial support in isolation scenarios (Ahmed et al., 2025; OECD, 2023).

Higher education institutions play a unique role by combining the provision of community services with training and applied research. In Latin America, universities have developed digital clinics that not only serve vulnerable populations but also serve as living laboratories for innovation in public health (OECD, 2023; Cervantes et al., 2025). However, their impact depends on the ability to reduce inequities, as the digital divide can perpetuate inequalities if not accompanied by technological literacy, accessibility, and social inclusion strategies (Badr, Motulsky & Denis, 2024). Thus, the success of university telemedicine requires integrating care, teaching, and social responsibility into a single innovation model.

The internationalization of university health services is seen as a natural evolution of the social mission of higher education institutions. Traditionally, this process focused on student mobility, joint publications, and shared programs, but today it also encompasses healthcare capabilities. Exporting community telemedicine models is a novel form of internationalization, where applied knowledge becomes a transferable asset with global impact. Internationalization theory, particularly the Uppsala model, explains this phenomenon by describing how organizations expand gradually as they accumulate experience, , and networks (Santangelo & Meyer, 2017). From local programs to international consortia, universities demonstrate that service innovation requires adapting to diverse regulatory frameworks and sociocultural contexts (Al-Alawy & Moonesar, 2023).

Global conditions are favorable, as the WHO's global digital health strategy promotes cross-border cooperation and shared innovation ecosystems (World Health Organization, 2024). The OECD documents that telemedicine improves efficiency and resilience in the face of health crises (Keelara, Sutherland & Almyranti, 2025). In Europe, the creation of the European Health Data Space constitutes a regulatory framework that enables interoperability and cross-border access to clinical information under uniform security criteria (Ueda et al., 2024; Van Kolfschooten & de Ruijter, 2020; Thapa & Camtepe, 2021). These initiatives open avenues for universities to actively participate in the export of digital health services, with regulatory backing and international legitimacy.

In this process, university-industry cooperation becomes indispensable (Haleem et al., 2021). The international provision of community telemedicine requires academic legitimacy as well as the technological and financial capacity of the private sector. Three collaboration models are identified: the academic-clinical model, where universities use teaching hospitals and community clinics in partnership with technology companies; the technology transfer model, based on the licensing or scaling of platforms created by universities; and the multilateral model, in which universities, companies, governments, and international organizations form consortia (Lewerenz, Martins & Martins, 2024; Kapitan et al., 2025). These frameworks ensure sustainability, social legitimacy, and openness to international markets.

Despite these opportunities, internationalization faces cross-cutting challenges. On the technological front, the lack of interoperability limits the integration of clinical data, and although standards such as HL7 FHIR represent progress, their implementation remains uneven (Martins et al., 2025). Regulatory tensions persist regarding the validity of medical licenses and civil liability for remote medical acts (Campiglio, 2024). Socially, digital divides and a lack of technological literacy may exclude the most vulnerable sectors, undermining the principle of equity (Badr, Motulsky & Denis, 2024). Financially, dependence on subsidies and international cooperation limits sustainability, making hybrid models necessary that integrate private investment without compromising social commitment (Ahmed et al., 2025).

Taken together, this framework shows that the internationalization of university telemedicine is not a linear process, but a complex phenomenon where social, regulatory, technological, and economic dimensions converge. Community telemedicine, understood as social innovation, offers universities the opportunity to transcend borders, consolidate their role as agents of change, and contribute to more inclusive and resilient health systems. To realize these opportunities, it is essential to foster university-industry collaboration, harmonize regulatory frameworks, and ensure equitable access. Only then can university telemedicine establish itself as an international public good aligned with the Sustainable Development Goals.

Models of University-Industry Cooperation in Digital Health

Cooperation between universities and companies in digital health is now a pillar for the development and sustainability of telemedicine. The technological complexity of these initiatives requires resources, infrastructure, and capabilities that exceed what an academic institution can offer on its own. In turn, companies find in universities a strategic partner that provides social legitimacy, access to vulnerable communities, and specialized talent. This two-way relationship has given rise to collaboration models that allow for scaling community telemedicine programs and bringing them to international settings.

One of the most common models is the academic-healthcare partnership, in which universities use teaching hospitals and community clinics as digital care platforms in alliance with technology companies. Under this framework, the academic institution ensures clinical quality and student training, while companies provide videoconferencing platforms, interoperable electronic health records, and remote monitoring systems. This model has proven effective in regions with limited public infrastructure, as it expands coverage through shared investment and strengthens digital health education (Lewerenz, Martins & Martins, 2024).

A second model involves technology transfer and the creation of spin-offs, where university research centers develop digital innovations, such as mobile apps for monitoring chronic

diseases, artificial intelligence platforms for patient triage, or remote monitoring systems. These products are subsequently licensed or transferred to companies with the capacity to scale globally. In this framework, the university functions as an innovation incubator and companies as agents of internationalization. Haleem et al. (2021) note that this type of collaboration boosts competitiveness and maintains a social focus by linking with academic and community projects.

A third model is that of multilateral cooperation, where universities, companies, governments, and international organizations form consortia to implement large-scale digital health programs. These projects seek to address challenges such as cross-border interoperability, the regulation of telemedicine, and the governance of clinical data. In Europe, the European Health Data Space promotes collaborative networks that bring together universities and companies to create a shared digital ecosystem that facilitates access to services and shared research (European Commission, 2025; Council of the EU, 2025). This model represents the most advanced level of cooperation, as it requires comprehensive agreements on governance and the distribution of responsibilities.

University-industry cooperation is not without its tensions. Debates persist regarding intellectual property, profit sharing, and the risk that commercial interests will prevail over social objectives. Al-Alawy & Moonesar (2023) warn that the excessive commercialization of digital health can undermine trust if robust ethical frameworks are lacking. However, recent studies indicate that the most sustainable and widely accepted projects are those with shared governance, transparency, and clearly defined roles for each stakeholder (Keelara, Sutherland & Almyranti, 2025).

In short, university-industry cooperation models in digital health are indispensable for the internationalization of community telemedicine. Whether through academic-clinical partnerships, technology transfer schemes, or multilateral consortia, these alliances expand universities' capacity to transcend borders and offer companies the opportunity to validate innovations in real-world, socially relevant contexts. Thus, collaboration becomes a space where research, technological innovation, and social commitment converge, forming a robust framework to transform telemedicine into a sustainable international public good.

Cross-cutting challenges: technological, regulatory, and social

The internationalization of university digital health services faces multiple challenges that hinder their establishment as a sustainable and equitable alternative. From a technological standpoint, the main limitation is the lack of interoperability among clinical information systems. Although international standards such as HL7 FHIR represent a step forward, their implementation is uneven and depends on the local capabilities of each country or institution. This fragmentation complicates data exchange, restricts continuity of care, and reduces the quality of services when seeking to expand them transnationally (Kapitan et al., 2025; Martins et al., 2025). Added to this are cybersecurity and privacy protection issues, as digitized clinical information constitutes a strategic resource that requires robust infrastructure and advanced security protocols.

The adoption of clinical information systems enabled by machine learning algorithms adds another layer of complexity to these challenges. According to Balch et al. (2023), machine learning-based clinical systems demonstrate significant benefits in diagnostic accuracy,

prioritization, and operational efficiency, but they depend on an interoperable and standardized infrastructure to function securely in cross-border environments. Their systematic review shows that, without robust data governance and compatible technical frameworks across countries, the integration of artificial intelligence into telemedicine may amplify existing gaps rather than reduce them.

On the regulatory front, the challenges are equally complex. Telemedicine raises uncertainty regarding the validity of professional licenses, applicable jurisdiction, and civil liability for clinical acts performed in different countries. These tensions are evident in the European Union, where, despite progress on the European Health Data Space (EHDS), debates persist regarding informed consent, secondary use of data, and the harmonization of clinical quality standards (Council of the EU, 2025; Campiglio, 2024). In Latin America, regulatory heterogeneity further limits the possibility of establishing robust, long-term international agreements, hindering the expansion of university programs in community telemedicine.

Added to these factors are social and equity challenges, perhaps the most sensitive issues in the practice of community telemedicine. The digital divide remains an obstacle: not all communities have access to quality internet, adequate devices, or sufficient digital skills to benefit from the services offered. As Badr, Motulsky & Denis (2024) point out, digital technologies can act as a driver of inclusion or, conversely, widen inequalities if they are not designed with a social justice focus. Likewise, cultural and linguistic differences affect the effectiveness of teleconsultation programs and influence community acceptance, requiring the implementation of adaptive strategies sensitive to diversity.

Finally, these three levels of challenges are closely interconnected. Technological limitations require regulatory frameworks that establish common standards, while social policies must ensure that vulnerable populations are not excluded from access to digital health. Ultimately, the success of the internationalization of university telemedicine depends on articulating comprehensive solutions that address these challenges simultaneously, under collaborative governance frameworks in which universities, companies, governments, and communities converge.

Methodologically, this chapter was developed based on a systematic review of the scientific literature, with the aim of identifying, analyzing, and comparing documented experiences regarding the internationalization of university health services and, in particular, the export of community telemedicine models. The choice of this methodology is based on its ability to synthesize existing knowledge using transparent, reproducible, and critical procedures, thereby enabling the construction of a robust evidence base to guide both institutional practice and public policy formulation (Rouleau et al., 2023; Sabiston et al., 2022; Pollock et al., 2024).

The search strategy was designed in accordance with the guidelines of the PRISMA 2020 statement, which ensures the traceability of the process and methodological quality. High-visibility, internationally renowned databases were used, including Scopus, Web of Science, and PubMed/MEDLINE, prioritizing literature published between 2018 and 2025 to ensure currency and relevance. The keywords included combinations in English and Spanish of the terms: telemedicine, community telehealth, university health services, internationalization, cross-border health, digital health, and academic health centers, along with Boolean operators AND, OR, and language filters (English and Spanish).

The selection process initially yielded 2,154 records in the databases consulted. After screening titles and abstracts, 386 articles were retained, of which 97 were analyzed in full text. Finally, 42 met the inclusion criteria and were considered for the qualitative synthesis. For systematic reviews, the AMSTAR-2 scale was applied, classifying 65% as moderate quality and 35% as high quality. For original studies, the CASP tool identified a predominance of qualitative methodologies (54%) over quantitative ones (46%).

The inclusion criteria considered original articles, systematic reviews, technical reports from international organizations, and case studies documented in journals indexed in Scopus or WoS that addressed university telemedicine, its community implementation, and/or service internationalization processes. Editorials, press releases, unreviewed gray literature, and documents without access to the full text were excluded. The selection of articles was conducted in three stages: first, screening of titles and abstracts; second, evaluation of full-text articles; and third, application of the AMSTAR-2 scale to assess methodological quality in the case of systematic reviews, and the CASP tool for original qualitative or quantitative articles.

Additionally, a selection of representative cases from universities that have exported community telemedicine models was conducted, prioritizing experiences from Latin America, Europe, and Asia. The inclusion of these cases was based on a theoretical maximum variation sampling approach, with the aim of illustrating different regulatory, technological, and sociocultural contexts. Among the criteria considered were: published evidence on clinical or social outcomes, the existence of university-industry partnerships, and the international or cross-border dimension of the programs.

The comparative analysis was conducted using qualitative synthesis techniques, grouping the findings into thematic categories that allowed for the identification of common patterns, relevant innovations, and successful and internationalization strategies. Additionally, a critical literature analysis approach was employed, considering not only reported effectiveness but also methodological biases, limitations noted by the authors, and the transferability of the findings to other contexts.

Finally, to ensure validity and reliability, source triangulation strategies (scientific literature, institutional reports, and international regulatory documents) were applied, as well as academic peer validation through review of the methodological protocol prior to data extraction and synthesis. This level of rigor ensures that the results presented reflect a robust, critical, and academically sound interpretation of the processes of internationalization of university health services through community telemedicine.

Models of University Telemedicine Internationalization

The literature review and comparative case analysis identified three predominant models of university telemedicine export, which reflect different strategies through which higher education institutions have scaled their community programs to international settings (Table 1). The first is the academic care model, characterized by the deployment of community care services as an extension of health sciences education (Mahdavi, Mahdavi & Moghbeli, 2025). In this framework, teaching hospitals and community clinics function as living learning environments where students and faculty participate in teleconsultations and remote patient monitoring. This approach, in addition to addressing social needs, contributes to the

development of digital competencies and has been documented at universities in Latin America and Asia (Ahmed et al., 2025; Keelara, Sutherland & Almyranti, 2025). A representative case is the University of São Paulo (Brazil), where the Telessaúde Brasil Redes program enabled students and faculty to participate in more than 45,000 annual teleconsultations, reducing unnecessary referrals to tertiary care hospitals by 28%.

The second model involves technology transfer, in which universities develop digital solutions such as telemedicine platforms, mobile apps for monitoring chronic diseases, or artificial intelligence systems for clinical triage, which are subsequently transferred to the private sector through licensing or the creation of spin-offs (Haleem et al., 2021; Shaffer et al., 2023). This model positions universities not only as service providers but also as innovation incubators capable of transforming knowledge into exportable products with global impact. An example of this model is the Polytechnic University of Catalonia (Spain), which transferred the Doctor Online platform to a European consortium, reaching more than 120,000 users in three countries, with evidence of cost reductions in primary care (Haleem et al., 2021; Kapitan et al., 2025).

The third model is that of multilateral cooperation, in which universities, companies, and governments join international consortia to implement large-scale digital health projects (Lewerenz, Martins & Martins, 2024). This model, based on shared governance, allows for overcoming the limitations of each actor: universities contribute social legitimacy and knowledge, companies contribute technology and innovation, and governments contribute regulatory frameworks and funding. Seoul National University (South Korea) participates in a consortium with Japan and the WHO for the telemonitoring of chronic diseases in border communities, which has enabled the standardization of interoperability and informed consent protocols; is an example of how this type of cooperation lays the groundwork for cross-border digital ecosystems in which universities actively participate in community telemedicine projects (European Commission, 2025; Council of the EU, 2025).

The implementation and export of these models, however, face cross-cutting challenges that must be addressed in a comprehensive manner. In the technological sphere, difficulties persist regarding interoperability, the digital divide in marginalized communities, and the need to strengthen cybersecurity to protect sensitive data (Martins et al., 2025). On the regulatory front, challenges include international regulatory differences, the lack of standardization of professional licenses, and uncertainties regarding legal liability for medical procedures performed remotely (Campiglio, 2024). Financially, the central challenge is sustainability, as many programs depend on public funds or international cooperation and lack scalable business models. Academically, there is a need to integrate global curricula in digital health that include training in technology, international regulation, and intercultural communication (Badr, Motulsky & Denis, 2024; Cervantes et al., 2025).

Taken together, the models and challenges analyzed show that the internationalization of university telemedicine is not a linear process, but a complex phenomenon in which academic, technological, business, and regulatory dimensions converge. The ability to articulate these elements coherently will determine not only the viability of the programs, but also their social legitimacy and their impact on reducing health inequities globally.

Table 1. Models for the export of university telemedicine and main challenges

Model	*Characteristics*	*Advantages*	*Limitations/Challenges*
Academic-clinical	Expands training programs through teaching hospitals and community clinics that offer teleconsultations and remote monitoring. Active participation of students and faculty.	Training in digital skills; direct social impact; academic legitimacy in communities.	Dependence on university infrastructure; limited international scalability; need for clear regulatory frameworks.
Technology Transfer	Development of platforms and applications in university laboratories; subsequent licensing or creation of spin-offs with potential for global expansion.	Generates applied innovation; fosters academic entrepreneurship; access to external funding.	Risk of commercialization; intellectual property disputes; high initial investment for scaling.
Multilateral cooperation	Consortia comprising universities, companies, and governments; cross-border projects with shared governance and mixed funding.	Synergy of resources; social and scientific legitimacy; international scalability with in regulatory support.	Complexity in inter-institutional coordination; regulatory differences; long-term institutional sustainability subject to political agreements.

The results confirm the relevance of Higher Education Institutions (HEIs) in their role as central actors in social innovation in digital health (Badr, Motulsky & Denis, 2024). Unlike other actors in the ecosystem, universities integrate academic, healthcare, and research functions with a social mission, making them ideal spaces for experimentation and the transfer of community telemedicine models (Kane, 2024). According to Martins et al. (2025), university digital health programs function as hybrid platforms for training and innovation, capable of generating social impact and scientific evidence applicable in diverse contexts. In this way, HEIs not only fulfill their educational mission but also establish themselves as agents of social change and applied innovation (Ahmed et al., 2025).

The implications of these findings transcend the academic realm and extend to university internationalization policies and academic diplomacy. The export of community telemedicine models constitutes a new form of internationalization that positions universities as service providers with transnational reach (Keelara, Sutherland & Almyranti, 2025). This perspective strengthens academic and health diplomacy by consolidating strategic alliances and positioning countries as responsible actors in the construction of global public goods (World Health Organization, 2024). Furthermore, university-business-government collaboration networks generate more resilient and equitable digital ecosystems, fostering trust and facilitating the adoption of innovations (Kapitan et al., 2025; Lewerenz, Martins & Martins, 2024).

In this way, community telemedicine export models can function as a mechanism of academic soft power, particularly in developing countries. According to the OECD (2023), universities that internationalize digital health services project innovation and strengthen international legitimacy by contributing to the reduction of health inequalities. This influence is reflected in a greater presence in multilateral forums and in attracting international cooperation. As Al-Alawy & Moonesar (2023) note, university telemedicine has unique potential for social legitimization by integrating digital equity and justice with academic and business strategies, becoming a form of academic diplomacy that combines knowledge transfer with service provision and reinforces the international influence of the countries that promote it (Zhang et al., 2023).

The analysis reveals structural limitations in the internationalization of university telemedicine. Technologically, infrastructure heterogeneity and low interoperability persist even in advanced regions (Duda et al., 2022; Monsen, Heermann & Dunn-Lopez, 2023; Kapitan et al., 2025). Regulatory-wise, regulatory fragmentation creates uncertainty regarding licensing and civil liability (Campiglio, 2024; Lewerenz, Martins & Martins, 2024). Socially, digital divides threaten to perpetuate inequalities without policies promoting digital literacy and inclusion (Badr, Motulsky & Denis, 2024; Kepper et al., 2024). Financially and politically, dependence on subsidies limits sustainability, requiring hybrid models that combine public, private, and multilateral resources (Shaffer et al., 2023; Keelara, Sutherland & Almyranti, 2025).

While the models described offer comparative advantages, there are critical perspectives that must be considered. Some authors warn that the commodification of digital health can create technological dependence on the Global North, limiting the autonomy of developing countries (Al-Alawy & Moonesar, 2023). In ethical terms, digital justice and cross-border data protection are central to ensuring social trust and legitimacy. Informed consent in multicultural contexts and the mitigation of biases in artificial intelligence algorithms are areas where regulation and clinical practice must evolve in tandem.

Conclusions

The analysis conducted reveals that university-based community telemedicine transcends its role as a technological tool to become a strategic mechanism for social and academic transformation. By integrating care, training, and innovation, universities generate added value that is difficult for other actors in the healthcare system to replicate, positioning these institutions as catalysts for structural changes in the delivery of digital services.

Beyond the immediate benefits in coverage and access, the export of university telemedicine models represents an exercise in building trust among communities, governments, and businesses. These programs not only provide clinical solutions but also consolidate social capital by fostering community cohesion and institutional trust—elements essential to ensuring the sustainability of any innovation in digital health.

Likewise, the study shows that the internationalization of university telemedicine constitutes a fertile ground for the generation of applied knowledge and for the training of professionals with global competencies. The fact that students and faculty participate in transnational projects not only strengthens the quality of education but also prepares future health professionals to work in increasingly interconnected and multicultural environments.

Finally, this study proposes the following areas for future research: (1) conducting longitudinal studies on the impact on equity and the reduction of digital divides; (2) designing financial metrics for public-private hybrid models; and (3) exploring the integration of global competencies in digital health into health sciences curricula. These actions will help consolidate university telemedicine as a sustainable international public good.

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Academic internationalization in the improvement of community health programs

Sánchez Márquez, Wilberto
Autonomous University of Tamaulipas, Mexico wsanchez@docentes.uat.edu.mx
https://orcid.org/0000-0003-1078-5721
Guerra Cárdenas, José Eugenio
Autonomous University of Tamaulipas, Mexico jguerra@docentes.uat.edu.mx
https://orcid.org/0000-0001-9495-024X
Amador Alonso, Rosalino
Autonomous University of Tamaulipas, Mexico ramador@docentes.uat.edu.mx
https://orcid.org/0009-0000-2873-6405

Introduction

Academic internationalization has become one of the central pillars of university life in the 21st century. It is not merely a matter of promoting student and faculty mobility, but of building a network of inter-institutional relationships, global knowledge networks, and cooperation projects that directly impact teaching, research, and university outreach. Within this framework, higher education institutions have found in internationalization a means to respond to global challenges, strengthen their local capacities, and contribute to solving complex social and health problems.

In the field of community health, academic internationalization takes on special relevance. Vulnerable communities face infrastructure limitations, shortages of specialized human resources, and deep social inequalities that limit access to and the quality of health services. Against this backdrop, international university cooperation becomes a mechanism that facilitates the transfer of best practices, the circulation of technological innovations, and the development of human capital with an intercultural and interprofessional focus. Recent evidence indicates that international partnerships have driven telemedicine programs, culturally adapted vaccination campaigns, and community health education models, with positive impacts on access, prevention, and continuity of care (Teixeira, Ferreira, & Franco, 2022; Huynh, Kroh, & Schultz, 2024).

The COVID-19 pandemic further highlighted the importance of internationalization. The disruption of in-person mobility forced universities to explore new forms of cooperation, particularly through virtual internationalization. This enabled the continuation of courses, seminars, and research projects remotely, while also expanding public health training opportunities in communities previously marginalized from access to international cooperation (Lindberg, Salmi, & Torp, 2023). At the same time, the health emergency highlighted the fragility of some cooperation schemes, which are dependent on external funding or limited by technological gaps, reinforcing the need for more sustainable and equitable models (Morosini, Corte, & Dias, 2021).

In Latin America, academic internationalization in community health faces particular challenges and opportunities. On the one hand, structural inequalities in access to funding, technology, and infrastructure persist, in addition to asymmetries in the production and circulation of knowledge relative to institutions in the Global North. On the other hand, Latin American universities have a rich tradition of university outreach, territorial work, and

community projects that strengthen the relevance of international initiatives. The key lies in articulating global cooperation with these local experiences, so that internationalization does not reproduce vertical relationships, but rather generates horizontal synergies based on shared responsibility and social justice (Maringe & Foskett, 2021; Altbach & de Wit, 2021; Braun & Clarke, 2021).

The rationale for this chapter is grounded in the need to examine how academic internationalization contributes to improving community health programs in contexts marked by inequality and structural constraints. It is proposed that internationalization, when strategically planned, can expand the reach of programs, strengthen their sustainability, and ensure greater equity in health care. However, it is also recognized that the impact of these initiatives depends on multiple factors, including the governance of partnerships, community participation in program design, the cultural compatibility of interventions, and the long-term availability of resources.

These studies show that the success of partnerships depends on factors such as community participation in identifying needs , institutional capacity to integrate teaching, research, and outreach, corporate commitment beyond funding, and project sustainability. Obstacles have also been identified. Cai & Etzkowitz (2020) documented that community health organizations perceive risks related to sustainability, legal liability, regulatory compliance, and partner reliability. These barriers illustrate the complexity of university–business agreements and underscore the need for more robust collaborative designs.

The purpose of this chapter is to critically examine the role of academic internationalization in strengthening community health programs. First, it seeks to analyze the fundamental mechanisms through which international cooperation influences the improvement of these programs, considering processes such as knowledge transfer, academic mobility, interprofessional education, and technological innovation. Second, it aims to identify the results documented in recent literature regarding experiences implemented in different regions of the world, with a particular emphasis on Latin America, where conditions of inequality and structural limitations give distinctive characteristics to internationalization processes.

In summary, academic internationalization constitutes a strategic resource for strengthening community health programs, but its effectiveness depends on the capacity of higher education institutions to link global cooperation with local needs. This analysis seeks to offer a critical and proactive perspective that contributes to both academic discourse and institutional practice, in line with the Sustainable Development Goals and universities' ethical commitment to generating a positive impact in their communities.

Academic Internationalization

Academic internationalization is now a cross-cutting pillar of university policies. According to Knight (2020), this concept refers to the process of integrating an international and intercultural dimension into teaching, research, and outreach, with the aim of raising academic quality and preparing students for a globalized world. Initially, internationalization was understood as a phenomenon almost exclusively related to student mobility and the reception of international students. However, over the past decade, a more holistic vision has taken hold, encompassing elements such as multilateral cooperation, the development of joint research projects, the

creation of dual-degree programs, and the consolidation of international knowledge networks (Altbach & de Wit, 2021).

The evolution of the concept has been marked by three main phases. The first, characterized by an outward-looking approach, sought to send students and academics abroad to enhance their education (Wijnen-Meijer et al., 2023). The second phase incorporated "in-house" internationalization strategies, aimed at integrating global perspectives into the curriculum, assessment processes, and university life. Finally, the current stage is defined by comprehensive and cross-cutting internationalization, in which all university functions are permeated by international cooperation and oriented toward the fulfillment of global goals such as the Sustainable Development Goals (SDGs).

Among contemporary approaches, the following stand out: student and faculty mobility; bilateral and multilateral agreements; dual-degree programs that allow students to earn academic degrees recognized in two countries; participation in international research and training networks; and virtual internationalization or virtual exchange experiences (Casados, Cruz & González, 2025; Luong et al., 2025). The latter expanded rapidly in the wake of the COVID-19 pandemic, allowing thousands of students to access intercultural exchanges and global educational experiences without the need to travel physically (Lindberg, Salmi, & Torp, 2023). This modality, in addition to reducing costs, expanded opportunities for inclusion for students from regions with economic or geographic limitations, reinforcing its democratizing potential in higher education.

Community Health Programs

Community health programs constitute an essential strategy within contemporary health systems, especially in regions with high levels of social inequality and infrastructure limitations (Nkimbeng et al., 2021). They aim to improve the health conditions of specific populations through preventive, educational, and primary care interventions, with a territorial and participatory approach (Obi et al., 2024; Tereshchenko et al., 2024). Unlike hospital-based models focused on curative care, community health prioritizes the promotion of healthy lifestyles, the strengthening of local capacities, and the reduction of gaps in access to basic services (World Health Organization, 2021).

Among its key characteristics is its community-based approach, which ensures that actions are adapted to the cultural, social, and economic realities of each community. Similarly, active community participation is a cross-cutting principle: interventions are not designed top-down by institutions, but rather integrate the voices of beneficiaries into the planning, implementation, and evaluation of programs. This shared responsibility reinforces the legitimacy of the actions and ensures higher levels of long-term sustainability (Medina-Córdoba et al., 2024).

The core objectives of community health programs include improving access to health services, preventing communicable and chronic diseases, providing culturally relevant health education, and strengthening resilience in the face of health emergencies. Additionally, they seek to empower communities by training health promoters, implementing local campaigns, and creating social support networks that contribute to collective well-being (Theobald et al., 2023; Yuntian & Jia, 2023).

In this context, universities play a strategic role. Their contribution is not limited to training professionals but extends to the design, implementation, and evaluation of community interventions. Through health brigades, university extension programs, supervised professional internships, and applied research, higher education institutions are able to translate scientific knowledge into concrete actions that directly impact the most vulnerable populations (Sulosaari et al., 2024). This work also strengthens student learning, as students acquire key intercultural and interprofessional competencies to address the challenges of health systems.

The evaluative role of universities is equally relevant. Thanks to their ability to generate rigorous empirical evidence, they help measure the actual impact of programs, ensuring transparency and the continuous improvement of interventions. In this way, university-led community health programs transcend the care dimension to become true mechanisms of social justice, aligned with the Sustainable Development Goals, particularly SDG 3: Good Health and Well-being (United Nations, 2020).

Convergence between internationalization and community health

The convergence between academic internationalization and community health programs constitutes a strategic space where global capabilities are aligned with local needs (Aryal et al., 2023). This convergence is not limited to the exchange of students and faculty but involves the creation of transnational cooperation networks, the circulation of scientific knowledge, and the cultural adaptation of health innovations to address specific realities (Bodinayake et al., 2025). In this regard, theoretical frameworks such as the Triple Helix, which explains the interaction between universities, industry, and government, have evolved into "multiple helix" models, where communities and civil society are recognized as key actors in generating sustainable health solutions (Cai & Etzkowitz, 2020).

Recent literature indicates that academic internationalization improves community health programs through various mechanisms. First, the transfer of knowledge and technologies enables populations with limited infrastructure to access innovations such as low-cost rapid diagnostics, digital monitoring systems, and telemedicine programs (Teixeira, Ferreira, & Franco, 2022; Villani, Rasmussen & Grimaldi, 2022). These advances, when culturally adapted, strengthen the effectiveness of interventions and increase social acceptance of the programs.

Second, internationalization promotes intercultural and interprofessional training for students and health professionals. By participating in projects and internships with foreign universities, future professionals develop competencies in cultural diversity, collaborative work, and community sensitivity—key elements for serving diverse populations in local and global contexts (Medina-Córdoba et al., 2024; Sulosaari et al., 2024). This learning not only enriches their academic profile but also contributes to the consolidation of multidisciplinary teams capable of addressing complex health problems with a comprehensive approach.

Third, convergence fosters the creation of international networks for responding to health emergencies. During the COVID-19 pandemic, global cooperation among universities made it possible to sustain community education programs, generate real-time scientific evidence, and design transnationally coordinated public health interventions (Morosini, Corte, & Dias, 2021; Lindberg, Salmi, & Torp, 2023). These experiences demonstrated that internationalization can serve as a catalyst for health resilience and equity in access to services.

From an ethical perspective, this convergence must be understood as part of a commitment to global social justice and health equity. Altbach and de Wit (2021) emphasize that internationalization cannot be reduced to indicators of mobility or university rankings— —but must be oriented toward generating collective and sustainable impacts. In Latin America, this approach is particularly relevant: by linking international cooperation with community programs, universities ensure that global knowledge translates into relevant solutions for historically marginalized populations (Amisi et al., 2023). However, this process requires horizontal relationships between international and local partners, avoiding asymmetrical practices and promoting shared responsibility in the production and application of knowledge (Maringe & Foskett, 2021).

In summary, the convergence of academic internationalization and community health constitutes a space for social and health innovation where technology transfer, talent development, and multilateral cooperation are aligned with principles of justice and equity. This approach not only strengthens existing programs but also lays the groundwork for building more resilient and sustainable health systems capable of responding to the global and regional challenges of the 21st century.

This chapter is based on a descriptive and analytical qualitative approach, aimed at understanding how academic internationalization influences the improvement of community health programs. The choice of this methodological perspective is justified by the need to explore complex social and educational phenomena, which manifest themselves in dynamic contexts and lack defined boundaries between the object of study and the environment in which they unfold. Unlike quantitative approaches, which prioritize the measurement of variables and the generation of statistical inferences, the qualitative methodology employed in this chapter allows for an interpretive approach to experiences of international cooperation, identifying patterns, facilitating factors, and limitations that shape their impact at the community level.

The design adopted is that of a multiple-case study. This choice stems from the desirability of analyzing diverse experiences, situated in different geographical and sociocultural contexts, with the aim of drawing lessons that are transferable beyond each particular situation. As Yin (2018) argues, multiple-case analysis allows for the generation of robust analytical inferences, as it facilitates the comparison of contexts, the recognition of similarities and differences, and the identification of critical variables that determine the success or failure of interventions. The methodology employed, therefore, was not limited to describing isolated examples but sought to articulate the experiences within a comparative framework to offer conclusions with greater explanatory power.

The selection of cases was carried out according to clearly defined criteria. Priority was given to community health initiatives implemented in the last five years to ensure the information was up-to-date. Furthermore, only programs in which higher education institutions actively participated—whether through teaching, research, or university outreach activities—were included. Another fundamental criterion was the existence of an explicit internationalization component, manifested in agreements, international networks, bilateral cooperation, or multilateral projects (Sumathipala et al., 2025). Finally, each case was required to have verifiable documentation, either in articles published in journals indexed in Scopus, Web of Science, or EBSCO, or in reports prepared by internationally recognized organizations.

Data collection was based on a strategy of triangulating sources designed to ensure the validity and reliability of the findings. Initially, a systematic review of academic literature published in the last five years was conducted, which helped identify trends, empirical findings, and conceptual frameworks related to academic internationalization and community health. Subsequently, institutional documents produced by universities in Latin America, Europe, and the United States were consulted, providing detailed information on agreements, university outreach reports, and the results of community intervention programs. Finally, external evaluation and systematization reports on best practices published by international university cooperation networks were included, offering a complementary perspective and reducing the risk of bias stemming from institutional sources.

The information was analyzed through a thematic coding process that combined pre-established categories with the identification of emerging patterns. The initial categories were defined based on the chapter's conceptual framework, including dimensions such as internationalization mechanisms, characteristics of community health programs, facilitating factors, barriers, and outcomes. As the case review progressed, an open coding process was carried out, which allowed for the identification of themes not initially anticipated but relevant to the interpretation of the phenomenon. Once the information was organized, comparative matrices were constructed to facilitate the comparison of cases based on the mechanisms applied, the achievements attained, and the limitations encountered. This procedure provided a comprehensive and nuanced view of how academic internationalization contributes to community health programs in different settings.

It is important to note that, although the study is based exclusively on secondary sources and did not involve direct contact with research subjects, fundamental ethical principles related to academic integrity were respected. All sources consulted were rigorously cited in accordance with the guidelines of the American Psychological Association, 7th edition (APA 7th), and priority was given to the use of scientific literature validated in recognized international databases. Likewise, the responsible use of information was ensured, acknowledging the contributions of each author and avoiding any form of plagiarism or misappropriation.

In summary, the methodology used allows for a critical and systematic analysis of the selected cases, ensuring that the chapter's conclusions are grounded in reliable empirical evidence and solid conceptual frameworks. The combination of literature review, triangulation of sources, and thematic analysis lends robustness to the study, while offering a contextualized and coherent approach to the inherent complexity of academic internationalization processes and their impact on community health.

Impact of Academic Internationalization on Community Health Programs

Analysis of the selected cases showed that academic internationalization contributes significantly to the improvement of community health programs by enhancing technological, educational, organizational, and scientific dimensions. The findings indicate that these contributions do not operate in isolation but are articulated within cooperative dynamics that strengthen the programs' capacity to respond to contexts of social vulnerability. One of the most relevant results was the transfer of methodological and technological innovations, particularly through agreements with foreign universities that facilitated the incorporation of telemedicine tools, low-cost rapid diagnostics, and digital monitoring systems, expanding access in rural communities and reducing gaps in care (Rivera García et al., 2025).

Interprofessional and intercultural training emerged as another key contribution. Academic mobility and virtual exchange programs created spaces for shared learning where students and professionals developed competencies to work in culturally diverse contexts and in multidisciplinary teams. This strengthened the relevance and acceptance of community interventions, especially among indigenous and rural populations (Van de Water et al., 2024; Emoto et al., 2025).

The programs also demonstrated greater resilience during crisis situations, particularly during the COVID-19 pandemic, thanks to the consolidation of international response networks. Global cooperation made it possible to maintain educational and preventive campaigns in a virtual format, ensuring continuity during lockdowns and reinforcing the adaptive capacity of community systems.

To summarize these findings, Table 1 presents the main impacts of academic internationalization on community health programs, organized by analytical dimensions.

Table 1. Impacts of academic internationalization on community health programs

Analytical dimension	*Observed results*	*Relevant examples*
Technology transfer	Introduction of rapid diagnostics, telemedicine, and remote monitoring systems	Agreements between Latin American and European/U.S. universities
Interprofessional and intercultural training	Development of skills in cultural diversity and collaborative work	Mobility and virtual exchange programs with internships in rural communities
Emergency response networks	Continuation of educational and preventive programs during the COVID-19 pandemic	Global cooperation that sustained community education in a virtual format
Sustainability	Increased funding and monitoring mechanisms for internationally supported programs	External evaluations and university outreach reports
Scientific production and dissemination	Increase in publications and systematization of replicable best practices	Publications in indexed journals and reports from multilateral organizations

Regarding sustainability, it was observed that programs supported by international agreements tended to have greater financial resources and more robust monitoring structures. However, limitations were also identified, such as excessive dependence on external funding, which in some cases jeopardized the continuity of interventions once international support ended.

The analysis also identified a set of factors that facilitated or limited the success of the programs. Among the most common facilitators were the existence of university cooperation offices with specialized staff, curricular compatibility for joint programs, the use of digital

technologies, and access to international funding. Conversely, barriers identified included institutional bureaucracy, a lack of flexibility in curricula, the digital divide in rural communities, dependence on external funding, and low social ownership in projects designed with minimal community participation.

Table 2 summarizes these facilitators and barriers, offering a comparative overview of the factors that influence the effectiveness of academic internationalization in the field of community health.

Table 2. *Facilitators and barriers to academic internationalization in community health programs*

Dimension	*Facilitators*	*Barriers*
Institutional	Cooperation offices with specialized staff; clear IP protocols.	Weaknesses in administrative management; excessive bureaucracy
Academic	Curricular compatibility and dual-degree programs; virtual mobility.	Lack of flexibility in curricula; limited recognition of academic credits
Technological	Use of digital platforms and telemedicine; open-source software exchange	Digital divide in rural communities; insufficient infrastructure for connectivity
Financial	Access to international funds and co-financing schemes	Excessive dependence on external resources; discontinuity upon the conclusion of financial support
Community	Involvement of local leaders in the design of interventions	Mistrust of external actors; lack of social ownership of projects
Scientific	Production of validated evidence in indexed journals; global research networks	Low capacity for systematization in local contexts; limited international visibility

Overall, the results indicate that academic internationalization serves as a driver of innovation and sustainability in community health programs. However, its actual impact depends on how partnerships are managed, the inclusion of communities in the design of interventions, and the ability to align international resources with local strengths.

The findings of this chapter allow for critical reflection on how academic internationalization contributes to strengthening community health programs, but they also highlight tensions and dilemmas that must be considered. First, internationalization should not be understood solely as a vehicle for the un transfer of technology and funding, but as a complex process that redefines power relations and the dynamics of knowledge production. While universities in the Global North contribute resources and methodologies, institutions in the Global South—

and particularly those in Latin America—possess invaluable capital in the form of contextual knowledge and cultural adaptability. The asymmetry between these actors can become a limitation if horizontal governance mechanisms are not established to ensure shared responsibility in the design, implementation, and evaluation of interventions.

From this perspective, academic internationalization must shift from being a strategy centered on competitiveness and institutional positioning toward a model of cooperation with a social purpose. Altbach and de Wit (2021) have already warned that internationalization, by focusing on rankings and mobility, runs the risk of becoming an end in itself. In the field of community health, this bias would be particularly problematic, as it would render local needs invisible and undermine the value of community participation. Therefore, it is essential that Latin American universities design internationalization agendas that incorporate social impact indicators, not just academic ones.

Another critical issue is sustainability. Although internationalization has facilitated the implementation of innovative programs, excessive dependence on external resources poses significant risks. The discontinuity of international funding, coupled with the absence of local consolidation plans, can lead to short-lived projects that fail once the agreements expire. This phenomenon not only erodes community trust but also perpetuates dynamics of dependency that limit the autonomous development of local institutions. Consequently, international agreements must include clauses for capacity transfer, progressive co-financing schemes, and explicit commitments to institutional continuity.

Likewise, it is necessary to critically examine the technological dimension of internationalization. Although innovations in telemedicine and digital platforms have demonstrated high potential, their effectiveness depends on closing structural gaps in connectivity and digital literacy. Recent literature emphasizes that technological solutions, if not accompanied by investment in infrastructure and community training, risk reinforcing existing inequalities (Teixeira, Ferreira, & Franco, 2022). Hence, technology transfer must be conceived not as a unilateral act, but as a two-way process in which the community appropriates, adapts, and transforms the tools received.

Finally, the analysis invites reflection on the ethical dimension of internationalization as applied to community health. Global social justice and health equity must become guiding principles, beyond traditional metrics of mobility, publications, or funding. In Latin America, where health systems face historical limitations and deep inequalities, internationalization makes sense only if it is aimed at strengthening local capacities and ensuring equitable access to care. This implies a paradigm shift: from internationalization as a strategy for academic prestige to internationalization as a tool for social transformation.

In short, the discussion shows that academic internationalization has considerable potential to impact community health, but its benefits are neither automatic nor linear. Its effectiveness depends on how partnerships are managed, on the capacity of local actors to negotiate on equitable terms, and on the willingness of universities and international organizations to direct cooperation toward social ends rather than merely competitive ones. Only under these conditions will internationalization be able to contribute to building more inclusive, resilient, and sustainable community health systems.

Conclusions

The analysis conducted establishes that academic internationalization constitutes a strategic tool for strengthening community health programs, although its impact depends on the management of partnerships and institutional capacity to integrate international resources with local needs.

It is recognized that internationalization should not be conceived as an end aimed at prestige or academic competitiveness, but rather as a means to promote health equity and social justice. The value of partnerships lies in their capacity to generate concrete transformations in community life through cooperation processes that go beyond student mobility or academic productivity metrics.

It is also concluded that community participation is essential to ensure the relevance and sustainability of programs. When communities are integrated as co-responsible actors in the design and implementation of interventions, the results are more durable and better suited to the cultural and social realities of each context.

Likewise, it is observed that sustainability remains a challenge. Although programs driven by international cooperation achieve short-term progress, there is a risk of excessive dependence on external resources if mechanisms for local consolidation are not established. Internationalization takes on true meaning when it is oriented toward strengthening institutional and community capacities, fostering the progressive autonomy of initiatives.

Finally, it is recognized that Latin America faces the challenge of reaping the benefits of internationalization without abandoning the development of its own agendas. The region's cultural and social richness must serve as a starting point for establishing more equitable and horizontal cooperative relationships, so that the " " internationalization becomes an instrument of social transformation at the service of communities.

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Communication Strategies for Strengthening University-Industry Partnerships in the Context of Internationalization

Hernández Rangel, Ma. de Jesús
Autonomous University of Tamaulipas, Mexico
maria.hernandez.rangel25@gmail.com https://orcid.org/0000-0001-7650-4502

Introduction

The incorporation of communication strategies for university-business partnerships in internationalization contexts is significant due to the information disseminated in the creation of visibility through structured actions designed to convey specific messages. Internationalization processes in public and private universities and in companies have become a strategic imperative in the 21st century, driven by economic globalization and digital transformation, which demand information, adaptive, and competitive capabilities in multicultural and technologically advanced environments (Díaz-Andrade and Urquhart, 2021). Universities face the challenge of training professionals with global competencies, while companies seek partnerships that enhance their innovation and international expansion; this creates a need to find new ways to facilitate their effective collaboration, however, a gap persists in understanding how communication strategies can mediate this process, particularly in Latin American contexts where institutional communication still lacks systematic approaches oriented toward mutual and shared strengthening (Castillo and Montes de Oca, 2021).

Internationalization processes in universities are promoted through the development of mobility programs and academic partnerships; however, these lack communication strategies to position their educational offerings to global companies, while the latter invest in expansion without fully capitalizing on university knowledge. Recent studies show that ineffective communication generates resistance to cultural change, underutilization of international networks, and technological gaps between universities and companies, which limits their joint competitive capacity. This problem is exacerbated in contexts of asymmetric internationalization, where emerging universities struggle to highlight their strategic role in the global business value chain.

Global companies exhibit characteristics such as geographic dispersion, cultural diversity, and technological heterogeneity, all of which increase the complexity of internal communication. Recent studies indicate that organizations with weak or fragmented communication networks exhibit greater internal digital divides and difficulties in standardizing the use of technological tools (Yu Zhao, et al., 2021); therefore, designing communication strategies within networks that articulate discourses, channels, and training processes becomes a key strategic requirement.

From the perspective of strategic communication, this book chapter provides a theoretical-practical framework that positions communication strategies as catalysts for mutual university-business strengthening, advancing the development of communication programs through the creation of university narratives using integrated digital channels and the management of relational networks to improve international visibility and foster shared competencies in

innovation and technology (Andrade et al., 2025). This approach contributes to the integration of communication as a mediating variable in internationalization processes and in the practical design of sustainable partnerships

The objective of this research was to analyze communication strategies for strengthening university-industry partnerships in internationalization contexts. Specifically, it addressed the context of internationalization and the process of organizational technological strengthening; the conceptualization of communication strategies, which goes beyond traditional descriptive analysis, proposing actionable models for global competitiveness.

A qualitative research design was employed as the methodology. Interviews were conducted with 120 employees from various public and private universities in Latin America, including the Autonomous University of Tamaulipas (Mexico), the Technological Institute of Matamoros (Mexico), the University of Northeast Mexico, the University of the Atlantic (Mexico), the University of Guadalajara (Mexico), the University of Zulia (Venezuela), and the Luis Vargas Torres Technical University in Esmeraldas (Ecuador).

Table 1. *Public and private universities in Latin America*

University	Country	Type
Autonomous University of Tamaulipas	Mexico	Public
Matamoros Institute of Technology, Mexico,	Mexico	Public
Northeastern University of Mexico	Mexico	Private
University of the Atlantic	Mexico	Private
University of Guadalajara	Mexico	Public
University of Zulia	Venezuela	Public
Luis Vargas Torres Technical University - Esmeraldas, Ecuador	Ecuador	Public

Twelve multinational companies were selected from the services, technology, and industry sectors, based on the following selection criteria: territorial, meaning their presence in Tamaulipas is confirmed. Sector classification was also used; two companies were selected per sector—such as services, technology, and industry—aligning them with their primary *service* activities (healthcare and logistics), *technology* activities (electronics and automotive*),* and *industrial* activities (manufacturing and petrochemicals), all of which operate in Mexico. Multinational status was identified as a final criterion; firms with foreign origins, global operations, and documented links with universities—such as technology transfer and dual training—were selected, as they are ideal for research on university-business communication in internationalization.

Table 2: *Multinational Companies, Service, Technology, and Industrial Sectors*

Company	Sector	Main location in Tamaulipas
Aptiv	Technology	Reynosa (Finsa Park)
LG	Technology	Reynosa
Flex Americas	Industry	Altamira (Petrochemical)
Mexichem (Orbia)	Industry	Altamira
Haemotronic	Services	Reynosa (medical technology)
Fresenius Medical Care	Services	Reynosa

Sony	Technology	New Laredo
Spellman High Voltage	Technology	Matamoros (Finsa)
Merit Automotive	Industry	Matamoros
Trico Products	Industry	Matamoros (Finsa)
Medline Industries	Services	Nuevo Laredo (recent expansion)
SVAM International	Services	Victoria

Eight semi-structured interviews were conducted with communication managers and digital transformation leaders at universities. The data were analyzed using descriptive statistics and thematic content analysis, supported by NVivo software.

Context of internationalization and the process of organizational technological strengthening

Internationalization has established itself as a potential strategic pillar for universities and companies in an interconnected world, where academic mobility, transnational partnerships, and integration into global value chains define institutional competitiveness. In Latin America, this process faces challenges such as technological asymmetry and limited university-business linkages, which constrain knowledge transfer to international markets (Ulloa De la Cruz et al., 2026); recent studies highlight that institutions with advanced internationalization strategies achieve greater global visibility and the ability to attract R&D investment, positioning themselves as key nodes in regional innovation ecosystems (Solórzano and Bravo, 2023).

The process of organizational technological strengthening involves the systematic integration of digital competencies into institutional processes, ranging from knowledge management to the adoption of Industry 4.0 tools. In universities, this translates into curricular transformation toward hybrid models and the development of joint innovation labs with companies, while business organizations prioritize the reskilling of their human capital to compete in digitized environments (García-Valcárcel et al., 2017). The convergence of technological training and strategic management emerges as a catalyst, enabling both entities to optimize their resilience in the face of global disruptions such as artificial intelligence and automation.

In 2026, the current context reveals that technological internationalization demands university-business partnerships that go beyond traditional training, incorporating technology watch and competitive intelligence as standard practices. Research confirms that the Triple Helix— —enhances innovation when managed through collaborative digital platforms, reducing access gaps in emerging regions (Palomares et al., 2026); however, obstacles persist, such as cultural resistance to change and the lack of unified metrics to assess joint technological impact, which calls for integrated communication strategies.

The current synergy between universities and global companies takes shape in cross-border innovation hubs; which are organizations operating in multiple countries that channel their R&D, partnerships, and business activities through hubs located in strategic regions where actors from different countries and jurisdictions converge. These hubs are designed to facilitate interaction among entrepreneurs, companies, universities, government institutions, and technology programs, with internationalization serving as an enabler of mutual strengthening. Several Latin American authors emphasize that shared technology watch strengthens

organizational culture, empowering leaders to align digital competencies with sustainable development goals (Solórzano and Bravo, 2023); this process not only enhances graduate employability and business productivity but also positions Latin America as a key player in the global knowledge economy.

In summary, the contemporary synergy between universities and global companies takes shape in cross-border innovation hubs and collaborative technology programs, where internationalization acts as a catalyst for mutual strengthening between both actors. This strategic alliance facilitates the two-way transfer of knowledge, integrating shared laboratories, strategic programs for the co-creation of products and services, and research, development, and innovation (R&D&I) networks that transcend geographical and disciplinary boundaries.

Communication strategies and specific contributions for the 21st century

Communication strategies represent planned organizational mechanisms that go beyond the mere transmission of information to become instruments of symbolic power and identity construction, aligning with institutional discourses aimed at positioning and controlling relationships from a position of authority. Dávila-Lorenzo and Saladrigas-Medina (2020) critique this instrumental conception by demonstrating that successful communication strategies emerge from emergent dialogic processes rather than predetermined linear plans, challenging the traditional planner-executor dichotomy in favor of adaptive models that incorporate real-time contextual feedback (Peralta, 2022). In universities and global companies, this perspective reveals tensions between the discursive homogenization required by internationalization and the preservation of distinct local identities that call for institutional redesign.

The Latin American approach further problematizes this definition by noting that communication strategies in emerging contexts— —frequently function as compensatory mechanisms for structural asymmetries rather than as autonomous enablers of development that, through the role of authority, manage to organize into norms and rules. Conforti and Endere (2012) argue that in Latin America, where digital, image, and cultural divides persist, communication strategies tend to reproduce traditional logics of knowledge when they prioritize global narratives over endogenous discourses, generating organizational resistance and displacing social values that limit their transformative effectiveness; this structural critique necessitates reformulating communication strategies not as ends in themselves, but as contextualized mediators that must negotiate power, culture, and technology in multidimensional internationalization scenarios.

In the context of communication strategies, we have:

a) Internal digital communication: another way of understanding

This communication integrates channels, frequency, and message clarity, where the university-business partnership must design digital communication architectures that incorporate collaboration, business chats, and training platforms within learning management system (LMS) environments to organize and manage online information in a clear and coherent manner. Communication should not be one-way but must incorporate feedback channels, forums, and periodic surveys to identify digital gaps in real time (Navarro et al., 2025). In this sense, technology enhances communication by digitizing information into large databases to transmit it with balance and social purpose, which requires organized structures and personnel to systematize it and address complexities in an era of high uncertainty.

b) Strategic Internationalization Communication: Visibility, Partnerships, and Global Institutional Brand

Strategic internationalization communication is defined as the systematic set of discursive and relational actions designed to maximize global visibility, consolidate transnational partnerships, and build a global and competitive university-business brand in multicultural settings (Paredes et al., 2024). Three interconnected dimensions operate within this strategic communication, as detailed below: reputational positioning through coherent institutional narratives, management of international stakeholders via integrated digital platforms, and the projection of an organizational identity that aligns local values with global standards of excellence.

Global institutional visibility

Visibility is achieved through academic, scientific, and business content marketing strategies, as evidenced by bilingual publications, scientific indexes, international webinars— , among others—and institutional SEO that integrates and positions the university-business partnership in global search engines to unify messaging, index content, and confidently enhance the university's and business's standing. Solórzano and Bravo (2023) demonstrate that universities with mature digital communication strategies increase their citations in QS and Times Higher Education rankings by 47%, evidencing a direct correlation between communicational visibility and the attraction of international talent, which reflects a comprehensive dissemination of information where companies play a strategic role.

Strategic Alliance Management

University-business partnerships require asymmetric relational communication that negotiates divergent interests through digitized memoranda of understanding and platforms, as well as specific collaborative governance mechanisms (Andrade et al., 2025). In his research, Tapia (2024) identifies relevant factors by noting that 68% of failed partnerships in Latin America are due to communication failures during the implementation phase, proposing intercultural communication protocols that integrate executive videoconferences, shared KPI dashboards, and quarterly executive reports; in this regard, universities and companies must identify key partners for the consolidation of strategies that disseminate information both internally within the management process and externally.

Building a Global Institutional Brand

The global brand is built through institutional storytelling that highlights cross-border success stories resulting from agreements or the management of scientific networks, and university-industry collaboration—such as joint R&D&I programs and projects, as well as so-called university spin-offs (companies arising from research conducted within a university) and patents shared between the university and the company based on their experience. Gómez and Pérez (2023) analyze how Spanish universities increased their global brand perception by 32% between 2018 and 2023 through country-brand strategies aligned with the Sustainable Development Goals, utilizing academic and branded influencers—these are important experiences that systematize approaches to building global institutional brands.

Findings on communication strategies for strengthening university-business partnerships:

The results showed that the complex university-business relationships are characterized by a context of internationalization with the growing presence of multinational companies in key sectors such as services, technology, and industry, which are crucial for countries' sustainable development, as well as by the growing need for both public and private universities—whether online or in-person—to align their academic and research offerings with global standards and networks that enable progress and new opportunities for development . A descriptive analysis of the responses from the 120 employees interviewed showed that internationalization is primarily perceived as an opportunity to access new markets, technologies, and forms of work organization; however, it is also considered a challenge in terms of continuously updating digital skills and mastering languages that are culturally relevant to internationalization processes (Garzón-González et al., 2025).

To strengthen organizational technology, the interviewees noted that the adoption of collaboration platforms, knowledge management systems, and automation tools has redefined the channels and timing of communication between universities and businesses, resulting in greater efficiency, transparency in the dissemination of public information, and a more effective approach to fields of study such as medicine, engineering, and the social sciences. However, with the emergence of tensions and the absence of formalization processes through standards and rules in communication, there are gaps in physical and digital infrastructure, as well as in training programs—especially regarding the integration of information systems between universities and businesses—which limit the full utilization of technologies for defining and executing jointly funded projects. Thus, the context of internationalization acts as a catalyst that compels a rethinking of communication processes and models of shared technological governance.

Several main categories of communication strategies emerged from the thematic content analysis of the interviews: a) the coordination of hybrid channels—that is, in-person and virtual ones, b) the development of ideas and discourses around shared narratives on innovation and social responsibility, c) relational management based on digital networks and platforms, and d) mechanisms for continuous feedback between strategic academic and business actors (Flores et al., 2025). These communication strategies take shape through means and practices such as joint communication committees, joint digital newsletters, online communities of practice, and specialized spokesperson programs for researchers and business executives to define common themes that address specific business challenges.

This study identifies the consolidation of strategic communication tailored to the 21st century; the university-business partnership extends beyond the occasional exchange of information to become a process of ongoing dialogue focused on innovation, employment, and social impact. Within this framework, communication ceases to be a mere instrumental tool and becomes an incremental intangible resource with the potential to build and adapt trust and foster mutual legitimacy in scenarios marked by digitalization, the speed and mass dissemination of information driven by technological transformations, and global competition for talent and human, material, and technological resources, among others.

The results, integrated from an analytical perspective, allow us to affirm that communication strategies constitute a determining factor for the strengthening of university-business ties in internationalization scenarios, to the extent that they facilitate the translation of global

objectives into concrete practices of local and regional cooperation. Qualitative data across the categories show that, where formal channels of strategic communication, clear protocols, and intensive use of collaborative technologies exist, employees perceive greater clarity in roles, a better understanding of shared goals, and a greater willingness to participate in joint projects involving research, dual training, and knowledge transfer to the business community in the regions where they are located.

Likewise, the study shows that universities with units specialized in strategic communication and digital transformation succeed in positioning themselves as preferred partners of multinational companies, not only due to their academic capacity but also because of their ability to manage complex relationships in multicultural and highly technology-driven environments (Illescas et al., 2025). This is reflected in the emergence of relational governance models in which decision-making regarding internationalization projects is supported by data derived from communicational interaction—such as platform analytics, stakeholder maps, and reputation monitoring, among others—which reinforces the strategic nature of communication as a unifying axis between innovation, internationalization, and organizational development.

The contexts of internationalization processes call for science policies that support international openness through regulations and rules; in other words, policies that identify the stakeholders involved, the purpose of the partnership through a strategic plan, and the financial resources that, through agreements, strategic alliances, and overseas offices, define the governance of internationalization. Table 1 below identifies the variables, research focus, and indicators of institutional internationalization policies:

Table 3. *Institutional Internationalization Policies*

Variable	Role in the study	Suggested indicators
Communication strategies	Independent	Clarity of messages, digital channels, frequency, engagement, feedback culture
Strengthening university–global business partnerships	Dependent	Technological competencies, joint innovation, mobility, international partnerships
Internationalization scenarios	Contextual	Agreements, global presence, explicit internationalization policies

Conclusion

The results lead to the conclusion that communication strategies constitute a critical axis for strengthening university-business relationships in internationalization scenarios, by mediating between global demands and local organizational capacities. Communication ceases to be a merely instrumental resource and becomes a strategic asset for articulating innovation, internationalization, and organizational development, fostering conditions of trust, legitimacy, and clarity of roles among the involved stakeholders.

In practical terms, it is recommended that universities establish strategic communication and digital transformation units that operate in coordination with international relations and community engagement offices, in order to design communication policies and protocols

aligned with international cooperation projects, dual training, and knowledge transfer. For multinational companies, the findings underscore the need to establish long-term relational frameworks with universities, based on hybrid channels, interaction metrics, and formal spaces for mutual governance, that allow for the alignment of talent management, open innovation, and corporate social responsibility.

As a future line of research, we suggest conducting in-depth comparative studies across different sectors and geographic contexts, as well as integrating mixed methodologies that include network analysis, digital metrics, and longitudinal studies on the evolution of university-business partnerships within the framework of internationalization. It is also important to note that the study provides a practical framework for universities and companies to develop digital communication plans aimed at developing technological competencies in global contexts.

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Strategic alliances between universities and multinational companies for the development of community health solutions

Peña Maldonado Alma Alicia
Autonomous University of Tamaulipas, Mexico, https://orcid.org/0000-0001-9770-9259
almapena@docentes.uat.edu.mx
Guerra Cárdenas José Eugenio
Autonomous University of Tamaulipas, Mexico, https://orcid.org/0000-0001-9495-024X
jguerra@docentes.uat.edu.mx
Reyna Beltrán Elizabeth
Autonomous University of Tamaulipas, Mexico https://orcid.org/0000-0001-7896-0560
ereyna@docentes.uat.edu.mx
Ramírez Pineda David
Autonomous University of Tamaulipas, Mexico, https://orcid.org/0009-0005-6448-3325
david.ramirez@docentes.uat.edu.mx

Introduction

In recent decades, the social determinants of health have received increasing attention in the literature. Evidence shows that individual health does not depend solely on the healthcare system, but also on factors such as housing, education, nutrition, access to services, equity, and community participation. In this context, strategic partnerships between Higher Education Institutions (HEIs) and multinational companies have become a promising avenue for mobilizing resources, know-how, technical know- , research capacity, and innovation models to serve vulnerable communities.

University-industry collaborations (UIC) have been systematically studied in relation to their socioeconomic impacts. It has been documented that, when they operate under knowledge transfer mechanisms, effective collaborative networks, and an appropriate organizational design, they generate economic, social, and financial benefits. A review of 94 articles proposed a conceptual model that distinguishes outcomes across economic, social, and financial dimensions. It also highlighted that context and institutional capacities account for much of the variability in outcomes (Abramo, D'Angelo & Di Costa, 2019).

In the health sector, service innovation in university hospitals has been linked to these collaborations. Huynh, Kroh & Schultz (2024) demonstrated that the intensity of university–industry collaboration has a positive impact on hospital innovation, although they cautioned that excessive intensity can produce negative effects. This finding suggests that the structure and management of the partnership are key determinants of its effectiveness.

Other interventions in vulnerable communities have also demonstrated the transformative capacity of academic collaborations when they include community participation. For example, the Health-Smart Church program, implemented in Hispanic churches in the Bronx, New York, improved the frequency of healthy behaviors among overweight and obese adults. However, some clinical indicators, such as body mass index, showed modest results (Parra-Medina et al., 2018).

Similarly, Florida International University's NeighborhoodHELP program organized interprofessional teams of students to conduct home visits in underserved communities. Participating households reported greater access to physical exams, blood pressure monitoring, and preventive screenings compared to non-participating households (De La Cruz et al., 2014).

These studies demonstrate that the success of partnerships depends on factors such as community participation in identifying needs, institutional capacity to integrate teaching, research, and outreach, corporate commitment beyond funding, and project sustainability. Obstacles have also been identified. Petchel, Gelmon & Goldberg (2020) documented that community health organizations perceive risks related to sustainability, legal liability, regulatory compliance, and partner reliability. These barriers illustrate the complexity of university–business agreements and underscore the need for more robust collaborative designs.

This chapter analyzes cases of strategic alliances between universities and multinational companies that succeeded in generating community health solutions for vulnerable populations. It seeks to identify success factors, limitations, and lessons learned that can strengthen future models of academic–business cooperation, with a special emphasis on Latin American contexts.

University-Industry Partnerships: Conceptual Foundations

Partnerships between universities and businesses have gained prominence as they are considered a cornerstone in building innovation ecosystems and generating solutions with social impact. Recent literature acknowledges that academic–industrial collaboration is no longer viewed as a one-way knowledge transfer mechanism. Today, it is understood as a co-creation process in which both parties—university and business—actively participate in all phases of the innovation cycle (Pujotomo et al., 2023; Tereshchenko et al., 2024).

One of the most frequently cited conceptual frameworks is the Triple Helix model, which posits that innovation results from the dynamic interaction between universities, industry, and government. Recent studies show that this framework has expanded toward "multi-helix" visions, which include additional actors such as civil society organizations and communities, especially in sensitive sectors like health (Yuntian & Jia, 2023). These approaches recognize that the complexity of health issues requires the incorporation of scientific, technological, financial, and cultural capital to achieve sustainable solutions.

Academic–industrial collaboration models take many forms: joint research, spin-off incubation, talent development, licensing agreements, the creation of shared laboratories, and professional training programs (Huynh, Kroh & Schultz; 2024; Pujotomo et al., 2023). In university hospitals, it has been demonstrated that the intensity of collaboration with industry improves service innovation. However, it can also generate risks of diminishing returns if not properly regulated (Huynh, Kroh & Schultz; 2024).

The concept of open innovation has gained prominence as an explanatory paradigm for these relationships. This approach proposes leveraging internal and external knowledge flows to energize innovation processes, facilitating technology transfer and increasing the likelihood that academic inventions will reach the market or social practice (Li et al., 2023; Pujotomo et al., 2023). Recent studies identify more than 30 success factors in university open innovation.

Among these, the company's capacity for technology absorption, knowledge management, and the existence of effective technology transfer offices stand out (Tereshchenko et al., 2024).

Technology transfer encompasses activities such as intellectual property protection, license negotiation, the creation of spin-off companies, and the commercialization of products or services (Villani, Rasmussen & Grimaldi, 2022). Current research shows that its effectiveness depends on cognitive proximity among partners, relational trust, and shared governance mechanisms (Tereshchenko et al., 2024; Yuntian & Jia, 2023). In the field of health, this transfer is reflected in low-cost medical devices, digital solutions based on artificial intelligence, and interprofessional education programs tailored to specific community needs (Theobald et al., 2023; Medina et al., 2024).

Significant barriers to the development of sustainable partnerships, however, persist. These include cultural differences between academia and industry, a lack of clarity in intellectual property agreements, dependence on government subsidies, and the difficulty of measuring social impact beyond economic indicators (Yuntian & Jia, 2023; Tereshchenko et al., 2024). These limitations highlight the need for stronger regulatory frameworks, appropriate incentives, and evaluation schemes that consider the social relevance of the results.

In summary, university–business partnerships are multifaceted processes grounded in conceptual models such as the Triple Helix, open innovation, and technology transfer. Integrating these approaches allows for an understanding of the complexity of interactions and provides a useful analytical framework for examining specific cases in community health. In Latin America, these partnerships take on special relevance when addressing structural limitations in funding, infrastructure, and access, highlighting the need for cooperation models adapted to regional realities.

Corporate Social Responsibility and Community Health

In the 21st century, corporate social responsibility (CSR) has established itself as a strategic pillar in the agendas of multinational companies, transcending traditional philanthropy to become an integral component of their business models and a mechanism for legitimizing their actions in the eyes of society (Latapí, Johannsdottir, & Davídsdóttir, 2019). In the health sector, CSR took on a particularly significant dimension, given that socioeconomic and territorial inequalities limit access to basic services, medications, prevention programs, and timely diagnostics. In response to this situation, multinationals implemented strategies aimed not only at improving their reputation but also at actively contributing to addressing critical community needs (Moura-Leite & Padgett, 2020).

Among the most common strategies employed by multinationals are the creation of programs providing access to essential medicines, the development of digital health initiatives, investment in joint research with universities, and participation in public-private partnerships to strengthen local health systems (Niu, 2024; He & Harris, 2020). For example, the pharmaceutical industry has promoted differentiated access programs for high-cost treatments in low-income regions, combining subsidies, voluntary licenses, and tiered pricing models. These actions respond both to the ethical need to contribute to global well-being and to the Sustainable Development Goals (SDGs), particularly SDG 3: Good Health and Well-being (Arora & Mishra, 2019).

Likewise, multinational companies have turned to open innovation projects in collaboration with local universities and startups to develop solutions tailored to vulnerable contexts, such as mobile telemedicine applications, low-cost diagnostic devices, and culturally relevant health education campaigns (Prasad, Segarra & Villanueva, 2022; Tereshchenko et al., 2024). These models allow scientific and technological knowledge generated in the private sector to be integrated with the research and outreach capabilities of academic institutions.

Within this framework, the role of the university is crucial in identifying medical needs among vulnerable populations. Higher education institutions (HEIs) fulfill a dual function: on the one hand, they generate scientific knowledge about the social determinants of health, and on the other, they act as mediators between business and the community by translating local needs into viable intervention projects (Medina et al., 2024). This capacity for situational diagnosis is enhanced by the presence of medical, nursing, and health sciences faculties, which maintain direct contact with community settings through professional internships, outreach programs, and health brigades (Theobald et al., 2023).

Recent literature shows that CSR projects with the greatest impact on community health are those that integrate the voices of beneficiaries and universities into planning from the outset. This avoids the risk of generating interventions that are out of context or short-lived, and promotes long-term social sustainability (Sulosaari et al., 2024; Huynh, Kroh & Schultz, 2024). Furthermore, universities provide scientific legitimacy and evaluation capacity, essential elements for measuring the actual impact of corporate programs in terms of health equity (Villani, Rasmussen & Grimaldi, 2022).

However, significant challenges remain: the tendency of some companies to prioritize media visibility over actual impact, the lack of comprehensive indicators of community outcomes, and tensions surrounding academic autonomy when projects rely excessively on corporate funding (Niu, 2024; Prasad, Segarra & Villanueva, 2022). These limitations highlight the importance of collaborative governance frameworks, where universities, companies, and communities share responsibilities, risks, and benefits.

In conclusion, CSR in community health constitutes a prime arena for university–business cooperation, in which multinationals contribute financial and technological resources, while universities ensure the relevance, sustainability, and equity of interventions. This synergy not only helps address medical needs in vulnerable populations but also strengthens the social legitimacy of companies and the social role of universities in achieving the SDGs.

Internationalization of Higher Education and Global Cooperation

The internationalization of higher education (HEI) has established itself as a strategic process through which universities strengthen their teaching, research, and outreach functions via transnational cooperation. This internationalization is reflected not only in academic mobility or the attraction of foreign students, but also in the capacity of institutions to participate in global knowledge networks, international research projects, and the formation of inter-institutional alliances that address common challenges (Knight, 2020).

In the field of health, partnerships between higher education institutions and international actors—including prestigious universities, multilateral organizations, foundations, and multinational companies—have facilitated the creation of joint academic programs, the development of collaborative research, and the transfer of health innovations to vulnerable

regions (de Wit & Altbach, 2021). For example, several Latin American universities have established agreements with European and U.S. institutions to implement telemedicine and interprofessional education projects in rural communities, demonstrating the capacity of global cooperation to overcome local limitations in infrastructure and funding (Teixeira, Ferreira & Franco, 2022).

However, university internationalization in the field of community health faces significant challenges. Among these are persistent inequality in access to technological resources across countries, linguistic and cultural barriers, financial dependence on international funds, and tensions related to sovereignty in knowledge production (Jones & de Wit, 2020). These challenges were exacerbated during the COVID-19 pandemic, when the suspension of in-person mobility programs and the need for rapid responses in local contexts highlighted the fragility of certain forms of cooperation (Morosini, Corte & Dias, 2021).

However, significant opportunities also emerged. The pandemic accelerated the adoption of digital technologies that facilitated virtual internationalization, expanding access to courses, seminars, and collaborative research projects conducted remotely (Lindberg, Salmi & Torp, 2023). Similarly, multilateral cooperation initiatives were promoted to ensure equitable access to vaccines, medicines, and digital health technologies, where universities played a key role as producers of scientific evidence and trainers of specialized human talent (Altbach & de Wit, 2021).

In this sense, the internationalization of higher education constitutes not only an institutional strategy but also a mechanism for global social justice, since by fostering the circulation of knowledge and multi-stakeholder cooperation, it expands the possibilities for addressing community health needs in historically marginalized regions. The key lies in building horizontal relationships between universities in the Global North and South, avoiding asymmetrical cooperation practices and promoting shared responsibility in the production of sustainable solutions (Maringe & Foskett, 2021).

This chapter was developed based on a descriptive and analytical qualitative study, focused on the review and systematization of documented cases of collaboration between universities and multinational companies in the field of community health. This approach was grounded in the relevance of case studies as a methodological tool for understanding complex phenomena in their real-world contexts, which is particularly well-suited for analyzing processes of inter-institutional cooperation and their impact on vulnerable populations (Yin, 2018).

A multiple-case analysis with a comparative design was adopted. This strategy allowed not only for the description of specific university–business partnership experiences but also for the identification of common patterns, divergences, and critical success factors. The choice of a qualitative approach responded to the need to explore contextual, organizational, and social dimensions that are difficult to capture through traditional quantitative studies (Baxter & Jack, 2020). The inclusion criteria for case selection were as follows:

- The collaboration had to explicitly involve a higher education institution (public or private university).
- The partner must be a multinational company with a transnational presence and established operations in at least two regions of the world.

- The partnership must be aimed at addressing a specific community health need, defined in terms of prevention, access to services, technological innovation, or strengthening local capacities.
- The project had to be supported by documented evidence, whether in indexed academic articles, institutional reports, or publicly available corporate documents.

These criteria ensured the relevance and comparability of the cases, while also enabling an analysis that reflects both the geographic and ge diversity of the strategies employed in university–business cooperation in health.

Data collection was based on three main types of sources:

- Academic articles indexed in high-impact international databases (Scopus, Web of Science, EBSCO), which provided empirical evidence and up-to-date conceptual frameworks on the subject (Pujotomo et al., 2023; Huynh, Kroh & Schultz, 2024).
- Institutional and corporate reports, including annual reports, social responsibility reports, and impact assessments prepared by universities and multinational companies (Niu, 2024; Arora & Mishra, 2019).
- Documents from multilateral organizations (WHO, UN, World Bank), which contextualized the projects within the global goals of sustainable development and health equity (World Health Organization, 2021).

The triangulation of these sources sought to strengthen the validity and reliability of the analysis by cross-checking information from academic, institutional, and corporate perspectives. Data analysis was conducted through a process of thematic comparison and categorization of contributions, following a qualitative content analysis approach (Elo & Kyngäs, 2020). The stages were:

- Initial coding, identifying emerging categories related to the nature of the partnership, the stated objectives, and the actors involved.
- Thematic grouping, which allowed for the identification of common dimensions: a) collaboration model, b) technology transfer mechanisms, c) community participation, and d) sustainability.
- Cross-case comparison, with the aim of identifying replicable success factors and recurring limitations.
- Categorization of contributions, which consisted of constructing a synthetic framework with the main lessons learned from each documented experience.

This procedure ensured a rigorous and systematic approach, allowing for the linking of empirical findings with the theoretical frameworks reviewed in the previous section.

Comparative analysis of university–industry partnerships in community health

This section presents the findings obtained from the analysis of collaboration cases between academic institutions and pharmaceutical companies in different regions of the world. Each selected case represents a specific experience in the implementation of health programs, vaccination strategies, and technological innovation in primary care. The characteristics of each partnership, the results achieved, and the challenges faced are described in order to identify

best practices and lessons learned that can guide future international cooperation initiatives in the field of public health. This comparative approach highlights how local contextualization, cultural adaptation, and inter-institutional coordination are critical to the success of the evaluated programs.

Cooperation between academia and the private sector has proven to be an effective mechanism for addressing complex health challenges. The comparative table presented below systematically summarizes the main characteristics of each partnership, the results obtained, and the challenges faced. This organization allows us to observe how the implemented strategies—whether health education, culturally adapted vaccination, or technological innovation in primary care—have varying impacts depending on the local context, while also highlighting common patterns regarding barriers, opportunities, and key lessons in the management of collaborative health programs (Table 1).

Table 1. Comparison of Results and Challenges in Academic and Pharmaceutical Partnerships for Public Health

Case	*Partnership*	*Results Achieved*	*Challenges faced*
Harvard – Novartis	Arogya Parivar Program: Deployment of mobile clinics and health educators in rural communities in Africa	Reached >36 million people with health education; provided direct care to >2.5 million; strengthened local capacities	Adaptation to diverse local contexts; financial sustainability; integration with existing health systems
UNAM – Pfizer	Culturally Adapted Vaccination Strategies in Marginalized Communities in Mexico and the United States	Increased vaccination rates; community-based interventions; reduced vaccine hesitancy	Risk of commercialization; intellectual property tensions; high initial investment for scaling up.
University of São Paulo – Johnson & Johnson	Implementation of digital technologies in primary care in Brazil	Improved quality of care during the pandemic; continuity of service; use of digital strategies for vulnerable populations	Digital exclusion; lack of clear planning regarding professional roles; poor integration between remote and in-person modalities

A comparative analysis of the three cases reveals common patterns and significant differences in the partnerships between universities and pharmaceutical companies, as well as in the results achieved and the challenges faced. Through this cross-sectional comparison, it is observed that, although the geographical and sociocultural contexts are diverse, the programs share similar objectives: improving access to healthcare, strengthening local capacities, and promoting innovation in public health (Chesbrough, 2017; Novartis, 2025).

Among the most notable success factors are the contextualization of interventions according to local needs, the cultural adaptation of strategies, and effective coordination among academic, private, and community actors. Likewise, the development of local human capital and the implementation of information and communication technologies have been critical to maximizing the impact and sustainability of the programs. Evidence suggests that a community-based approach and health education significantly increase the acceptance and effectiveness of interventions, as observed in the Harvard–Novartis and UNAM–Pfizer cases (Genies et al., 2024; Du, Zhu & Li, 2023).

However, recurring limitations in cooperation were also identified. These include the programs' financial dependence on private sponsors, the difficulty in ensuring long-term sustainability, and challenges associated with local health and technological infrastructure (Stein & Ferri, 2017; Abdur et al., 2022; Ahsan & Siddique, 2022). These limitations highlight the need for robust planning strategies, diversification of funding sources, and strengthening of local institutional capacities to avoid excessive dependence on external partners.

The contributions of these partnerships to sustainable development are significant, especially in relation to SDG 3: Good Health and Well-being. The evaluated programs contribute to expanding access to health services, disease prevention, and community health promotion. Furthermore, they generate practical evidence on how cooperation between academia and the private sector can support the achievement of global health goals, while strengthening the resilience of health systems in the face of health emergencies and socioeconomic inequalities (Abdur et al., 2022; Ahsan & Siddique, 2022; Li et al., 2023).

In summary, the university–business partnerships analyzed demonstrate that strategic collaboration, when grounded in local context, community engagement, and technological innovation, has a positive impact on public health. However, sustainability and financial independence remain key challenges that must be addressed to ensure the continuity and scalability of these programs.

Conclusions

The cases analyzed show that partnerships between universities and multinational companies represent a strategic mechanism for addressing complex public health challenges. The main findings indicate that the effectiveness of these collaborations depends on the ability to adapt programs to local contexts, integrate scientific and h y knowledge with community needs, and foster the active participation of beneficiaries. Furthermore, technological innovation and health education strategies emerge as key tools for amplifying impact and ensuring the continuity of interventions.

For universities, these experiences underscore the importance of establishing strong ties with private actors, not only to access resources and funding, but also to enrich academic training and applied research. For multinationals, partnerships offer a pathway to generate social

value, strengthen their corporate responsibility, and contribute tangibly to the well-being of communities. Looking ahead to future collaborations, it is recommended to prioritize the sustainability of programs through long-term planning, diversification of funding, and institutional strengthening. Furthermore, it is essential to promote capacity-building at the local level and the continuous evaluation of outcomes, ensuring that programs address real needs and contribute to the development of more resilient health systems. Globally, these experiences can serve as a model for replicating effective strategies in different regions, with a special emphasis on Latin America, where inter-institutional collaboration can enhance the coverage, equity, and quality of community health services.

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Artificial Intelligence, Data Analytics, and Information Technology in Business

Smart Tourism and Information Systems for the Development of Sustainable Business Strategies

León Cavero, Francisco Rafael
San Pedro University, Chimbote, Peru, francisco.leon@usanpedro.edu.pe
https://orcid.org/0000-0001-5955-4495, Scopus Author ID: 58193786500
Zavala Soto, Mario William
San Pedro University, Chimbote, Peru, mariowilliamzavalasoto@gmail.com
https://orcid.org/0009-0009-4081-2293
León León, Sebastián Rafael
Universidad Privada del Norte, Trujillo, Peru, N00418015@upn.pe
https://orcid.org/0009-0007-1187-1679
León León, Fabrizio André
Universidad Privada del Norte, Trujillo, Peru, N00473805@upn.pe
https://orcid.org/0009-0004-4883-1687

Introduction

Smart tourism is an innovative approach to tourism that has emerged as a result of its relationship with the use of new information and communication technologies, representing a new model of competitiveness and tourism development based on governance and the definition of sustainable public policies; however, as proposed by Valencia et al. (2025), it must be grounded in cutting-edge technological infrastructure that ensures the development and growth of the region, facilitating interaction and integration with the environment. This enhances the quality of the tourist's experience at the chosen destination and contributes to the region's economic dynamism by improving the quality of life.

Now, these cutting-edge technologies are based on information systems, the latter referring to an organized set of mechanisms consisting of a series of interconnected and interacting resources designed to manage valuable data and information so that it can be processed and retrieved easily and quickly; in other words, through these systems, information can be collected, statistics processed, and files organized, among other features, according to users' needs. As Pérez and Echarri (2021) point out, information systems in this new digital era have become a basic tool for the advertising, promotion, and management of tourist destinations, as evidenced by the need to develop websites that offer a variety of travel plans for both business travelers and vacationers during both low and high seasons, with a variety of options for lodging and leisure activities, while also being able to provide up-to-date information effectively, thereby becoming accurate sources of information for users.

Tourism information systems are focused on continuously and systematically collecting, organizing, and processing the most accurate information on the most sought-after tourist destinations, which is derived from an evaluation process conducted by various public and private tourism stakeholders. As Fernández and Salinas (2020) note, developing a tourism information system requires the collaboration of a specialized technical team capable of interpreting the vast amount of information generated in this field.

Currently, the goal across all sectors of economic activity is to create smart and useful spaces with the help of technology. However, according to López and García (2015), smart tourism is based on four basic pillars: geographic-sustainability (natural resources and society), systematic (stakeholders in the region), technology-IT (algorithms and data), and communication-

accessibility (information exchange), in order to provide the best possible service to tourists. However, the perception of sustainability in the tourism sector and its impact on sustainable business development are rarely analyzed as a single construct.

The objective of this study is to analyze smart tourism and the information systems used for the development of sustainable business strategies. The methodology applied was analytical, descriptive, field-based, and non-experimental, utilizing a survey instrument consisting of 10 items, which allowed for the analysis of factors such as smart tourism, information systems, and sustainable infrastructure through correlation, regression, and the independent t-test.

The sample used as a reference for data collection was a convenience sample based on accessibility, comprising a total of 150 male and female tourists who arrived at and departed from Jorge Chávez International Airport, located in Lima, Peru, at different times; that is, the survey was administered over 15 days, selecting the same number of tourists on various days, hours, and dates, with the aim of obtaining representative data, as shown in Table 1.

Table 1. *Sample Distribution*

Day	Time of day	Number of respondents		
		Men	Women	Total
Monday	Morning	15	15	30
Wednesday	Afternoon	3	3:30	30
Saturday	Morning	15	3:30	30
	Afternoon	3	3:30	30
Friday	Morning	6	6	12
	Afternoon	9	9	18
Total, Respondents		**75**	**75**	**150**

Source: Author's own work (2026).

The equal distribution of the sample (75 men and 75 women) ensured gender representativeness in data collection, while the variety of survey times (morning and afternoon, on different days of the week) helped reduce temporal biases and capture the diversity of tourist flow at the airport.

Smart tourism: an offshoot of information systems

Smart tourism is fundamentally an evolution of tourism based on the incorporation of information systems, data analytics, and digital technologies to support decision-making, improve competitiveness, and guide the sustainability of destinations. In this approach, smart tourism destinations transform scattered data into useful knowledge for planning, management, and innovation in the sector (Mendes et al., 2022).

From this perspective, smart tourism not only automates processes but also reconfigures the way destinations observe demand, monitor flows, personalize services, and coordinate public and private actors. Recent literature also links it to destination governance, the inclusion of local actors, and the strengthening of value chains, demonstrating that its scope extends beyond technology and is embedded in territorial strategy.

In this case, the digital revolution is linked to the emergence of the concept of smart tourism, whose purpose is to improve the tourist experience by facilitating the integration and use of

technology, particularly information systems for cities (Neuhofer, Buhalis, and Ladkin, 2012). According to Lamsfus et al. (2015), a tourist destination is considered smart when it makes intensive use of the technological infrastructure offered by the city to: a) improve the experience of travelers by raising awareness of available tourism services and products, and b) empower destination management organizations, local institutions, and tourism companies in decision-making.

According to Femenia-Serra and Ivars (2018), smart tourism focuses on a technological infrastructure or smart system that enables the effective identification, understanding, and response to various concerns regarding accommodation and iconic sites to visit at the destinations tourists seek, thereby creating better experiences that contribute to sustainability. As time goes on, society becomes more dependent on technology, especially before and during trips or visits to specific destinations, since through it, one can learn in advance everything about the place one wishes to explore or visit for work-related reasons; for this reason, in recent years, many destinations have decided to adopt smart tourism as a way to promote themselves and meet the needs of each of their visitors, while also improving the quality of life for their residents (Torres et al., 2022).

In turn, it is worth noting that today, internet tools such as social media and Big Data are essential for the development of smart tourism destinations because, through the internet, they can present themselves to the world, interact with potential visitors, receive complaints and/or suggestions from users, and showcase the experiences visitors have had during their stays, serving as a reference for new visitors and thus becoming one of the largest sources of tourism information (Piñón and Castillejos, 2018).

On the other hand, López and García (2015) indicate that tourist destinations become smart when they are supported by four (4) fundamental pillars: technology, innovation, universal accessibility, and sustainability. They also mention that innovation refers to the implementation of technological resources and innovative ideas that help improve and increase the destination's tourism promotion. By way of reflection, travel consulting firms or tourism agencies are trying to adapt to technological advances and take advantage of the benefits that information systems provide, giving rise to what is now known as smart tourism, which offers a range of tools that help companies reach potential customers, provide packages tailored to the needs of business travelers and vacationers, and showcase photos and reviews of iconic sites and other visitors' experiences—thereby enhancing tourism promotion for various destinations and ensuring their sustainability.

The Concept of Sustainability: Toward a Sustainable Infrastructure

Today, following major scientific advances in resource conservation, various strategies and programs have been developed that incorporate best practices in labor, technical, and/or social areas, capable of producing physical and regulatory infrastructure that enables the creation of sustainable markets. Sustainability, understood as a guiding principle of development, requires that institutional and territorial decisions simultaneously integrate environmental conservation, social equity, and economic viability. In the field of infrastructure, this approach involves planning projects and systems capable of meeting current needs without compromising the territory's carrying capacity in the future. The management of sustainable land use planning in Latin America demonstrates that incorporating a vision of sustainable development is strategic for ensuring the conservation and sustainability of human

life, which is particularly relevant when considering infrastructure as a foundation for development. Along the same lines, the sustainability approach cannot be reduced to technical efficiency but must be integrated with public management decisions, land use planning, and the responsible use of space, so that infrastructure contributes to collective well-being and territorial resilience (Villamil, 2022).

Likewise, standardization practices have become key elements in the production of techno-scientific knowledge, where standards in the social sciences— that is, the specific forms of social orders that incorporate knowledge policies and the organization of science, have been developed in relation to the problematization of classification and quantification practices, examining the infrastructures that underpin them and, above all, revealing the social consequences of their production and use across different temporalities and localities (Sánchez-Vargas, 2019). Thus, the sustainability of infrastructure depends not only on materials or technology, but also on governance capable of integrating environmental impact, social responsibility, and long-term benefits (Ortiz, 2025).

The term "sustainable" is used by various authors as an adjective for the word "development," with the concept of sustainable development being the result of an effort to understand and overcome the limitations related to economic growth and development, specifically those related to the development of current technology, the scarcity of social and economic resources, and the biosphere's capacity to absorb the effects of human activity (Sánchez-Vargas, 2019).

The concept of sustainable development is key to framing sustainability as a standardizable issue. As Brooks (1992) argues, the need to integrate the environment and the economy was developed within a framework in which economic activity is not viewed as a threat to the environment, but rather it is environmental degradation that threatens it; where the ultimate goal of economic growth is its indefinite sustainability over time.

Sustainable Business Development through Smart Tourism and Digital Information Systems: Results

The development of sustainable business strategies requires the integration of solid theoretical foundations that connect competitiveness with environmental and social responsibility (Santamaria et al., 2025). Creating shared value represents a fundamental strategic evolution, where companies identify opportunities to generate economic value while solving social and environmental problems, shifting from the traditional approach to corporate social responsibility toward embedding sustainability at the core of the business model.

McDougall et al. (2019) developed the natural resource-based view, which posits that sustainable competitive advantages emerge from three interconnected strategic capabilities: pollution prevention, product stewardship, and clean technologies, theoretically grounding the idea that integrating environmental considerations into business strategy generates superior long-term performance. This theoretical perspective has been empirically validated, demonstrating that organizations that implement these capabilities achieve defensible competitive positioning in increasingly environmentally regulated markets.

This conceptual framework provides the scientific basis for developing business strategies that simultaneously address the three pillars of sustainability through the complementarity of sustainable transformation narratives in this decade. Sustainable business development in the

context of smart tourism represents the strategic convergence of efficient resource management, technological innovation, and socio-environmental responsibility (Cortés et al., 2026). Smart tourism destinations position themselves as new management models that address technological advancements and an increasingly digital customer base, establishing five fundamental pillars: governance, technology, innovation, accessibility, and sustainability. Sustainability is one of the most analyzed pillars and the most complex to implement, as it seeks to provide high-quality experiences without negatively impacting the environment on which both the host community and visitors depend

A positive correlation was found between smart tourism and information systems across the different types of questions. An interesting relationship was observed between the two open-ended questions and problem-solving tasks, with a correlation coefficient of 0.431 ($p < 0.01$). Furthermore, tourism quality correlated positively with the development of sustainable strategies ($r = 0.250$, $p < 0.01$) and in the PSQ ($r = 0.324$, $p < 0.01$); however, no significant relationship was found when smart tourism and information systems were measured using multiple-choice questions.

Correlational Analysis between Smart Tourism, Information Systems, and Sustainable Infrastructure

Pearson's correlation analysis revealed the existence of significant positive relationships among the study's three main variables: smart tourism, digital information systems, and sustainable infrastructure. The correlation coefficients obtained show that the adoption of smart technologies in tourist destinations is directly associated with the implementation of advanced information systems and the development of sustainable infrastructure.

The findings of this research empirically corroborate the relationship between smart tourism, digital information systems, and sustainable infrastructure, providing quantitative evidence that supports existing conceptual frameworks on smart tourist destinations. The moderate-to-strong correlation between information systems and sustainable infrastructure ($r = 0.524$) is consistent with the literature that identifies technology as a critical enabler of environmental sustainability in the tourism sector.

Table 2. *Correlation Matrix among Main Variables (N = 150)*

Variable	Smart Tourism	Information Systems	Sustainable Infrastructure
Smart Tourism	1,000	—	—
Information Systems	$r = 0.431$**	1.000	—
Sustainable Infrastructure	$r = 0.387$**	$r = 0.524$**	1.000

Source: Author's own work (2026).

As shown in Table 2, the strongest correlation was identified between digital information systems and sustainable infrastructure ($r = 0.524$, $p < 0.01$), indicating a moderate-to-strong relationship that suggests destinations implementing advanced information systems tend to develop more sustainable infrastructure. This finding is consistent with the literature on smart tourism destinations, where technology is positioned as a key enabler of environmental sustainability.

The correlation between smart tourism and information systems was moderate ($r = 0.431$, $p < 0.01$), confirming that smart tourism initiatives rely significantly on the implementation of digital technologies and platforms for their operation. This relationship is consistent with the five fundamental pillars of smart tourism destinations, where technology constitutes one of the structural pillars. Meanwhile, the correlation between smart tourism and sustainable infrastructure was moderate ($r = 0.387$, $p < 0.01$), suggesting that while a positive association exists, the implementation of sustainable infrastructure also depends on factors beyond technology, such as public policy, economic investment, and governance.

Linear Regression Analysis: Prediction of Sustainable Infrastructure

The multiple linear regression model was used to determine the predictive power of the independent variables (smart tourism and information systems) on the dependent variable (sustainable infrastructure). The results indicate that the model is statistically significant and explains a considerable percentage of the variance in sustainable infrastructure.

Table 3. *Summary of the Linear Regression Model*

Statistic	Value	Interpretation
R	0.612	Moderate-strong multiple correlation
R^2	0.375	The model explains 37.5% of the variance
Adjusted R^2	0.366	36.6% of variance explained (adjusted for degrees of freedom)
Standard error of the estimate	0.847	Model accuracy
Snedecor's F	43.12	Significant ($p < 0.001$)

Source: Author's own work (2026).

The coefficient of determination $R^2 = 0.375$ indicates that 37.5% of the variability in sustainable infrastructure can be explained jointly by smart tourism and digital information systems. This result is consistent with previous research identifying technology as an important, though not exclusive, enabler of tourism sustainability.

The standardized regression coefficients reveal that digital information systems have a greater impact on sustainable infrastructure ($\beta = 0.456$, $p < 0.001$) compared to smart tourism ($\beta = 0.294$, $p = 0.0004$). This indicates that for every standard deviation increase in the implementation of information systems, sustainable infrastructure increases by 0.456 standard deviations, holding other variables constant . This finding underscores the critical importance of digitalization as a strategic lever for business sustainability in the tourism sector.

The predictive power of digital information systems on sustainable infrastructure ($\beta = 0.456$, $p < 0.001$) confirms that strategic digitalization constitutes a fundamental lever for sustainable business development in tourism. This result aligns with the integrative framework of D'Amato and Korhonen (2021), who argue that the convergence of the green economy, the circular economy, and digital technologies points toward an economy based on renewable processes that meet economic, social, and environmental requirements. An independent samples t-test was conducted to determine whether there were significant differences between men and women in their perception and evaluation of smart tourism, information systems, and sustainable infrastructure.

Table 4. *Comparison of Means by Gender (N = 150)*

Variable	Men (*M* = 75)	Women (*M* = 75)	*t*	*gl*	*p* (two-tailed)
Smart Tourism	3.84 (±0.67)	4.02 (±0.59)	−1.823	148	0.071
Information Systems	3.91 (±0.72)	4.15 (±0.63)	−2.247	148	0.026*
Sustainable Infrastructure	3.76 (±0.71)	3.89 (±0.66)	−1.174	148	0.242

M = mean; SD = standard deviation; p < 0.05; Source: Author's own work (2026).

The results in Table 4 indicate that there are no significant differences between men and women in their perception of smart tourism (p = 0.071 > 0.05) or sustainable infrastructure (p = 0.242 > 0.05). However, a significant difference was identified in the perception of digital information systems (t = −2.247, p = 0.026 < 0.05), where women (M = 4.15, SD = 0.63) showed a significantly higher rating than men (M = 3.91, SD = 0.72). This finding suggests that women may have greater sensitivity or more positive experiences with digital technologies applied to tourism, which warrants future research on gender differences in technology adoption in the tourism sector.

Table 5. *Effect Size of Gender Differences (Cohen's d)*

Variable	Cohen's *d*	Interpretation of Effect Size
Smart Tourism	0.28	Small effect
Information Systems	0.35	Small-moderate effect
Sustainable Infrastructure	0.18	Very small effect

Source: Author's own work (2026).

The effect size calculated using Cohen's d reveals that, although the difference in information systems is statistically significant, the effect size is small to moderate (d = 0.35), indicating that the practical magnitude of the difference is limited. This suggests that, while a statistical difference exists, both perceptions (men and women) are generally positive and convergent regarding the assessment of tourism technology.

Conclusions

The results suggest that tourism companies seeking to transition toward sustainable business models must prioritize investment in digital technology infrastructure as a necessary, though not sufficient, condition for achieving environmental sustainability. The ability to analyze large volumes of data, predict visitor behavior, and dynamically adjust services according to demand is essential for reducing waste, optimizing resource use, and minimizing the carbon footprint. The research also shows that corporate sustainability in tourism requires a comprehensive approach that goes beyond isolated technology adoption. Sustainable infrastructure depends on multiple interconnected factors, including favorable public policies, adequate economic investment, effective governance, a committed organizational culture, and an appropriate regulatory framework.

A key finding identified that women expressed a more positive view of digital information systems applied to tourism compared to men. This difference suggests that women may have a greater affinity for digital technologies or experience more satisfying interactions with technological platforms in tourism contexts. This result raises important questions for future

research on gender differences in technology adoption, the digital tourism experience, and perceptions of sustainability in the sector.

This research provides empirical evidence that validates conceptual frameworks on smart tourism destinations and corporate sustainability, integrating existing theoretical perspectives on efficient resource management through digital technologies. The results confirm that the creation of shared value in tourism is possible through the strategic integration of technology, economic profitability, and socio-environmental responsibility. In this regard, the evidence obtained supports the theory that technological and environmental capabilities generate sustainable long-term competitive advantages, thereby substantiating the natural resource-based view that posits that the integration of environmental considerations into business strategy produces superior performance.

For tourism businesses: The adoption of digital information systems should be viewed as a strategic investment that facilitates the implementation of sustainable practices. Digitalization enables the optimization of operations, reduces operating costs, improves the visitor experience, and transparently communicates environmental performance to stakeholders. For tourism destination managers: Strategic planning must prioritize digitalization as a cornerstone of smart governance, fostering the co-creation of sustainable experiences through digital technologies and establishing public-private partnerships for technological infrastructure.

Research confirms that the transition toward smart and sustainable tourism models is possible, desirable, and necessary, and that the path to this transformation begins with the strategic decision to integrate technology, sustainability, and corporate responsibility into a holistic and systemic approach.

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Artificial Intelligence and Its Applicability in Businesses: A Systematic Review

Rivera García, Guadalupe Esmeralda
TecNM. Higher Technological Institute of Pánuco, Ver., Mexico.
esmeralda.rivera@itspanuco.edu.mx
https://orcid.org/0000-0003-3730-4801
Ramírez Vázquez, Juan Carlos
TecNM. Higher Technological Institute of Pánuco, Ver., Mexico.
carlos.ramirez@itspanuco.edu.mx
https://orcid.org/0000-0003-0125-6502

Introduction

Artificial intelligence (AI) has established itself as one of the most influential technological pillars in the transformation of contemporary organizations and business models. In general terms, AI can be defined as the set of computational systems capable of performing tasks that, when executed by humans, require intelligence, such as learning, reasoning, perception, natural language understanding, and decision-making in complex contexts. From a business perspective, AI is viewed as an enabling technology that allows for the automation of processes, the analysis of large volumes of data, and the support of strategic decisions based on predictive and adaptive models, thereby generating economic value and sustainable competitive advantages (Haenlein & Kaplan, 2021; Reier-Forradellas & Garay-Gallastegui, 2021; Davenport & Ronanki, 2018; Tarafdar et al., 2019).

From a more precise theoretical perspective, artificial intelligence has been defined as the discipline that studies and develops agents capable of perceiving their environment, processing information, and acting rationally to maximize the achievement of specific objectives. This definition emphasizes the notion of rationality and adaptation, and underscores that AI is not limited to the imitation of human behavior, but rather includes systems capable of surpassing human performance in defined tasks through the use of advanced machine learning and deep learning algorithms. In this regard, recent literature highlights that AI should be understood as a set of socio-technical capabilities integrated into organizational structures and decision-making processes, rather than as an isolated tool (Janiesch et al., 2021; Dwivedi et al., 2021; Raisch & Krakowski, 2021; Faraj et al., 2018).

The objective of this research was to analyze artificial intelligence and its applicability in businesses; specifically, it is approached from a theoretical perspective and advances the interrelation of some relevant findings.

From a methodological perspective, this chapter is based on a systematic review of the scientific literature on the applicability of artificial intelligence in businesses. The search was conducted in indexed academic databases, primarily Scopus, Web of Science, and ScienceDirect, considering articles published between 2021 and 2025. Keywords such as artificial intelligence, business applications, organizational performance, and digital transformation were used. Only peer-reviewed articles with an active DOI and published in indexed academic journals were included, while theses, repositories, institutional documents, and non-peer-reviewed sources were excluded. This process allowed us to identify trends,

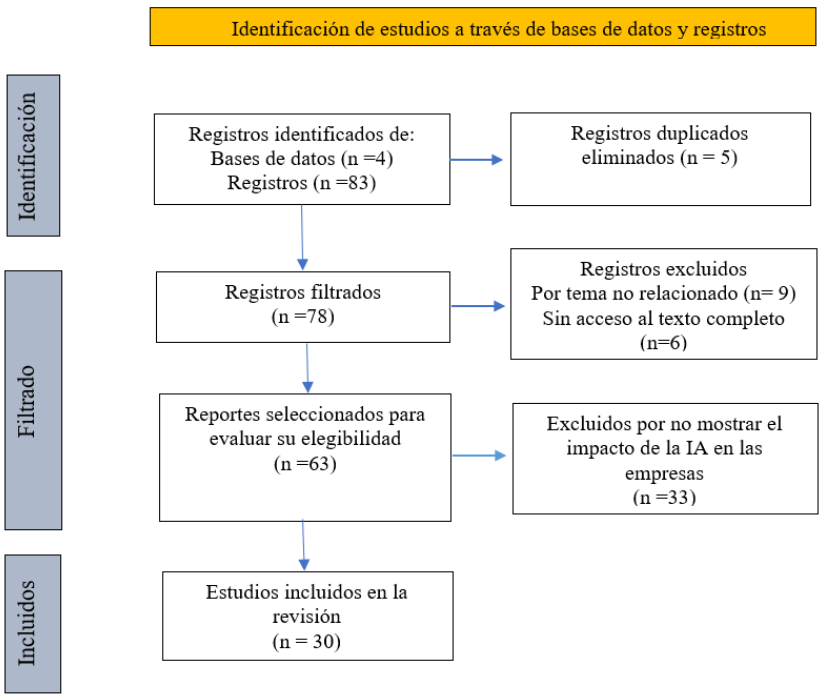
benefits, and challenges associated with the adoption of AI in the business sector, which are analyzed in the following sections.

Between January and September 2025, the authors conducted a literature review in academic databases such as Scopus, PubMed, ScienceDirect, and Web of Science. The search was limited to scientific articles with the following keyword combinations: "artificial intelligence" AND "businesses" AND "impact" and "systematic review" AND "artificial intelligence" AND "businesses." The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology was used for the selection.

The following inclusion criteria were established: (1) articles written in English or Spanish, (2) peer-reviewed, (3) focused on the application of AI models in the business sector, and (4) published within the last ten years. Likewise, literature that did not align with the research objective, duplicates, articles without access to the full text, and those that did not present results on the impact of AI on businesses were excluded.

Following the PRISMA methodology, an exhaustive search using keywords was conducted during the identification phase. A total of 83 articles were identified. Of these, 5 were excluded due to duplication. Of the remaining 78 articles, 9 were excluded for not meeting the research objectives and 6 for lacking access to the full text. Then, of the 63 studies available, 33 were excluded because they did not report on the effects of AI on businesses. Finally, 30 studies that met all the criteria were included in the review. The scientific article selection process is shown in Figure 1.

Figure 1. Flowchart of the scientific article selection process.



Artificial Intelligence: Specific Contributions from a Conceptual Perspective

Historically, the conceptual foundations of artificial intelligence date back to the work of Alan Turing, who in 1950 proposed the so-called Turing Test as a criterion for evaluating a machine's ability to exhibit behavior indistinguishable from that of a human. Subsequently, researchers such as John McCarthy, who coined the term "artificial intelligence," and Marvin Minsky made decisive contributions to the formalization of the field during the second half of the 20th century. However, the widespread adoption of AI in the business world has been driven primarily by recent advances in machine learning, deep learning, the availability of big data, and high-performance computing capabilities—factors that have accelerated the transition from experimental developments to high-impact organizational applications (Janiesch et al., 2021; Dwivedi et al., 2021; Makridakis, 2017; Brynjolfsson et al., 2018).

In the contemporary business environment, artificial intelligence has been progressively integrated into critical functions such as human resources management, logistics, marketing, finance, customer service, and supply chain management. Various empirical studies show that companies adopting AI-based solutions tend to improve their organizational performance, innovation capacity, and competitiveness, particularly when the technology aligns with corporate strategy and the organization's internal capabilities. In this context, AI acts both as a mechanism for automation and for augmenting human decision-making capabilities (Arias-Vargas et al., 2023; Reier-Forradellas & Garay-Gallastegui, 2021; Shrestha et al., 2019; Keding, 2021).

However, recent literature warns that the implementation of artificial intelligence in companies does not depend exclusively on technological factors. The success of AI adoption is contingent upon the existence of organizational, human, and strategic capabilities that enable the effective integration of these tools into business processes. Aspects such as data quality and governance, organizational culture, staff training, and change management are critical to maximizing the benefits of AI and avoiding suboptimal results or internal resistance. In particular, it has been documented that small and medium-sized enterprises (SMEs) face greater adoption barriers related to limited resources and technological knowledge gaps (Rojas-Ahumada et al., 2023; Villarreal-Satama & Flor-Terán, 2023; Jöhnk et al., 2021; Sousa et al., 2020).

Additionally, the incorporation of artificial intelligence systems raises ethical, legal, and social challenges that must be explicitly considered by organizations. Algorithmic transparency, model explainability, personal data protection, and the impact of automation on employment constitute critical dimensions of the current debate on AI in the business sphere. Various authors agree that the absence of clear ethical frameworks can erode organizational and social trust in these technologies, reinforcing the need for responsible governance and accountability approaches in the design and deployment of intelligent systems (Dwivedi et al., 2021; Martin, 2019; Frank et al., 2019; Wirtz et al., 2018).

Within the context of digital transformation, artificial intelligence also plays a central role in business innovation processes, particularly in small and medium-sized enterprises (SMEs), which face the challenge of competing in increasingly digitized environments. Recent evidence indicates that the strategic adoption of AI can facilitate innovation, improve operational efficiency, and strengthen the competitive position of SMEs, provided there is adequate

alignment between technology, business strategy, and available resources. In this regard, the literature emphasizes that AI should not be implemented in isolation, but rather as part of a comprehensive organizational transformation strategy aimed at creating long-term value (Calle-García et al., 2024; Contreras-Contreras & Olaya-Guerrero, 2024; Vrontis et al., 2022; Bughin et al., 2018).

Findings on the Application of Artificial Intelligence in Businesses

The systematic review shows that the implementation of artificial intelligence (AI) acts as a transformative agent in companies, with consistent effects on operational efficiency, productivity, and competitiveness. To improve clarity and reduce length, the findings are presented in two tables: (1) a methodological synthesis of the selected studies and (2) a thematic synthesis of the main reported effects.

Table 1. *Methodological characteristics of the studies included in the review*

No.	*Authors*	*Methodology*	*Type of evidence*
1	Tenés Trillo (2023)	Qualitative literature review	Business context (Peru), employment, and regulation
2	Quinto et al. (2021)	Systematic literature review	Management decision-making, ethics, and strategy
3	Martínez-Ortega & Medina-Chicaiza (2020)	Literature review	Marketing, personalization, and analytics
4	Villarreal Satama & Flor Terán (2023)	Qualitative documentary	Internal transformation and ethical risks
5	Erazo-Castillo (2023)	Review + interviews + case studies	Audit, efficiency, cost reduction, and
6	Rojas Ahumada et al. (2023)	Systematic review (PRISMA)	Chatbots and Customer Service
7	Contreras-Contreras & Olaya Guerrero (2024)	Systematic review (PRISMA)	Business management and productivity, gradual implementation, and sustainability

Artificial intelligence (AI) enables the hyper-personalization of products and services, as well as the optimization of internal processes, allowing companies to respond more nimbly to changing market demands. Recent literature demonstrates that these capabilities translate into substantial improvements in operational efficiency, productivity, and decision-making quality, particularly in organizations with high levels of digital maturity and established analytical capabilities (Reier-Forradellas & Garay-Gallastegui, 2021; Arias-Vargas et al., 2023; Davenport & Ronanki, 2018). However, these benefits are not distributed evenly across different types of organizations. While large corporations have succeeded in integrating AI into advanced and scalable platforms, micro, small, and medium-sized enterprises continue to face structural barriers—such as limitations in technological infrastructure, a shortage of specialized talent, and financial constraints—that limit the scope and speed of adoption of these technologies (Jöhnk et al., 2021; Calle-García et al., 2024).

Table 2. *Main organizational effects of AI reported in the analyzed studies*

No.	*Thematic area*	*Reported evidence*	*Representative studies*
1	Efficiency and productivity	Task automation, time/cost reduction, process optimization	Contreras-Contreras & Olaya Guerrero (2024); Villarreal Satama & Flor Terán (2023)
2	Decision-making	Greater accuracy and speed in data-driven managerial decisions; support for human judgment	Quinto et al. (2021); Martínez-Ortega & Medina-Chicaiza (2020)
3	Customer experience	Improved service, automated responses; limitations due to lack of empathy	Rojas Ahumada et al. (2023)
4	Work transformation	Job creation/destruction, role reconfiguration, and training needs	Tenés Trillo (2023); Rodríguez Alegre et al. (2023); Salavarría & Bazurto (2024)
5	Risks and Governance	Ethical challenges, privacy, transparency, accountability, and the need for regulation	Penalva (2021); Pirela (2020); Villarreal Satama & Flor Terán (2023)
6	Implementation and barriers	Talent, resistance to change, infrastructure, investment, gradual adoption	Tenés Trillo (2023); Mendez (2021); Contreras-Contreras & Olaya Guerrero (2024)

In organizational terms, one of the main challenges associated with AI adoption is cultural and structural resistance to change. Various studies agree that this resistance stems both from fear of job displacement and from mistrust of algorithmic systems involved in sensitive processes, such as performance evaluation, resource allocation, or financial decision-making. This phenomenon is explained, in part, by the lack of transparency and explainability of AI models, which hinders their internal legitimization and acceptance by employees (Raisch & Krakowski, 2021; Faraj et al., 2018; Dwivedi et al., 2021). Added to this are ethical and legal dilemmas related to algorithmic discrimination, the protection of personal data, and the absence of harmonized regulatory frameworks, which reinforce the need for responsible, supranational governance approaches (Martin, 2019; Wirtz et al., 2018).

From a strategic perspective, the literature emphasizes that the value of artificial intelligence lies not only in the automation of tasks, but in its ability to complement and augment human capabilities, shaping hybrid decision-making models. In this regard, recent research highlights that combining intelligent systems with human oversight allows for maximizing the benefits of AI, while mitigating risks associated with algorithmic errors or the loss of contextual sensitivity

(Haenlein & Kaplan, 2021). This automation–augmentation logic is particularly relevant in knowledge-intensive sectors with high social impact.

One area where this integration takes on particular importance is health services management, where AI has become a key tool for improving administrative efficiency, service quality, and clinical and managerial decision-making. Recent studies indicate that the application of artificial intelligence in healthcare management enables the optimization of administrative processes, supports diagnosis and resource planning, and improves patient care; however, it also poses significant challenges in terms of ethics, professional responsibility, and data governance (Cervantes López et al., 2024). These findings are consistent with the international literature, which warns that, in complex and regulated organizational contexts such as the healthcare sector, the adoption of AI must be gradual, strategic, and subject to strong human oversight to ensure sustainable and socially responsible outcomes (Vrontis et al., 2022; Frank et al., 2019).

Likewise, empirical evidence indicates that the impact of artificial intelligence varies depending on the sector of activity and the level of digital maturity of organizations. In areas such as logistics and supply chain management, AI has demonstrated clear benefits in terms of traceability, demand forecasting, and reduced operating costs, even contributing to sustainability goals (Makridakis, 2017; Janiesch et al., 2021). In contrast, in functions related to strategic management and corporate governance, the main challenges center on the continuous training of human talent, the redefinition of job roles, and the alignment between technology and business strategy (Keding, 2021; Teixeira et al., 2022).

In summary, although the literature agrees that the potential benefits of artificial intelligence far outweigh its limitations, the success of its implementation depends on organizations' ability to integrate technological innovation with robust strategies for change management, competency development, and ethical governance of algorithms. In this regard, the findings integrated into this review confirm that a conscious, strategic, and responsible adoption of AI constitutes a key factor in strengthening the sustainability, resilience, and innovative capacity of contemporary organizations (Dwivedi et al., 2021; Brynjolfsson et al., 2018; Reier-Forradellas & Garay-Gallastegui, 2021).

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Random forest for system identification in level processes

Karla Yohana Sánchez-Mojica
Msc Ingeniería Industrial, Corporación Universitaria Iberoamericana, Grupo de Investigación GIGCIC, Bogotá, Colombia, karla.sanchez@docente.ibero.edu.co

Introduction

Predicting variables in industrial systems allows for anticipating behaviors and improving operational efficiency. This work applies the Random Forest algorithm to predict the level in a level plant[1], using historical data on time, inlet flow rate, outlet flow rate, and level. Unlike a control-loop system, a predictive model is proposed that allows estimating system behavior without direct intervention using a machine learning-based approach, offering an effective alternative for processes with complex dynamics.

Level control in industrial systems, such as chemical plants, water treatment plants, or energy processes, is a fundamental task to guarantee the efficiency, safety, and operational stability of the system. Traditionally, classical control strategies such as PID control [2]-[3]-[4] have been used, which work adequately under linear and stable conditions; however, in dynamic, nonlinear, and multi-disturbance scenarios, these techniques can be limited, and the importance of applying intelligent approaches arises as an effective alternative to improve the performance and adaptability of level control systems.

The use of machine learning algorithms allows to build models capable of learning the behavior of the system from historical data, without the need for explicit mathematical modeling [5]. For this reason, algorithms such as decision trees, artificial neural networks, support vector machines and Random Forest models have demonstrated a high capacity to predict the tank level based on input variables such as inlet flow rate, outlet flow rate and time [6]-[7], allowing to anticipate critical situations such as overflow or emptying of the tank and adjust the manipulated variables in real time to keep the process within the desired parameters.

AI enables the implementation of intelligent predictive control systems where the learning model not only predicts the future level, but also optimizes the control action to minimize error or energy consumption [8]-[9]-[10]. Analyzing this type of intelligent solutions, they adapt to changing conditions and present superior robustness against noise, sensor failures and external disturbances.

For this research, a set of experimental data from a level plant was used, where the variables Time, Inlet Flow, Outlet Flow, and Level were recorded. The information was extracted from the "AVERATES" section of a spreadsheet-structured file, with 1,115 records taken over 8 days of operation, equivalent to 1 record per minute. However, by processing the data to eliminate duplicate, unread, or null data, the database is consolidated with 1,115 records.

A prediction model was implemented using the Random Forest Regressor algorithm , due to its ability to handle nonlinear relationships and avoid overfitting on small data sets. Using a Random Forest model for tank level control is appropriate in contexts where historical system

data is available and an artificial intelligence-based solution capable of modeling nonlinear relationships between variables is sought.

By combining multiple decision trees, the algorithm allows for predicting level behavior based on variables such as inlet and outlet flow rates, and time as a cross-cutting variable, without requiring detailed knowledge of the physical equations of the process. Furthermore, its robustness to noise and its ability to generalize make it a useful tool for complex systems or in variable industrial environments.

Although Random Forest does not act as a traditional controller, it can be integrated into predictive control schemes or automated decision-making systems that dynamically adjust process actions based on predictions, thereby helping to efficiently and accurately maintain the tank level within desired limits. The model was developed and trained in Google Colab , using libraries such as Scikit-learn and Pandas; the average model training time was one hour and sixteen minutes.

The data were divided into two subsets: 80% was used for training and the remaining 20% for validation. The main evaluation metric was the coefficient of determination R^2 [11], accompanied by the mean absolute error (MAE), in order to quantify the accuracy of the predictions. The model was trained exclusively with the variables Time, Inflow and Outflow as inputs (X) and Level as output (y), discarding other variables that did not provide predictive value [12], which allowed to reduce the dispersion and improve the stability of the model

Figure 1 shows the basic layout of the plant used for data collection and system operation.

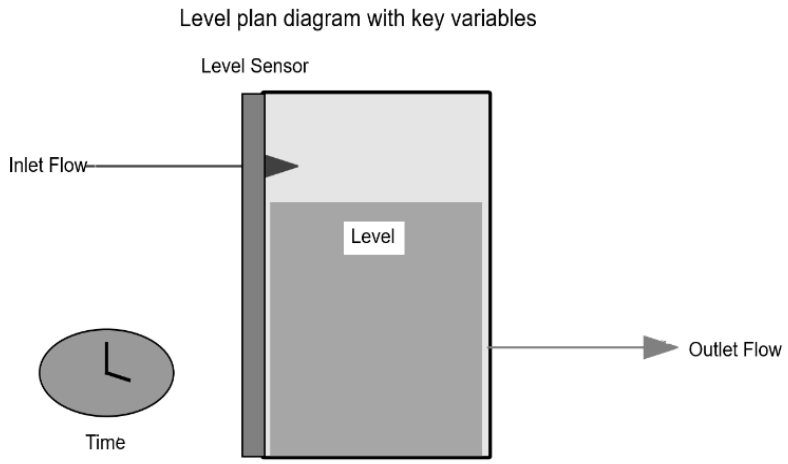


Figure 1. Representation of the level plan

Table I represents the system variables:

Table 1. *System variables*

Variable	Nomenclature	Unit	Description
Tank level	h	meters (m)	Height of the liquid in the tank, process variable to be controlled.
Inlet flow rate	Qin	m^3/s	Flow entering the tank, manipulated variable.
Output flow	Qout	m^3/s	Flow leaving the tank can be manipulated or disturbed.
Time	t	seconds (s)	Temporary variable that indicates the evolution of the system.
Tank section area	TO	m^2	Cross-sectional area of the tank, used in dynamics equations.
Predicted level (by AI)	$\underline{\hat{h}}$	meters (m)	Level estimated by the prediction model
Desired level	h_{ref}	meters (m)	Target value of the level to be maintained.
Level error	$e(t) = h_{ref} - \underline{\hat{h}}(t)$	meters (m)	Difference between the desired level and the predicted or measured level.

Random Forest model uses a machine learning algorithm to predict the future tank level based on key variables such as inflow rate, outflow rate, time, and current level. Using traditionally collected data, the model learns the nonlinear relationships between these variables and constructs multiple decision trees that, together, produce a robust and accurate prediction of system behavior (Table II).

Table 2. *Characteristics of the proposed model*

Feature	Description
Nature of the algorithm	Supervised learning
Expected entry	Numeric variables
Exit	Continuous variable
Number of trees	Number of trees that make up the forest (120)
Division criterion	Mean square error (MSE)
Advantage	High accuracy, robustness to noise and overfitting, no data normalization required, nonlinearity handling capability

Disadvantage	Computationally heavier model

This prediction is used within an intelligent control logic that compares the estimated level with the operating limits (minimum and maximum levels) and determines the most appropriate action, such as opening or closing valves. Although the Random Forest model does not act as a traditional controller, its predictive capacity allows for early decisions that stabilize the system, making it an effective tool for supporting the automated control of level plants under dynamic conditions and disturbances.

Prediction-based control logic involves using a machine learning model, such as Random Forest, to estimate the future behavior of the tank level variable, based on current and past values of relevant variables such as inflow rate, outflow rate, and time. Based on this prediction, the control system compares the estimated level value with a defined operating range (minimum level 1 meter and maximum 10 meters) and determines in advance what action to take to prevent deviations.

If the level is predicted to fall below the minimum, the inlet flow rate is increased; if it is expected to exceed the maximum, the inlet flow rate is reduced or the outlet flow rate is increased. This approach allows for a more anticipatory and adaptive response than traditional controllers, improving system stability and avoiding delayed reactive responses to disturbances or changes in process dynamics.

Figure 2. Model prediction and actual system behavior

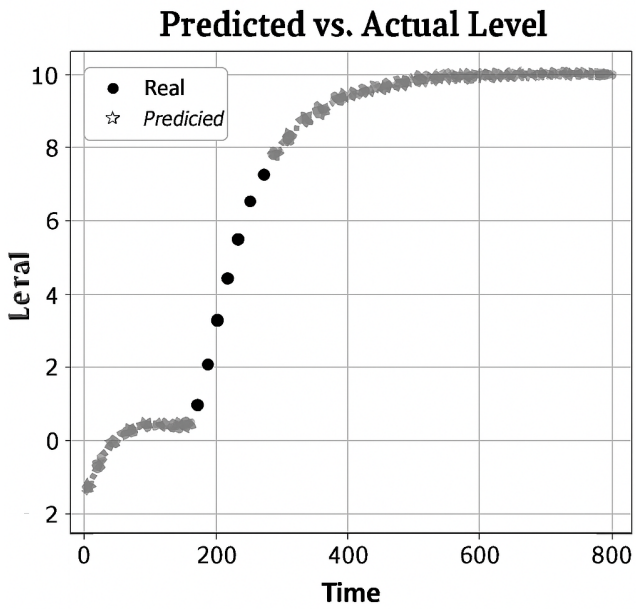


Figure 2 shows the comparison between the actual tank level (blue curve) and the level predicted by the Random Forest model (orange curve) over time. The prediction model accurately follows the evolution of the actual level, including periods of accelerated growth, stabilization, and saturation.

During the initial phase, the level increases progressively, reflecting controlled filling, and at about 600 seconds, it reaches a quasi-steady state close to the maximum. The superposition of both curves indicates a high degree of model accuracy, demonstrating that the prediction-based control logic can effectively anticipate system changes and make informed decisions. This suggests that the model can be reliably used as part of an intelligent control scheme in level systems

The mean absolute error (MAE) and coefficient of determination (R^2) were used as evaluation metrics. The model achieved an MAE of approximately 0.00687 and an R^2 of 0.999, indicating an excellent fit between the predictions and the actual values of the system. These values reflect the model's high accuracy and its ability to generalize correctly to unseen data (Figure 3).

Figure 3. Results of the proposed model

```
MAE: 0.006878563738903296
R² Score: 0.9999674908797991
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After observing the model's behavior, a prediction of future data is generated taking into account a time of approximately 1 hour, which is a strategy that allows action to be taken or incidents to be prevented at the plant (Figure 4).

Figure 4. Model prediction, actual system behavior, and future behavior

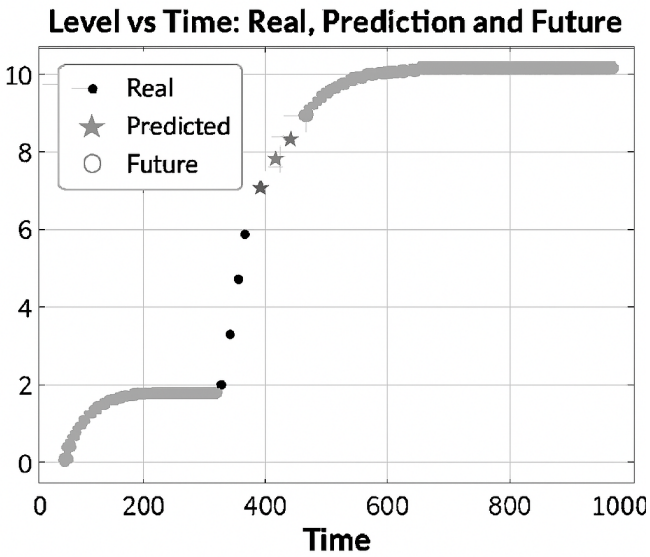


Figure 4 shows the evolution of the tank level over time, comparing three components: the actual level (in blue), the level predicted by the Random Forest model (in orange) and the future level prediction (in green). This shows an excellent match between the actual values and those estimated during training, which validates the accuracy of the model in the known phase of the process.

Starting at a time point close to 900 seconds, future predictions, represented in green, are introduced. These predictions indicate a level stabilization near the maximum, suggesting that the system has reached a steady state, and this predicted behavior is consistent with the expected dynamics of a filling system under constant conditions. Figure 4 supports the use of

the model not only as a prediction tool but also as a useful component for anticipating decisions in an intelligent control scheme, where actions can be taken before critical tank level deviations occur.

From the mathematical representation, Random Forest replaces the traditional dynamic equation with a practical prediction function [13], which estimates the future level directly from the observed input variables, then it is to think that the model behaves as a predictive black box, useful for the design of intelligent controls based on data and can be represented as shown below:

$$\hbar(t+1) = fRF\ (Qin(t), Qout(t), h(t), t)$$

Where fRF is the prediction function learned by the Random Forest model, $\hbar(t+1)$ represents the predicted tank level at the next instant and $Qin(t), Qout(t), h(t), t$ are input variables to the model. From here we can think of the following mathematical representation of the model Random Forest with M=120 independent decision trees and each tree Ti makes a prediction Ti(x) on the output variable level:

$$\hbar(t+1) = \frac{1}{120}\sum_{i=1}^{120} Ti(x) \text{ where } x = [\ Qin(t), Qout(t), h(t), t]$$

Conclusions

The Random Forest model proved effective in predicting level behavior in an industrial plant, using only the time variable as input. The results obtained, with a low MAE and an R^2 close to 1 (0.984), indicate excellent model fit and high predictive capacity. This approach offers a practical alternative for anticipating system behavior without the need for active control, making it useful in discrete environments where precise monitoring is required.

The comparison between actual and predicted levels reveals minimal deviation and the model's excellent ability to adapt to variations in inflow, outflow, and temporal conditions. The inclusion of future predictions reinforces its usefulness as a tool for analyzing future system behavior , allowing this approach to be integrated into intelligent control schemes.

The successful implementation of the Random Forest model for level prediction in industrial tank systems has a significant impact on efficiency, safety, and process automation. It enables accurate level behavior estimates without the need for detailed physical models, facilitates the design of data-driven predictive control systems, and can reduce modeling and commissioning costs, improves response to disturbances, and enables anticipatory actions to prevent overflows or depletions.

This approach is also scalable and adaptable to diverse industries such as food, chemicals, water treatment, and energy, where fluid-based processes are common. Random Forest's ability to learn and adapt to new data also promotes predictive maintenance and resource optimization, aligning with Industry 4.0 and cyber-physical systems trends.

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Integrating Statistical Methods and Machine Learning to Optimize Investment Decisions in Bitcoin

Óscar Iván Rodríguez-Cardoso
Corporación Universitaria Asturias (Colombia),
oscar.rodriguez@asturias.edu.co, https://orcid.org/0000-0003-1203-4999

Introduction

From a data analytics standpoint, Bitcoin represents a unique phenomenon in modern finance due to its decentralized architecture and the richness of its historical price data. Introduced in 2009 by Nakamoto (2008), Bitcoin's peer-to-peer structure eliminates the need for financial intermediaries, relying instead on a cryptographically secured network that effectively solves the double-spending problem. This innovation not only catalyzed the emergence of thousands of digital assets but also challenged conventional valuation paradigms. In light of Bitcoin's extreme volatility and lack of intrinsic fundamentals, technical analysis offers a statistically grounded alternative for modeling price behavior, emphasizing observable market dynamics over theoretical assumptions.

Theoretical Basis of Technical Analysis for Forecasting Future Bitcoin Prices

Technical analysis, as a discipline centered on historical price and volume behavior, offers robust tools for anticipating market trends by identifying recurring patterns in financial data (Edwards *et al.*, 2021). Its core assumption is that all relevant information—economic, political, and psychological—is already embedded in asset prices, allowing analysts to derive insights from market movements alone. Unlike fundamental analysis, which relies on intrinsic valuation based on financial and macroeconomic indicators (Graham & Dodd, 2008), technical analysis focuses exclusively on how prices behave over time. This distinction becomes particularly relevant in the context of cryptocurrencies such as Bitcoin, where the absence of traditional financial statements makes fundamental analysis less applicable (Lo *et al.*, 2000).

Over the years, technical analysis has evolved from basic chart observation to include sophisticated quantitative tools—oscillators, moving averages, and volatility-based indicators—without compromising its methodological consistency (Edwards *et al.*, 2021). Among these, Bollinger Bands have become one of the most widely used indicators for identifying overbought or oversold zones by incorporating standard deviation around a moving average (Bollinger, 2002). Their adaptive nature makes them particularly suitable for volatile environments.

Recent advances in artificial intelligence have further expanded the scope of technical analysis by integrating machine learning algorithms that enhance its predictive power. The Random Forest algorithm, in particular, has shown excellent performance in forecasting financial time series due to its capacity to model nonlinear relationships, detect variable interactions, and

control overfitting (Hyndman & Athanasopoulos, 2018). The synergy between machine learning and classical technical indicators supports the development of hybrid models that combine data-driven rigor with empirical market knowledge. The growing complexity of financial markets in the 21st century has accelerated the adoption of statistical time series techniques in finance (Chatfield, 2000). While linear regression remains a foundational approach for approximating relationships between dependent and independent variables, its limitations in capturing nonlinear dynamics and structural shifts are well-documented (Chatfield, 2000). The emergence of machine learning in the late 20th century marked a paradigm shift in forecasting methodology, driven by access to massive data volumes and advances in computational power (Ahmed et al., 2010; Cerqueira *et al.*, 2019). These models have proven more effective in identifying hidden structures and adapting to volatile, nonlinear systems such as cryptocurrency markets (Bontempi et al., 2013). Their application enables deeper insights and longer-term forecasting capacity, improving both temporal accuracy and model generalizability (Pavlyshenko, 2019; Masini *et al.*, 2023). Recent studies confirm that successful Bitcoin price forecasting hinges on the model's ability to capture complex temporal dependencies and latent patterns, such as trend cycles or seasonality. When such elements are not adequately modeled, prediction accuracy declines sharply (López-García, 2023). This highlights the need for flexible approaches that combine classical and modern techniques. Accordingly, the present study explores the integration of linear regression and Random Forest to estimate Bitcoin's future price behavior—proposing a hybrid strategy that merges technical insight with the predictive strength of AI-based analytics.

This study was conducted using a quantitative, predictive, and computational approach, aimed at analyzing the historical behavior of Bitcoin's price through statistical and machine learning models. To this end, tools from the Python programming language—widely used in data science and financial analysis projects—were employed. The dataset was obtained from public historical records, comprising over 5,400 daily observations of Bitcoin's price from 2010 to June 2025, sourced from www.investing.com. The dataset includes variables such as date (Date), opening price (Open), daily high (High), daily low (Low), trading volume (Vol new), and daily percentage change (Change %). The closing price (Price) was selected as the dependent variable for the predictive models. Initially, a multiple linear regression model was implemented using the LinearRegression class from the scikit-learn library. The model was trained using a random split of 80% of the data for training and 20% for validation. Subsequently, the classical statistical assumptions of linear regression were evaluated through graphical analyses and tests such as Breusch-Pagan (for homoscedasticity) and Durbin-Watson (for autocorrelation). As a second strategy, the ensemble algorithm Random Forest Regressor (sklearn.ensemble.RandomForestRegressor) was employed, using 100 trees (n_estimators=100) and a fixed random seed (random_state=42) to ensure reproducibility. This model does not require linear assumptions and is capable of capturing non-obvious interactions among variables. The performance of both models was evaluated using the coefficient of determination (R^2) and the root mean squared error (RMSE), calculated on the test set. All visualizations were generated using the matplotlib and seaborn libraries, and data processing was conducted with pandas. The entire analysis was carried out locally in a Jupyter Notebook environment.

Results of the Linear Regression Model

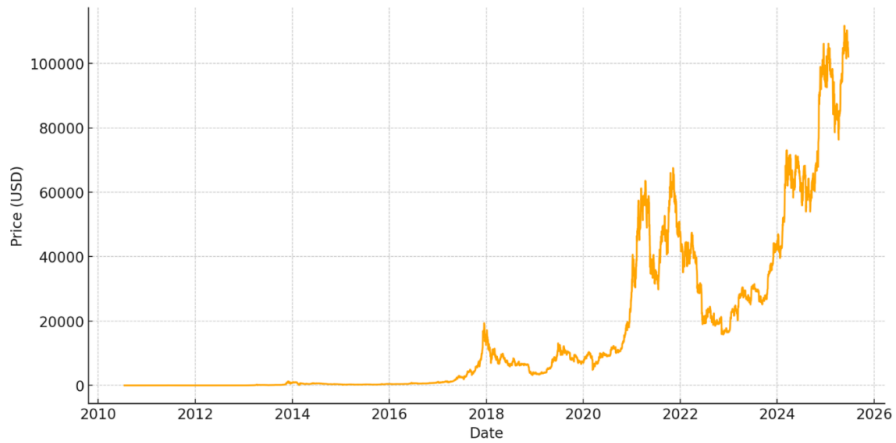
To estimate the daily closing price of Bitcoin, a multiple linear regression model was

developed using the Python programming language, integrating tools from the data science ecosystem applied to financial analysis. The dataset used contains over 5,400 historical daily records of Bitcoin, providing a statistically robust foundation. The data was organized in an Excel file, which was processed using the pandas library—widely used in Big Data environments for its efficiency in handling tabular structures. From the dataset, the closing price (Price) was selected as the dependent variable, while the predictors included Open, High, Low, Vol new, and Change %, all of which are related to the intraday behavior of the asset. This selection aims to capture not only the opening price but also daily volatility, transaction volume pressure, and the direction of the daily percentage change—key factors in the dynamics of financial assets, particularly cryptocurrencies. The model was trained on a random sample comprising 80% of the data, with the remaining 20% reserved for validation. This procedure was carried out using the train_test_split function from the scikit-learn library, which ensures a coherent separation between training and testing sets, minimizing the risk of overfitting. Subsequently, the linear regression was implemented using the LinearRegression class, which estimates the coefficients of the linear function that best fits the data through the ordinary least squares method, resulting in the following model:

$$\boldsymbol{Price \approx -4.83 - 0.4697open + 0.8334High + 0.6339Low - 9.74 \times 10^{-10} Vol\ new + 14.5268Change\%}$$

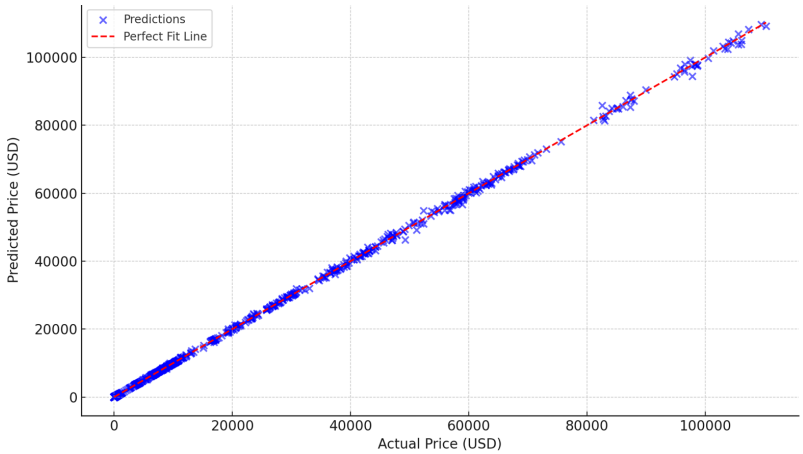
The results obtained demonstrate an outstanding fit of the model. The coefficient of determination (R^2) was 0.9998, indicating that the model explains 99.98% of the variability in Bitcoin's closing price. Likewise, the root mean squared error (RMSE) was approximately USD 389.22, a reasonable magnitude given the asset's scale in recent years. The estimated coefficients show that the day's high and low prices have a strong positive influence on the closing price, while the transaction volume presents a very small, nearly negligible, negative coefficient. This latter variable was included for reference, although its predictive power is limited. To visually validate the model's predictive capacity, two visualizations were generated. The first (see Figure 1) shows the historical evolution of Bitcoin's price from 2010 to mid-2025. This visualization allows for an appreciation of the asset's exponential growth and highlights the need for models capable of estimating its behavior. The second (see Figure 2) displays the scatter plot of actual price values versus the values predicted by the model. In this figure, the cloud of points is almost perfectly aligned along the diagonal reference line (y = x), visually demonstrating the excellent fit achieved by the model.

Figure 1. Historical Bitcoin price 2010-2025.



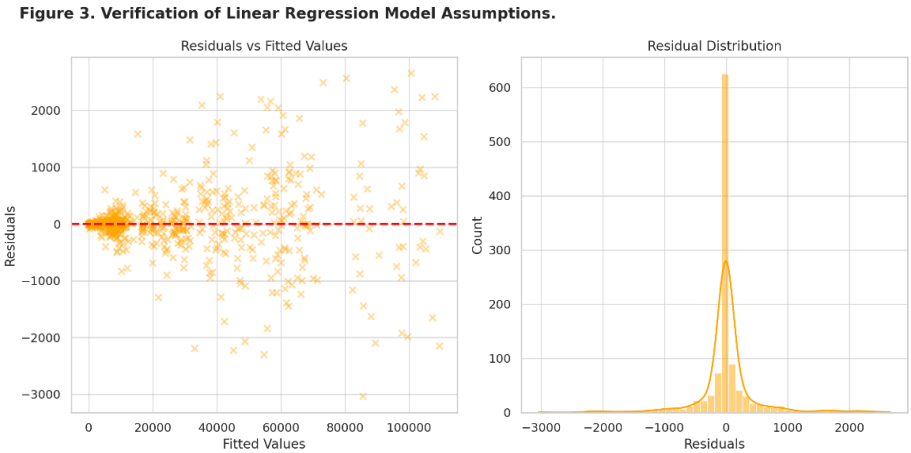
To ensure the validity of the linear regression model fitted to Bitcoin's price, a systematic verification of the classical assumptions underlying its application was conducted: linearity, normality of residuals, homoscedasticity, and absence of autocorrelation. First, the assumption of linearity was examined through a residuals-versus-fitted-values plot. This chart allows for a visual assessment of whether any systematic relationship exists between the model's errors and its predictions.

Figure 2. Comparison between Actual and Predicted Price – Linear Regression Model.



As shown in Figure 3, the residuals are randomly distributed around the horizontal zero line, without forming discernible patterns. This suggests that the relationship between the predictor variables and the price reasonably approximates a linear structure. Next, the normality assumption of the residuals was evaluated. Figure 3 also presents the histogram of residuals along with its corresponding fitted density curve.

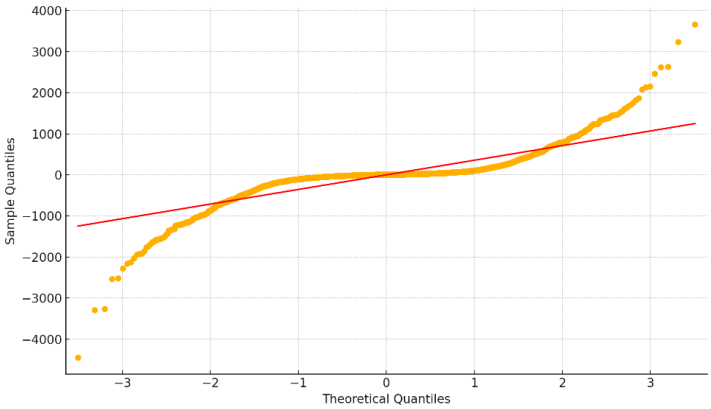
Figure 3. Verification of Linear Regression Model Assumptions.



Although the residuals are highly concentrated around zero, somewhat elongated tails can be observed. This observation is further supported by Figure 4, which shows the Q-Q (quantile-quantile) plot of the residuals. While most of the points align with the theoretical diagonal, slight deviations appear at the extremes, suggesting mild asymmetry or the presence of outliers. However, given the large sample size (over 4,000 training observations), the impact of

this deviation on the estimation of the coefficients is limited, in accordance with the central limit theorem.

Figure 4. Residuals Q-Q plot.



To assess homoscedasticity—that is, the constancy of the variance of the errors—the Breusch-Pagan statistical test was applied. The result was highly significant ($p < 0.001$), indicating the presence of heteroscedasticity in the residuals. Although this finding does not invalidate the model as a predictive tool, it suggests that the standard error estimates may be biased, and therefore it is recommended to complement the analysis with robust models or variable transformations. Finally, the Durbin-Watson statistic was calculated, yielding a value of 2.03, which falls within the acceptable range (between 1.5 and 2.5). This result suggests that there is no significant first-order autocorrelation in the residuals, thus satisfying this final assumption. In summary, the linear regression model reasonably meets the classical assumptions, with the exception of homoscedasticity, which shows signs of non-constant variance. However, this does not substantially affect its predictive power, given that the coefficient of determination remains exceptionally high ($R^2 = 0.9998$).

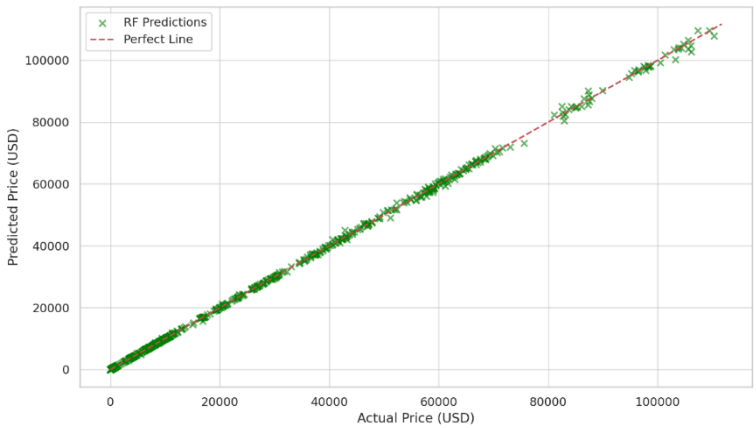
Results of the Random Forest Model

With the aim of strengthening the artificial intelligence approach in the predictive analysis of Bitcoin's price, a Random Forest Regressor model was implemented as a supervised machine learning technique. Unlike the previously used linear regression model, Random Forest does not require the verification of classical statistical assumptions and is particularly effective at capturing nonlinear relationships between variables, as well as handling complex interactions within the data. The model was developed in Python using the following libraries from the data science ecosystem: pandas, for data manipulation and structuring; scikit-learn (specifically sklearn.ensemble, sklearn.model_selection, and sklearn.metrics), for model creation, data splitting, and performance evaluation; and matplotlib and seaborn, for generating interpretive visualizations of the results.

The dataset contains more than 5,000 daily records of Bitcoin prices from 2010 to mid-2025. The closing price (Price) was used as the target variable, while the selected predictor variables were: Open, High, Low, Vol new, and Change %. These variables were chosen for their relevance to the intraday dynamics of the crypto market and for their historical availability for each observation. The Random Forest model was trained on 80% of the data using the RandomForestRegressor class from sklearn.ensemble, with 100 trees (n_estimators=100) and a

fixed random seed (random_state=42) to ensure reproducibility. Once the model was fitted, its performance was evaluated on the remaining 20% of the data, which was not seen during training. The results of the model were highly satisfactory. The coefficient of determination (R^2) reached a value of 0.9998, confirming that the model explains virtually all the variability in the closing price. Additionally, the root mean squared error (RMSE) decreased to USD 328.99, improving the accuracy compared to the classical linear regression model, which had an RMSE of 389.22. Although this improvement is marginal, it reinforces the value of using advanced machine learning algorithms in scenarios where the relationships between variables do not necessarily follow a linear pattern. Figure 5 presents the scatter plot of actual prices versus the values predicted by the Random Forest model. The close alignment of the green points along the red diagonal indicates a high level of fit and low variability in the prediction errors. Moreover, the model's robustness is visually evident, even without having assumed any prior functional relationship between the variables. Finally, the relative importance of each predictor within the model was analyzed—an essential aspect in ensemble algorithms such as Random Forest. The results indicated that the variables High and Low accounted for more than 96% of the total importance, making them the most influential in price prediction. In contrast, variables such as Change % and Vol new showed virtually no impact, suggesting that their contribution to the model is marginal and that they could be excluded in optimized versions of the analysis.

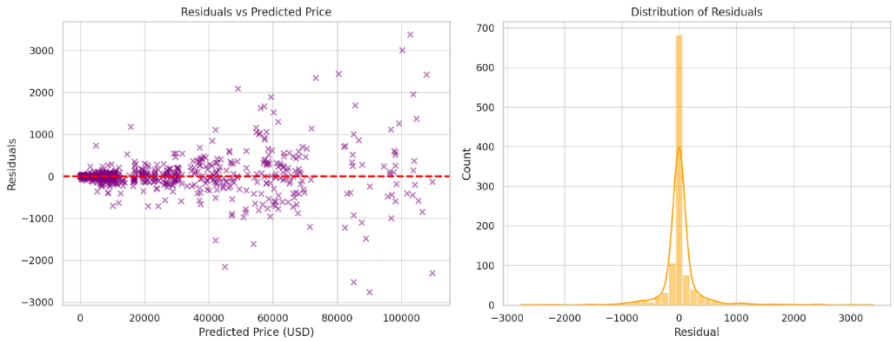
Figure 5. Actual Price vs Predicted Price – Random Forest Model.



To validate the robustness of the Random Forest–based predictive model, a detailed residual analysis was conducted to detect potential signs of overfitting—a common phenomenon in highly flexible machine learning models. The scatter plot of the residuals (the difference between the actual and predicted values) versus the predicted price is shown in Figure 6. In this plot, the points are centered around the horizontal zero line, without forming noticeable patterns or systematic structures. This is a positive indication, as it suggests that the model does not make systematic errors but rather random ones, which is desirable in a well-performing predictive model. However, there is a slightly greater dispersion at the lower end, where predicted prices are low. This could be associated with higher volatility during the early years of Bitcoin's price history, when its value was lower and more unstable. Additionally, the histogram of the residuals (see Figure 6) shows an approximately symmetrical distribution centered around zero, with a slight negative skew. There are no pronounced tails or signs of

extreme residuals that would suggest severe prediction errors or model instability. This residual behavior reinforces the idea that the Random Forest model generalizes well on the test data, without showing evidence of memorizing the training set. Taken together, both visual analyses suggest that the model does not exhibit significant overfitting. Although its performance is exceptional ($R^2 \approx 0.9998$), this high level of accuracy does not appear to result from overfitting the training data, but rather from the structural strength of the predictor variables (High and Low) and the quality of the historical data.

Figure 6. Residuals vs Predicted Price (Random Forest)-Distribution of Residuals (Random Forest.



Nevertheless, as a best practice in modeling environments with large datasets, it is recommended to complement this evaluation with cross-validation techniques to confirm the stability of the model's performance across multiple random data splits.

Conclusions

This study has demonstrated the feasibility of applying both classical statistical approaches and machine learning methods to the historical analysis of Bitcoin's price, integrating models such as multiple linear regression and the Random Forest algorithm to generate estimates of its behavior. The implementation of both models revealed a remarkable explanatory capacity, with coefficients of determination exceeding 99.9% and relatively low prediction errors, considering the asset's scale and volatility. The linear regression model, despite its structural simplicity and the classical assumptions it entails, showed solid performance when applied to clean, structured data with high correlation among variables. Its interpretability allowed for the identification of clear linear relationships between the closing price and variables such as the daily high and low, reaffirming its usefulness as a reference tool in low-complexity scenarios. In contrast, the Random Forest model, by not relying on parametric assumptions and allowing for the capture of nonlinear relationships, provided a marginal improvement in prediction error and greater robustness to potential irregularities in the data structure. Residual analysis and visual evaluation confirmed the absence of overfitting, which reinforces the model's generalization capability on unseen data. Nevertheless, it is important to interpret these results with caution. Although the models were able to replicate the historical evolution of the price with high precision, this does not imply that they can be used as infallible forecasting tools or as investment advice. The estimates presented here are derived from patterns observed in past data and are subject to inherent limitations, such as the stability of the modeled relationships, the quality of the data, and the inability to incorporate exogenous events that may abruptly impact financial markets. Therefore, this study should not be interpreted as a guide for making

investment decisions, but rather as an analytical and exploratory exercise that illustrates the potential of statistical and machine learning models in the context of highly volatile digital assets. In summary, the integration of explanatory models and artificial intelligence techniques represents a promising path for the quantitative analysis of cryptocurrencies. However, their use must be accompanied by a deep understanding of their limitations and should never replace expert judgment or the fundamental principles of risk management in real financial contexts. This work contributes to the growing body of research on the use of hybrid methods in financial analysis and lays the groundwork for future explorations in the field of cryptoasset forecasting through artificial intelligence.

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AI-generated content in search engine results pages and their impact on informational websites

Antonio Rico Sulayes
Universidad de las Américas Puebla (Mexico),
antonio.rico@udlap.mx, https://orcid.org/0000-0003-0932-4733

Introduction

Over the last few years, the results pages rendered by search engines have changed noticeably with the addition of AI-generated content. Before the inclusion of this new information, search engines used to produce a list of results that showed the title of the page, a link to it and a snippet of its contents (Varlamis & Stamou, 2009). Traditional snippets included in results pages are usually composed of a piece of text relatively contiguous and a few sentences in length. This text is supposed to offer a glimpse of the webpage, so users can determine whether they should click on its link. Therefore, these types of results were basically designed to help users find the answers to their needs in third-party websites. AI-generated content in results pages has the potential to answer directly certain kinds of queries, deemphasizing the need to visit a website. This will likely change the rules of the game for website developers and entrepreneurs. The present research shows an attempt to determine whether AI-generated content in Google has had a positive or negative impact on an informational website, a dictionary of neologisms for native and non-native speakers of Spanish.

Evaluating the impact of AI-generated content in search engine results pages (SERPs), such as AI overviews or featured snippets, is neither easy, nor cheap. Free-of-charge tools that measure website performance do not separate information regarding the traffic derived from this type of content. Google Search Console, for example, is a tool that provides website owners with information regarding the most common queries associated with their site in this search engine, as well as their clicks and impressions (visualizations in SERPs), among other useful data (Google, n.d.). However, this free tool shows all these performance metrics globally. Thus, using Google Search Console does not allow owners to link any performance changes of their websites to AI-generated content. A seemingly simple solution is to pay for a service that tracks AI overviews performance (Sanger, 2025). However, the information provided by these kinds of tools still must be analyzed and compared with a website overall traffic. Even more importantly, for a non-funded, free-of-charge educational tool, such as an online Spanish neologisms dictionary, paying for these tools is prohibitive.

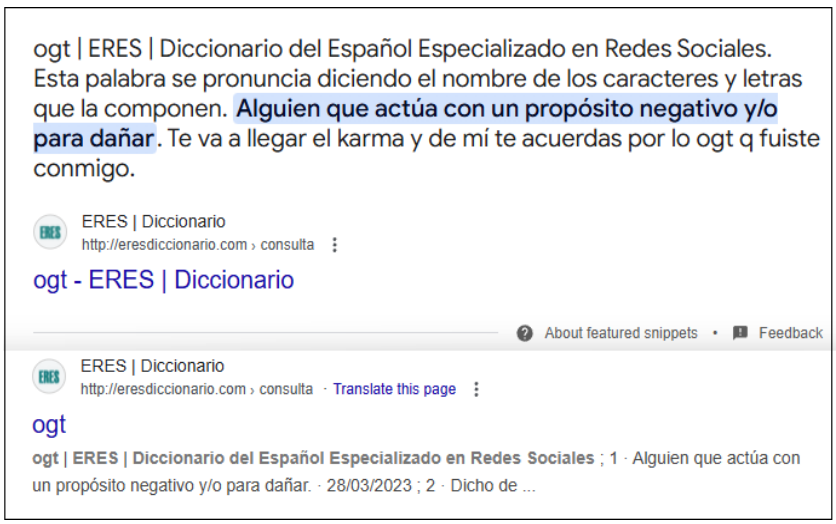
In face of this type of challenge, the present study proposes a scale to evaluate the presence of a webpage in AI-generated content in SERPs. Then, it explores whether this evaluation model helps identify and explain traffic trends in webpages that score high with the proposed scale. The proposed framework is tested using traffic information from *Diccionario del Español Especializado en Redes Sociales* (*ERES*) (Rico-Sulayes, 2025). The online interface of this dictionary, under the domain eresdiccionario.com, has obtained over 15 thousand clicks and 3.4 million impressions during the last year, according to data obtained in Google Search Console. As discussed later, the scale has proved useful in the exploration of how the dictionary has been included in Google AI-generated content, as well as in the identification of

webpages with performance changes at the level of clicks and impressions, or visualizations in SERPs. In an overall analysis of the dictionary, the AI-generated content in Google search engine has had a negative impact in organic traffic, but a positive one in terms of the website visibility.

AI-generated content in SERPs

Currently, there are two main forms of AI-generated content in Google results pages, featured snippets and AI overviews. In a featured snippet, the result of a query is presented in reverse order from a regular result, with the snippet appearing before the link to the webpage and its title (Google, 2025a). Featured snippets are also displayed with a larger font. Figure 1 below shows a featured snippet on top of the snippet of a traditional result in a SERP. Both produced with a 100% zoom of the same browser, the two types of results in Figure 1 link to *ERES* entry for *ogt*, an acronym that refers to somebody harmful or with bad intentions.

Figure 1. A featured snippet and a traditional result for the same page of *ERES*.



The above figure shows that featured snippets may contain more information than traditional results, which are usually restricted to two or three lines of text. Featured snippets also link directly to the text extracted from the website, scrolling down to its position if necessary and highlighting the most important information in both the featured snippet and the linked page.

Featured snippets can also appear in a related questions group, usually known as a "People Also Ask" section. This type of section usually presents a few questions that may be related to the original query of the user, but they are linguistically more elaborate. Drawing on the former example, the snippets shown in Figure 1 were retrieved using the query *que significa ogt en chat*, "what does *ogt* mean in a chat [conversation]". For this query, the People Also Ask section offers four questions with a downwards arrow at the end, which if clicked on, display a featured snippet or an AI overview. The first question suggested for the original query is *¿Qué significa la palabra ogt?*, "What does the word *ogt* mean?" Not only does this query sound more natural than the original one, but it also follows conventional grammar and spelling rules. Google has not officially labelled featured snippets as AI content. However, they have been produced in the natural language processing community using transformers (Bink *et al.*, 2022), one important component of AI systems that has been successfully used in many AI

applications (Lin *et al.*, 2022).

In contrast, AI overviews in Google are explicitly recognized as AI-generated content. The main difference with featured snippets besides their name is that they are produced using more than one webpage (Semrush, 2024). For this reason, they show a list that usually includes between two and six sources used as references. AI overviews were experimentally produced and tested since May 2023, and fully released in the United States one year later. The first Spanish speaking country to get this function was Mexico in August of last year (Miranda, 2024) and the function was released in Spain in April of this year (Costa, 2025). Figure 2 below shows the top of the Google results page for the query *fangirleando*, the gerund form of a verb that refers to *the action of a woman showing great enthusiasm regarding some topic.*

Figure 2. An AI overview and a People Also Ask question for the same page of *ERES*.



Figure 2 shows the AI overview on the top left corner and its first reference on the top right corner. At the bottom of the figure, the first question of a People Also Ask section has already been displayed, after clicking on the arrow at the end of the question, which is then shown pointing upwards. The question *¿Qué significa fangirlear?*, "What does *fangirlear* mean?" represents a linguistically more elaborate query than the gerund form of the verb alone.

The position of AI overviews and featured snippets, including People Also Ask questions, which may contain any of the former two, are ranked according to where they appear in a SERP (Sanger, 2025). Since the rollout of this type of content, they usually occupy the first or first few places at the top of a results page. In the case of an AI overview, with its several references, all the URLs cited in it inherit its position. Impressions or visualizations are counted following general Google rules (2025b), namely they must be displayed by scrolling down or clicking on arrows to get an impression, or visualization.

Services to track websites traffic originated in AI-generated content

The possibility of a webpage getting cited in AI-generated content seems desirable at first, given the top position of results produced with this kind of information. However, the possible

determent of clicks is something that should also be considered (Goodwin, 2025). As mentioned before, measuring the impact that this inclusion may have on clicks to the cited page is not possible using Google tools or any other free-of-charge services. Sanger (2025) lists some of the benefits of paying for a service that tracks AI overviews. Regarding the inclusion of websites in AI overviews, these services allow subscribers to monitor the inclusion of webpages, to analyze keywords that help a website to get cited, to explore how competing websites are performing, to track websites evolution over time, and to explore detailed figures about impressions, clicks and other related metrics. This expert also lists several services that he classifies into subscription and specialized tools, with the latter offering tools that allow for more complex, large-scale performance analysis.

Sanger also mentions one free service for this type of tracking, Advanced Web Ranking (2025). Unfortunately, their free-of-charge Google AI Overview Tool only offers statistics for a large set of websites categorized under 16 different industry sectors, which include automotive, education, health, legal, and travel, among others. Therefore, there is no way to use this service to evaluate the inclusion and impact of AI-generated content on an individual site, such as the online dictionary here explored.

Data and Methods

The objectives of this research are as follows: (1) Explore the inclusion of *ERES* in Google AI-generated content using queries in which the dictionary has a high position in SERPs. (2) Identify trends and distributions in terms of AI overviews, featured snippets and People Also Ask questions groups, as well as combinations of the former ones. (3) Design a scale to evaluate the inclusion of individual pages of *ERES* in these types of results and explore whether the scale helps identify pages with changes in performance regarding clicks and visibility.

In order to collect data, I used as a point of departure the list of the 1,000 most popular queries for *ERES* over 3 months, between February and April 2025. Obtained with Google Search Console (n.d.), these queries are originally ordered by the number of clicks they obtained over some time. Instead of using this original order, I decided to explore the queries that had a higher position in SERPs since AI-generated content is placed at the top of them. In Google Search Console, the smaller the number of a position, the higher its priority. Namely, position 1 has the highest priority. After exploring the 100 queries with the highest priority over the last 3 months, it became obvious that a significant proportion of them (30%) were not represented in AI-generated results. Since much of Google AI-generated content has been available in Spanish for a fairly short period (barely a month in Spain at the moment the data was collected) I decided to shorten the time span in my list. Thus, I used the same 1,000 most popular queries, reordered by their position, for the 28 days before this second data collection, which included the first four weeks of May 2025. Analysing 455 queries with a high priority (with a position less than 6) only 25 were not included in AI-generated content. Namely, 94.5% of these queries did appear in some form of AI-generated result. Therefore, this was the final list of queries to which I applied the methodology explained below.

For the 455 queries just described, the following information was collected in Google search engine: (1) Whether a dictionary page was cited in the AI overview at the top of the page and if true, in what position of its list of references. (2) Whether a dictionary page was listed in a feature snippet and if true, in what position was the featured snippet listed. (3) Whether a dictionary page was listed in a question of a People Also Ask section originally displayed with

the query and if true, in what position of the section was the question listed. Regarding this last piece of information, a People Also Ask section changes and populates with new questions every time a user clicks on a question to display its answer, so the results page for the query was refreshed every time after clicking on a question to only consider the original list of questions displayed with a query. Finally, (4) if the answer to a People Also Ask question contained an AI overview in which a page of the dictionary was cited, the position in its list of references was also registered.

Using the above information, I created the following rules to assign a score to a page of the dictionary based on its presence in AI-generated results in Google. (1) Since in the old SERPs there used to be ten results per page, I decided to give ten points for being at the top position of the first SERP, 9 for second place, and so on, with only the first 10 results being considered. For this, I first subtracted a position in a SERP from the initial ten points and then added one. Adding one at the end was necessary because the top position is represented with number one so humans understand it better, but mathematically it should be zero. Therefore, if a page was in position 2, it obtained 9 points because 10-2= 8 and 8+1=9. These points were only given to a query if a dictionary page appeared in some form of AI-generated content, namely AI overviews and featured snippets, including People Also Ask questions originally displayed with the query. (2) If besides being in a position of the initial SERP, a link to the dictionary was further included in another list, like a list of references of an AI overview, I subtracted that position and added one once more. This was done to affect the original score based on the priority given to the link in a list of references. Thus, if a link to the dictionary was included in AI overview in position 3 and it was the second page cited, this reference produced 7 points because 10-3=7 and 7+1= 8, for the first part of the calculation, and 8-2= 6 and 6+1=7, for the second part. This was also done with questions in a People Also Ask section, subtracting points for the second and later questions. (3) If several links to a page of the dictionary, even to the same page, were included in several AI-generated results, I repeated this process and added all the scores obtained by the dictionary links in such a query. Also, if different sources of AI-generated content appeared all at the top of the SERP, with no intermediate results, they were all given position one. This is because Google seems to draw a division line right after all these contents, as if they were only one block.

As an example, we can look at the score obtained with this scale by the query *dosmilero*, a noun and adjective that refers to trends and fashion that dominated the first decade of the century and anything that is related to them. A link to the dictionary appears in an AI overview at the top of the SERP and it is the first reference in its list of cited pages. This gives the query 10 points because 10-1=9 and 9+1=10, which is the score for the overview, and 10-1=9 and 9+1=10, after considering its position in the list of references in the overview. Then, the same link to the dictionary appears in a People Also Ask group, right after the AI overview. The link is shown in the first question in the format of a feature snippet, and it obtained 10 points because 10-1=9 and 9+1=10, as the section is also at the top of the page in one block with the AI overview, and 10-1=9 and 9+1=10, as it is the first question in the group. Finally, the link also appears in the second question of the People Also Ask section, which contains an AI overview, and the link is the second in its list of references. For this, the query gets 8 more points because 10-2=8 and 8+1=9, for being the second question, and 9-2=7 and 7+1=8, as the link is the second reference in the AI overview shown in this second question. The query *dosmilero* was originally listed at position 59 of the 1,000 most common queries reorganized in terms of their highest position in SERPs. However, given the 28 points scored with the scale just

presented, the query is listed in position 12 in terms of its presence in AI-generated results. So, the scale is supposed to give a higher score to pages with multiple inclusions in AI-generated results in top positions.

The following section shows the figures obtained in terms of the inclusion of *ERES* pages in Google AI-generated results, their trends and distributions among the different forms of these types of contents, and how the scale has helped identify pages with changes in performance regarding clicks and visibility.

Using the figures mentioned in the last section, it is possible to identify a progressive inclusion of the dictionary pages in AI-generated sources in the last few weeks. As commented before, among the 100 most popular queries in terms of their highest position in SERPs, only 70% produced AI-generated content in the last 3 months, with a clear decreasing tendency in this figure as I continued exploring the list of 1,000 queries. However, in the more recent list of 28 days, 94.5% of the 455 most popular queries did retrieve some form of AI-generated content. So, not only has the proportion of pages produced by the queries increased, but the total number of them in this higher proportion is also larger.

Regarding the distribution among the different types of AI-generated results, the 455 queries with the highest position in SERPs were present in all forms of these types of contents: AI overviews at the top of SERPs, featured snippets in various positions, and People Also Ask questions, which include AI overviews and featured snippets too. Table 1 below shows the number of queries that included links to *ERES* pages in AI-generated results.

Table 1. *Presence of ERES pages among different types of AI-generated results*

Page links	AI overviews in top position	Featured Snippets	People Also Ask AI overviews	People Also Ask Featured Snippets
Number	198	53	61	219
Proportion	0.44	0.12	0.13	0.48

Proportion: the number of links divided by the total of 455 queries explored.

As shown in Table 1, the 455 queries explored produced links to the dictionary in 198 AI overviews in top position and in 53 featured snippets, which represent 44% and 12% of all queries, respectively. A total of 280 pages are included in a People Also Ask section, out of which 61 display an AI overview if clicked on and 219, a featured snippet. These figures represent, respectively, 13% and 48% of the queries explored. The added number of all AI-generated results is 531, which is bigger that the total number of the queries because many of latter produced more than one type of AI-generated result for the dictionary. As formerly mentioned, 5.5% of all queries did not produce these types of results at all. Therefore, there is a high representation of the dictionary pages among all forms of AI-generated results, when looking at high priority queries in which a dictionary page is among the first 5 positions of a SERP. Finally, exploring the first few queries ranked with the proposed scale, the results are varied. However, among the top ranked queries is possible to identify some with a negative trend in their production of clicks. This is the case of the query *dosmilero*, formerly used to

exemplify the application of the scale to produce a score. The negative trend of this query can be seen in Figure 3 below, which shows the line described by the number of impressions, or visualizations, on top of the line for the number of clicks, both for the query *dosmilero*, over a period of 12 months.

Figure 3. Impressions and clicks for the query *dosmilero* over the last year.

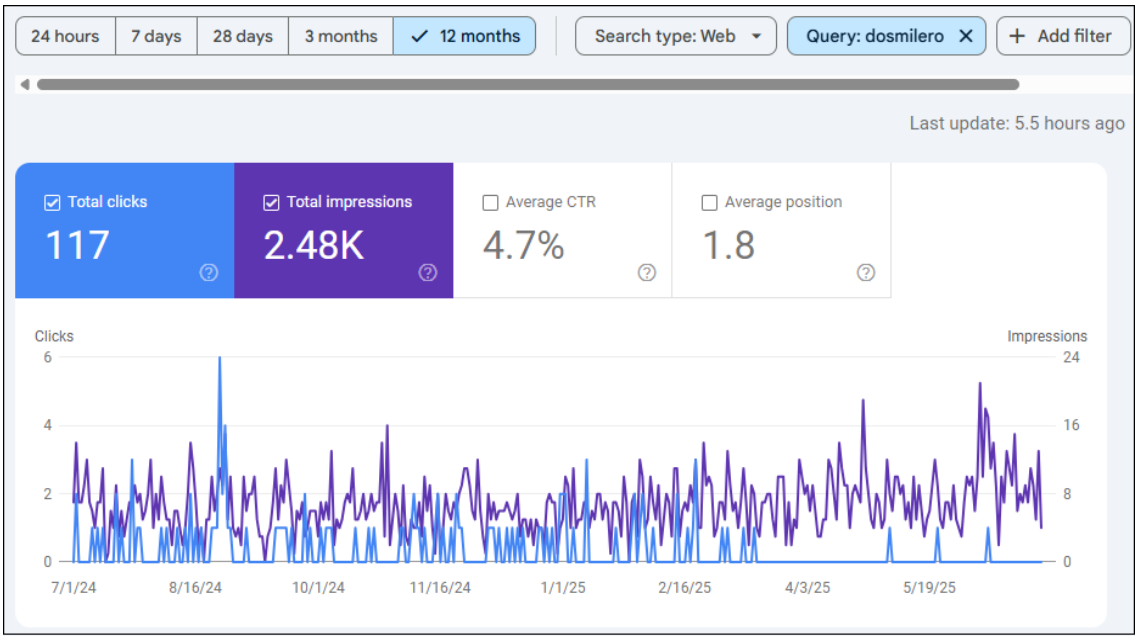


Figure 3 above shows that in the last couple of months, the impressions for the query *dosmilero* have increased, but its number of clicks has also decreased noticeably. This negative trend in the production of clicks confirms the expectation that AI-generated results are likely to reduce the number of clicks, particularly for informational websites (Goodwin, 2025). It should also be mentioned that not all queries ranked high with the proposed scale show this negative trend. The queries that do not show this trend seem to have less clicks in general. In any case, further exploration of the scale usefulness remains to be conducted. However, at least in a number of cases, the scale has proved useful to identify individual queries that respond to a general trend of the dictionary domain that became apparent since a couple of months ago, in which the number of impressions has effectively increased, but a decrease in clicks has also been attested.

Conclusions

This article examined the inclusion of a neologisms dictionary, a mostly informational website, in Google AI-generated results. The research attempted to find trends and distributions of dictionary pages among the different forms of these types of results. The article also proposed the creation of a scale to evaluate such inclusion and identify pages with changes in performance regarding clicks and visibility.

As discussed in the former section, the exploration conducted showed that in the last few weeks, the dictionary has gained a high inclusion in AI-generated results, with its most popular pages included in all forms of these types of results, in some cases with multiple inclusions. The proposed scale also helped identify some pages that, scoring high in the scale, have

experienced a negative trend in their production of clicks. This negative trend has been found to occur alongside an increase of impressions, which represents an improved visibility of the dictionary. This double trend of less clicks along with more impressions is something that has been observed in the general behaviour of the dictionary figures in Google Search Console. Therefore, the proposed scale and analysis has helped explained with particular examples the general behaviour of the dictionary traffic since the rollout of AI-generated content in Google search engine. This can help website developers and entrepreneurs gain important insights about the impact of the imminent changes that are coming with AI technologies and understand better what specific content in their websites is driving this impact.

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Artificial Intelligence in E-Commerce – Disruptive Strategies for Personalization and Sales Optimization

Deidy Gutiérrez Niño
Corporación Universitaria de Asturias – UNIASTURIAS (Colombia), deidy.nino@asturias.edu.co,
http://orcid.org/0000-0001-6786-5568

Introduction

The new trends in e-commerce have had a significant impact on the way individuals purchase goods or sell their products and services, enabling ventures into previously unexplored spaces, whether through omnichannel strategies or internationalization processes. These trends aim to expand Markets and enhance customer experience given current trends such as omnichannel and unified commerce (e.g., buy online and pick up in store); internationalization with localized catalogs, currencies, and payments; mobile and social commerce (live shopping and sales with creators); personalization with AI and experimentation at scale; conversational commerce with chatbots and voice assistants; dynamic pricing with demand forecasts; fintech integration (digital wallets and "buy now, pay later"); and last-mile innovations such as micro-fulfillment, parcel lockers, and route optimization., necessitating a robust logistics process and a competitive, secure, and trustworthy environment in which customers seek businesses that guarantee reliability and support.

As e-commerce becomes more consolidated, it must adapt to consumer demands across different geolocations. Consumers expect high-quality service, efficient product or service delivery, and seamless and personalized experience. Platforms must ensure straightforward navigability and provide efficient 24/7 customer service; consequently, the use of Artificial Intelligence (hereinafter referred to as AI) has become a key tool for enhancing operational efficiency and enabling data-driven decision-making. According to Accenture (2023), companies that incorporate AI into their digital value chain can achieve a return on investment of approximately 33%, or even higher, compared to their direct competitors. This is attributed to the adoption of agile business models and suitable technologies that allow them to remain relevant in an increasingly competitive digital environment.

Furthermore, recent studies indicate that more than 50% of e-commerce companies have adopted AI technologies, and that personalized AI-based recommendations contribute to a 15% to 20% increase in conversion rates, while 80% of customers consider themselves more likely to make purchases if offered a personalized experience (eDesk, 2023). Similarly, in the Spanish market, AI tools such as Adyen Uplift have been documented to increase payment conversion by up to 6%, reduce costs by around 5%, and improve fraud detection accuracy, empirically reinforcing the tangible potential of AI in sales and security.

This study adopts a qualitative and descriptive approach, aimed at a deeper understanding of how Artificial Intelligence impacts personalization and sales optimization in e-commerce. The research is based on an exhaustive documentary review of academic literature and official corporate sources, selected based on criteria of relevance, timeliness, reliability, and thematic relevance.

The bibliographic search was conducted between 2022 and 2024 in high-impact databases such as Scopus, ScienceDirect, and Google Scholar, as well as on official websites of leading companies in the sector (Amazon, Rappi, and Mercado Libre). This search used combinations of keywords in Spanish and English, such as: "Artificial Intelligence in e-commerce," "personalization strategies," "sales optimization with AI," "AI in e-commerce personalization," and "sales optimization with AI."

The analysis included the development of comparative matrices that allowed us to identify common patterns, strategies, and results in the implementation of AI, evaluating its applicability in real-life contexts. A case study was also conducted focusing on three representative companies in the digital market—Amazon, Rappi, and Mercado Libre—to assess the scope, benefits, challenges, and lessons learned from the adoption of AI technologies.

Finally, the findings were organized according to the research objectives, prioritizing the identification of key technological applications, the evaluation of their impacts, and a reflection on the ethical and regulatory challenges that influence their implementation in the field of e-commerce.

This section outlines the analytical path that connects the study objectives with the documentary review and the cases (Amazon, Rappi, and Mercado Libre), defining categories and criteria to synthesize the evidence that will later be consolidated in Results.

Evolution of AI in E-Commerce

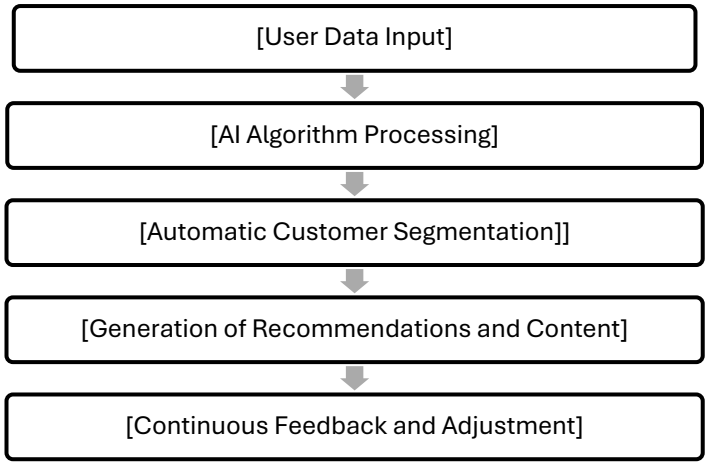
New trends in e-commerce require the use of tools adaptable to each context. The increase in customers and the globalisation of markets demand specific strategies to achieve timely and efficient customer service. Many tasks that in the past required manual processes have been systematized, but this was not sufficient. AI began to be incorporated through chatbots, which were still not enough to meet the demand for products and services resulting from the expansion of commerce. With the emergence of big data and the development of techniques such as machine learning and deep learning, these processes have become modernized, enabling the personalization of the customer experience by tailoring shopping strategies in real time. Based on user navigation, it is now possible to identify browsing behaviour, interests, and predict purchasing preferences.

Consequently, elements such as demand prediction, logistics process optimization, dynamic pricing, and fraud detection have been integrated, all aiming to enhance customer experience and streamline internal commerce processes through intelligent systems. McKinsey (2022) states that 70% of digital companies recognize AI as a key factor in their growth, as this transformation not only improves efficiency but also redefines the relationship with the customer, ensuring strong Personalization and increasing security in the digital environment.

Personalization Process Using AI

User experience becomes one of the key applications of AI, as strategies are generated to recommend products or services based on the analysis of browsing history, previous searches, and purchase profiles. These become crucial points for suggesting products or services according to customer interests. In this regard, Figure 1 illustrates the process by which AI generates recommendations and content based on the user's interaction.

Figure 1. Personalization Process through AI in E-Commerce Platforms Source. Prepared by the authors based on Smith & Johnson (2021)



Price Optimization and Inventory Management

AI enables the implementation of dynamic pricing strategies and the Optimization of Inventory levels through accurate forecasting and automated restocking.

Table 1. *Price Optimization and Inventory Management. Source. The above table is based on previous studies conducted by (Pérez et al., 2022)*

Aspect	Traditional E-Commerce	E-Commerce with AI
Customer Service	Manual	Automated with Chatbots and Assistants
Recomendations	Static	Dynamic based on Behaviour
Inventory Management	Reactiva	Predictive and Automated
Price Setting	Manual or Fixed	Dynamic with Predictive Models
User Experience	Generalice	Personalised and Interactive

Smart Logistics and Last Mile

The use of AI in the logistics chain has significantly improved efficiency. Algorithms optimize routes, forecast demand peaks, and redistribute resources in real time.

Table 2. *Smart Logistics and Last Mile. Source. The above table is based on previous studies.*

Stage of the Process	AI Application	Example
Storage	Automatic Stock Detection	Amazon with Kiva robots
Shipping and Distribution	Optimal Routes and Traffic Prediction	Rappi in Latin American Cities
Last Mile	Autonomous Vehicles and Delivery Prediction	Mercado Libre – Pilots in Buenos Aires

Ethical and Regulatory Challenges

AI in e-commerce poses privacy and equity risks due to massive data collection and automated decisions. Protecting users requires informed consent, transparency, and accountability. Algorithms can reproduce biases, affecting recommendations, pricing, and credit. Ethical regulation and governance—aligned with UNESCO/EU and adapted to Latin American gaps—are required to ensure equity, inclusion, and transparency.

Business Case Analysis

To understand more clearly how the implementation of AI in e-commerce materialized, it is essential to analyze concrete cases of leading companies in the sector. In this case, an analysis is conducted of the use of AI by Amazon, Rappi, and Mercado Libre, examining the challenges they faced, and the business decisions made, which have enabled their platforms to be positioned as innovation benchmarks.

Amazon

Amazon is considered a pioneer in the use of Artificial Intelligence due to its strategy of radical transformation in commerce. Its business model is highly influenced by intelligent systems operating in various strategic areas. It includes recommendation algorithms to personalize user experience, logistics processes, and inventory management, as detailed below:

Table 3. *AI Applications on Amazon and Their Benefits. Source. Own elaboration based on data from (Amazon Annual Report, 2023) & (McKinsey, 2022)*

Application Area	AI Technology Used	Generated Impact
Recomendations	Collaborative Machine Learning	35% increase in conversion rate
Logistics and Warehouses	Robotics + Demand Forecasting	20% reduction in delivery times
Price Setting	Dynamic Pricing Models	Real-time adjustments based on competition
Customer Service	Alexa, NLP y Chatbots	Personalised and scalable 24/7 service

Rappi

Rappi, the Colombian on-demand delivery and services platform, has incorporated artificial intelligence as a central part of its scaling strategy. Its implementation focuses on predicting consumption habits, dynamic customer segmentation, route optimization, and automated demand management. These elements have allowed it to differentiate itself in a highly competitive market and efficiently offer personalized services.

Table 4. Key AI Components Implemented by Rappi. Source. Own elaboration based on reports from (Rappi, 2023)

Strategic Function	Applied AI Technology	Obtained Impact
User Segmentation	Clustering with Machine Learning	Personalised offers based on profile
Logistics Delivery	Optimal route algorithms	18% reduction in delivery times
Demand Forecasting	Supervised learning models	Dynamic adjustment of delivery staff availability
User Interaction	Chatbots with NLP	Improvement in user experience and loyalty

Mercado Libre

Mercado Libre has incorporated AI across all its business units, becoming one of the most important technology companies in Latin America. Its ecosystem includes e-commerce, financial services (Mercado Pago), logistics (Mercado Envíos), and big data, all integrated through intelligent algorithms. The company prioritizes personalization, fraud prevention, logistics efficiency, and advanced analytics for decision-making.

Table 5. *AI Strategies of Mercado Libre by Business Unit. Source. Own elaboration based on corporate reports and (Deloitte, 2023)*

Business Unit	AI Application	Strategic Benefit
Mercado Libre (Sales)	Intelligent Recommendations	40% increase in repeat purchases
Mercado Pago	Fraud Detection with AI	90% reduction in fraudulent attempts
Mercado Envíos	Predictive Logistics	Improved delivery punctuality (95%)
Customer Analysis	Advanced Analytics Dashboards	Segmentation and Behaviour Prediction

Table 6. *Impact of AI on Business Models. Source. Own elaboration based (IBM, n.d.; McKinsey Global Institute, 2018; Garay Gallastegui, 2022; Daki, 2023).*

Dimension	Observed Impact
Personalization	(High) Engagement and Loyalty
Smart Logistics	(Low) Operational Costs
Automation	(High) Efficiency and Scalability
Advanced Analytics	(High) Data-driven Decision-making

E-commerce trends demand adaptable tools and specific strategies to promptly serve growing and globalized markets. Simple systematization of tasks was insufficient: AI began with chatbots, but the leap forward came with big data and ML/DL techniques, which modernized processes and enabled real-time personalization. Today, user behaviors and interests are identified, and purchasing preferences are predicted.

Consequently, elements such as demand prediction, logistics process optimization, dynamic pricing, and fraud detection have been integrated, all aiming to enhance customer experience and streamline internal commerce processes through intelligent systems. McKinsey (2022) states that 70% of digital companies recognize AI as a key factor in their growth, as this transformation not only improves efficiency but also redefines the relationship with the customer, ensuring strong Personalization and increasing security in the digital environment. The three companies prioritize AI on different fronts (Amazon: recommendations/logistics; Rappi: routes/demand; Mercado Libre: comprehensive ecosystem), obtaining measurable benefits.

Table 7. *Comparison of AI Strategies in Amazon, Rappi, and Mercado Libre. Source. Own elaboration*

Company	Main AI Focus	Applied Technology	Highlighted Strategic Benefit
Amazon	Recommendations, logistics, pricing	Machine Learning. Robótica, NLP	Increased conversion rate – Efficiency in logistics processes
Rappi	Demand forecasting, routes, UX	Clustering and Optimization algorithms	Dynamic personalization Reduction in delivery times
Mercado Libre	Personalization Payment Methods, Logistics	Customer recommendation, Fraud detection Predictive AI	Improved customer Loyalty Reduction of fraud

Conclusions

Comparative evidence confirms that AI creates tangible value in e-commerce by boosting personalization and sales optimization; the greatest effects are seen in conversion, logistics efficiency, and fraud control, provided the technology is aligned with quality processes and data.

AI applications act in a complementary manner: recommendation + dynamic pricing + predictive *inventory* + smart logistics improve overall performance; their phased adoption enables quick gains without completely replacing existing systems.

The cases demonstrate differentiated and effective strategies: Amazon (recommendation and supply chain), Rappi (prediction and routing), Mercado Libre (ecosystem with fraud prevention and advanced analytics); there is no single recipe; the choice depends on the business model and digital maturity. The sustainability of the value generated requires responsible governance: minimum transparency/explainability, data protection, and bias mitigation with

metrics and periodic audits. Privacy by design, continuous risk assessment, and correction protocols for unintended impacts are recommended.

The comparison (Table 7) identifies three AI configurations—scale efficiency, operational agility, and trusted ecosystem—that explain the differences between Amazon, Rappi, and Mercado Libre. Their performance depends on the business model and data maturity, and the effects originate from three mechanisms: real-time decisions, data economy, and assisted automation. Their performance is conditioned by quality, data governance, practices, product category, and regulatory context.

By aligning the analytical architecture with the dominant objective and validating with causal metrics; deploying in stages and with governance (privacy, biases, drift), a limitation is observed regarding document review, which may lead to reporting bias.

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Intelligent automation and business growth: data-driven entrepreneurship strategies

Luis Carlos Cárdenas-Ortiz
Corporación Universitaria de Asturias,
luis.cardenas@asturias.edu.co, https://orcid.org/0000-0002-0702-2742

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Introduction

Intelligent automation has emerged as one of the most influential technological transformations in today's business context, particularly in the field of entrepreneurship. The use of tools such as artificial intelligence (AI), machine learning (ML), and robotic process automation (RPA) systems is redefining the ways in which entrepreneurs conceive, manage, and scale their projects. These technologies enable the development of agile solutions that reduce human errors, improve operational efficiency, and support informed decision-making, all based on real-time data analysis (Brynjolfsson & McAfee, 2017; Davenport & Ronanki, 2018).

In recent years, various studies have examined the impact of intelligent automation on the development of sustainable business models. del Carmen López-Urbina (2025) highlight that the value of these technologies lies not only in their technical capabilities but in their strategic integration with organizational processes. This perspective is particularly relevant in entrepreneurship, where responsiveness to the environment and resource optimization are key factors for the survival of new ventures. Similarly, Shrestha et al. (2019) emphasize that artificial intelligence facilitates the detection of hidden patterns in large data sets, improving the accuracy of business forecasts and the identification of emerging opportunities.

Intelligent automation also impacts customer experience. According to Díaz-Soloaga & Pelzer-Peinado (2024), AI-based systems enable more precise customization of products and services, increasing user loyalty by anticipating needs. In this regard, the strategic use of data not only enhances customer relationships but also redefines competitive dynamics, allowing emerging companies to position themselves in markets traditionally dominated by established players. Iansiti and Lakhani (2020) argue that organizations born with integrated AI technologies develop more resilient and scalable operating models, which translate into sustained competitive advantages.

In the digital entrepreneurship environment, intelligent automation has democratized access to advanced technological capabilities. Tools such as chatbots, advanced analytics platforms, virtual assistants, and recommendation systems have been adopted by startups with limited budgets, expanding their potential impact (Lee & Trimi, 2018). This technological availability fosters continuous innovation processes and strengthens a culture of experimentation, especially in early stages. Furthermore, according to Bughin *et al.* (2018), automation not only affects technical functions but also transforms organizational structures by freeing time for creative and strategic tasks.

From a regional perspective, studies such as that of Bautista, L. C., & Tapia (2023) show how in Latin America, entrepreneurial ventures are adopting intelligent automation solutions to

overcome structural barriers, reduce operating costs, and adapt to environments with limited infrastructure. These advances are reinforced by institutional programs seeking to link technology with business development, such as initiatives promoted by the IDB Lab and organizations supporting women entrepreneurs. However, these studies also warn of the need to strengthen digital skills and ensure equitable access to technological resources.

Data-driven automation also raises ethical, organizational, and pedagogical implications. Islas *et al.* (2024) and Park *et al.* (2025) have examined the risks associated with the use of artificial intelligence in educational and organizational contexts, stressing the importance of designing methodological and regulatory frameworks that guide its responsible implementation. These studies underline that intelligent automation is not solely a technical phenomenon, but a structural shift that demands new ways of thinking about innovation, decision-making, and knowledge management.

The analysis of these precedents positions intelligent automation as a central axis in entrepreneurship strategies aimed at growth. Data-driven technologies are shaping new ways of creating value, managing resources, and connecting with customers, reconfiguring the traditional logics of entrepreneurship. This chapter aims to examine how entrepreneurs are leveraging intelligent automation to drive business growth, focusing on data-based strategies that optimize processes, anticipate trends, and build sustainable models in highly dynamic environments.

The methodology adopted in this research was based on an interpretive qualitative approach, with the aim of gaining an in-depth understanding of the internal dynamics involved in the adoption of intelligent automation technologies in ventures from different sectors. Eight cases were selected through purposive sampling, prioritizing sectoral diversity and varying levels of technological maturity. The sectors represented included technology, retail, logistics, and financial services. The cases were chosen to reflect contrasting experiences in terms of size, organizational context, and digital capabilities, to enrich the analysis of common patterns and significant differences in the implementation of tools such as RPA, artificial intelligence applied to customer service, and data analytics platforms for decision-making.

Data collection was carried out through semi-structured interviews with founders, technology managers, and process leaders, aiming to explore motivations, obstacles, lessons learned, and results obtained after adopting intelligent technologies. The interviews were complemented by documentary analysis of internal reports, performance indicators, and digital strategy materials, which enabled triangulation of information sources and increased the validity of the findings. Data analysis was conducted through thematic coding and constant comparison, allowing the identification of emerging categories associated with operational efficiency, market responsiveness, service personalization, and the scalability of the business model.

Automation in Customer Service

The cases analyzed show that intelligent automation has begun to consolidate as a strategic pillar for the evolution of startups and small businesses by integrating technological capabilities with efficiency and scalability objectives. In several of the ventures studied, the use of automated customer response systems, through artificial intelligence-based interfaces, significantly reduced response times, improved user retention, and ensured constant operational availability, even outside regular business hours. This permanent availability

translated into a competitive advantage for emerging companies operating in high-turnover markets such as e-commerce or financial services. Furthermore, the implementation of chatbots trained with company-specific databases facilitated the resolution of frequent inquiries and freed human teams to focus on more complex tasks. In some cases, automated customer service solutions were combined with predictive tracking modules, enabling companies to anticipate service issues and respond proactively before users filed formal complaints.

Logistics Optimization through RPA and Predictive Analytics

In the logistics sector, one startup implemented RPA tools to automate inventory management, order tracking, and delivery report generation. The reduction of human error and the increased speed of order processing had a direct impact on customer satisfaction and the capacity to handle greater volumes without the need to increase operational staff. This automation, combined with predictive analytics on demand and customer behavior, allowed the redesign of distribution strategies based on historical data and projections, thereby increasing the efficiency of logistics cycles and improving resource utilization. Companies were able to predict demand peaks, adjust delivery routes, and optimize warehouse use. In several cases, automation contributed to reducing transportation costs and minimizing downtime in critical processes.

Personalization in the Retail Sector

In retail sector ventures, there were cases where intelligent automation enabled detailed product offer personalization based on purchasing behavior analysis and individual preferences. This personalization was made possible through the application of machine learning algorithms that classified customers into dynamic profiles, adapting recommendations in real time according to interactions recorded on digital platforms. Advanced segmentation increased sales conversion rates and allowed for more precise advertising campaigns, optimizing investments in digital marketing. In some ventures, recommendation engines were incorporated to link products with emotions inferred from tone analysis of comments or reviews, opening new pathways for emotional personalization in consumption.

Operational Efficiency in Financial Services

Another noteworthy case was that of an emerging financial services company that integrated intelligent automation systems to validate documents, generate risk reports, and process loan applications. This integration reduced response times and validation errors, improving the user experience and strengthening internal control mechanisms. The management team noted that this implementation allowed the operation to scale without proportionally increasing the human workforce, which was critical in a high-demand context. Additionally, real-time analytics systems were implemented to monitor default risks and prevent fraud, increasing the reliability of the credit process. These advances helped position the company as a trustworthy option among segments traditionally excluded from the formal financial system.

Scalability Capabilities in Educational Technology

A company dedicated to educational technology solutions applied natural language processing techniques to adapt content to different learning profiles. This strategy enabled the delivery of personalized learning pathways for users based on their previous performance, increasing course completion rates. Moreover, the automated immediate feedback system reduced reliance on human tutors, facilitating the scalability of the business model into new regional markets. In some cases, AI systems were able to identify patterns of disengagement or demotivation, triggering support resources or content redesign. The analysis of learning trajectories also allowed startups to continuously improve their educational offerings, adapting to changing trends and emerging labor market demands.

Conclusions

Intelligent automation is driving significant transformations in the operational models of startups and small businesses by enabling greater efficiency, adaptability, and precision in decision-making. The implementation of technologies such as artificial intelligence, machine learning, and robotic process automation systems is expanding response capabilities in dynamic and demanding environments. Solutions applied in customer service, logistics, service personalization, financial analysis, and education show improvements in response times, error reduction, and resource optimization.

The ventures analyzed were able to scale their operations through the strategic use of data, without requiring proportional increases in infrastructure or personnel. This controlled expansion capacity allowed them to adapt to new demands, consolidate their market presence, and diversify their portfolios. At the same time, the use of automated systems fostered new forms of interaction with users, strengthening relationships through personalized services and more agile experiences.

The results show that the positive impact of intelligent automation largely depends on its integration with business objectives, the organization's readiness for change, and the ability of teams to interpret, adjust, and improve processes. In these cases, technology becomes an enabler of informed decision-making, continuous learning, and operational evolution. However, the process requires methodological support, ongoing skill development, and sustained ethical reflection on its use.

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Global Business and Corporate Transparency

Ramírez Aguirre, Raúl Carlos
National University of San Marcos, Lima, Peru, rcra1962@gmail.com
https://orcid.org/0000-0001-8059-0423
Adanaqué Vilcherrez, José Alex
San Pedro University, Chimbote, Peru, alex.adanaque@gmail.com
https://orcid.org/0009-0001-4305-2201
Marcelo Cashpa Cesar Orlando
San Pedro University, Chimbote, Peru, cmarceloc@distriluz.com.pe
https://orcid.org/0009-0005-0766-5739
Ramírez Berrospi, Marcos Jesús
Universidad Privada del Norte, Trujillo, Peru, marcosjesusramirezberrospi2@gmail.com
https://orcid.org/0009-0005-8038-5645Introducción

Introduction

The management of the international supply chain and the definition of entry and production strategies in foreign markets require a realistic assessment of each country's institutional frameworks, the legality of promoting trade liberalization, and global business practices that advance the establishment of legal and institutional capacities to operate in the production, marketing, and distribution of goods and services across various commercial sectors worldwide. The factors affecting the economy are defined by the dynamics of the domestic market, based on the conditions for the timely supply of goods and services required by that market. In this context, sustainable international trade practices are selected for the supply, procurement, and domestic diversification of products (Rodríguez et al., 2024).

Macroeconomic factors such as economic stability, growth rates, inflation, and gross domestic product directly influence the economic, political, and social viability of each country, where simplified legal frameworks in public trade policies, international agreements, and legal regulations vary by country and possess distinct characteristics based on the economic and development model pursued within the territory (Escobar et al., 2024). Latin America faces a context of strict requirements for global business expansion regarding compliance with tariff barriers and labor standards; cultural, technological, and exchange rate risk factors demand financial management and marketing strategies adapted to local contexts, that is, to each country (Meza-Salas, 2017).

In Peru, effective management of the international supply chain enables companies to coordinate and optimize production, distribution, and logistics on a global scale, responding to market demands and regulatory requirements. Strategies for entering foreign markets—such as alliances, mergers, or direct exports—are key decisions that determine a company's adaptability and competitiveness in diverse multicultural and legal contexts. At the same time, the global regulatory framework establishes norms and guidelines governing business conduct, ensuring that operations comply with international legal and ethical standards (Turnes, 2015; Pérez & Gómez, 2024).

Corporate transparency is another cross-cutting factor that significantly impacts corporate governance and social responsibility, which underpin global business. It is considered a commitment involving openness, clarity, and accessible communication regarding a company's policies, decisions, and results, fostering trust among stakeholders. In a globalized

environment, transparency not only enhances corporate reputation but also facilitates accountability and sustainability, responding to growing regulatory and social demands to combat corruption and promote ethical practices (UN Global Compact Spain, 2024; Innovatica, 2025). Thus, transparency acts as an integrating force that strengthens business ethics within the complex dynamics of global business (Gerged, 2023) (World Bank, 2023).

In the contemporary context, global businesses face growing challenges due to the interconnection of markets and international regulations. Transparency emerges as a fundamental value for ensuring the trust of various stakeholders, from investors to consumers and governments. Within this framework, transparency is not only considered an ethical requirement but also a competitive strategy that fosters corporate legitimacy and sustainability. Furthermore, globalization requires companies to adopt open and responsible practices to adapt to international regulatory frameworks and combat corruption. Therefore, analyzing the role of transparency in the global arena is crucial for understanding its impact on international business dynamics.

The objective of this research was to analyze the relationship between global business and corporate transparency, particularly the role played by the global institutional regulatory framework, international supply chain management, and marketing strategies for entering foreign markets.

The research adopts a qualitative approach with an explanatory scope, which allows for an in-depth understanding of the relationships and meanings associated with transparency, corporate governance, and social responsibility in global business. This approach is suitable for analyzing complex and contextual phenomena involving perceptions, practices, and social norms, without being limited to quantifiable variables (Brítez, 2025).

The methods used are documentary analysis and a systematic literature review, which includes the selection and examination of scientific articles, institutional reports, and relevant academic sources on transparency and governance in the global context. An analysis matrix is used to organize the information, and thematic coding is employed to identify patterns, controversies, and consensus in the field of study. This methodology facilitates critical interpretation and the conceptual development of the factors linking transparency to corporate governance and social responsibility (Brítez, 2025).

Notable among the techniques applied are the search for and selection of sources in recognized academic databases such as Scopus, Web of Science, and Scielo; axial coding of data for thematic categorization; and thematic analysis to articulate the results. These techniques ensure rigor, validity, and analytical depth in the research, allowing for the exploration not only of theory but also of the practical application of transparency as a cross-cutting factor in global business (Brítez, 2025).

Theoretical Approaches to Global Business: From Internationalization to Disruptive Innovation

Global business is underpinned by the interrelation of various theoretical elements, both internal and external, which explain its dynamics and structures. These may vary depending on the economic and administrative model in place in the country, the historical moment, and the prevailing constitutional and legal framework; together, they establish the conditions for an internationalization perspective.

While global business is defined as the commercial and investment activities carried out by companies across national borders to establish cross-border trade and business relationships (Cavusgil et al., 2015), it specifically involves planning, organizing, and sourcing processes on an international scale through the collaboration of companies, governments, and international agencies, thereby moving beyond traditional views that consider companies as the sole actors in the practice of sustainable global business.

In this sense, international business encompasses a comprehensive definition by emphasizing that it is based on cross-border exchanges of goods, services, or resources between two or more nations. These exchanges can go beyond the exchange of money for physical goods to include international transfers of other resources, such as people, intellectual property patents, copyrights, trademarks, and data, among others, and contractual assets or liabilities related to the right to use a foreign asset, provide a future service to foreign customers, or execute a complex financial instrument (González et al., 2022).

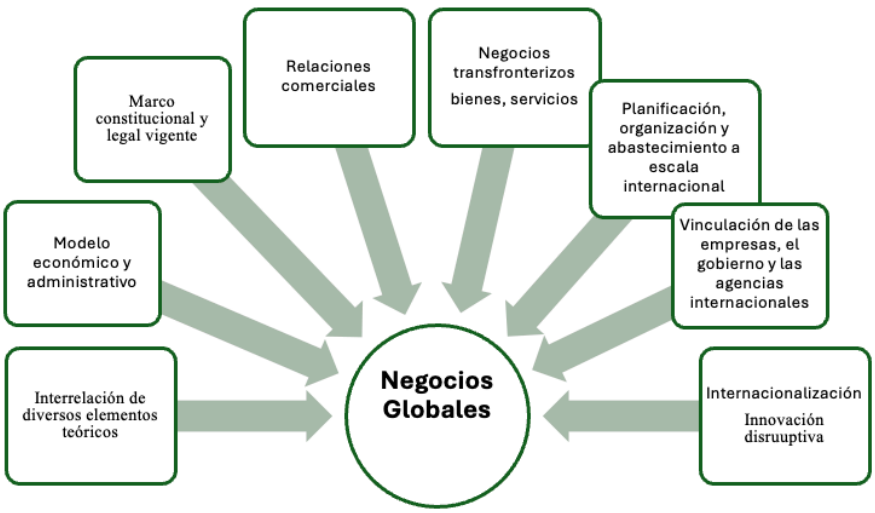


Figure 1: Characteristics of the theoretical definition of global business

Finally, the entities involved as international businesses range from large multinational firms with extensive employee rosters operating in various countries under diverse organizational structures to small sole proprietorships acting as importers or exporters, and include cross-border transactions conducted for profit as well as those motivated by non-financial gains (Carpenter & Dunung, 2011: 11), that is, moving toward models that are transformed in a conventional manner and turned into disruptive ones that allow them to transcend the

exchange of goods and services; is expanded through the inclusion of the exchange of various resources to attract greater attention.

Global Institutional Regulatory Framework

The global regulatory institutional framework is the set of norms, laws, agreements, and policies that govern economic, commercial, and social activity at the international level, establishing a legal context that facilitates cooperation among countries and regulates cross-border relations. This framework seeks to ensure that international transactions, operations, and business activities take place under conditions of transparency, justice, and equity, promoting stability and trust among different global actors (OECD, 2021). Furthermore, it enables the harmonization of standards and coordination among various jurisdictions, which are essential for addressing the specific challenges of globalization, such as corruption, tax evasion, and corporate social responsibility (RICG, 2025).

In a globalized environment, the institutional regulatory framework must be dynamic and adaptive to respond to constant technological, economic, and social changes. Characteristics such as flexibility, functionality, and the capacity for revision are fundamental to ensuring that regulations do not become obsolete and can foster innovation and sustainable development (GSMA, 2024). Likewise, this framework includes multilateral and regional instruments that seek a balance between state sovereignty and the need for common standards to protect fair trade, human rights, and the environment (OECD, 2021).

Finally, the global institutional regulatory framework is a pillar of corporate transparency, as it establishes mechanisms for accountability, protection against corrupt practices, and regulatory compliance in international markets. These mechanisms strengthen corporate governance and enable companies to operate with integrity and social responsibility in a complex and multidimensional context (RICG, 2025). Therefore, understanding and acting in accordance with this framework is essential for companies seeking to compete and grow in the global market. In Peru, the global institutional regulatory policy governing global business is built upon a combination of constitutional norms, domestic legislation, international treaties, and regulatory policy frameworks supported by international organizations such as the OECD (Organization for Economic Cooperation and Development) Thus, the Political Constitution of Peru (1993) addresses the supreme hierarchy that determines the regime of international treaties (Articles 55, 56, and 57) and the manner in which they are incorporated into domestic law. It also guarantees fundamental rights, private property, and economic openness, which underpin an institutional environment for foreign investment and international trade.

Regarding international treaties and free trade agreements, Peru has signed a broad network of treaties with institutions such as the WTO, FTAs, and integration agreements like the Andean Community and USMCA, among others, with the aim of incorporating them into domestic law through the specified constitutional procedure (approval by Congress or the Executive, as applicable). Regulatory policy and administrative simplification: The country has adopted a regulatory policy framework inspired by international standards, with requirements for regulatory impact analysis, public consultation, and administrative burden management, as evaluated by the OECD.

The OECD identifies in Peru a set of regulatory policy tools—such as regulatory impact analysis, public consultation, and the governance of independent regulators—as central

elements that influence the country's business climate and international competitiveness. In this regard, *international supply chain* management is defined as the coordinated and efficient process of planning, implementing, and controlling the flow of goods, services, and information from the procurement of raw materials to the delivery of the final product to the customer, crossing national borders (SAP, 2025; IBM, 2022). This complex system encompasses activities such as procurement, production, storage, transportation, and distribution in a global context, where coordination among multiple actors and adaptation to international regulations and risks are essential (Beltrán García, 2025).

Peru has signed a broad network of treaties (WTO, FTAs, integration agreements such as the Andean Community, USMCA, etc.), which are incorporated into domestic law through the specified constitutional procedure (approval by Congress or the Executive, as the case may be). Theoretically, international supply chain management is based on the integration of logistical and strategic processes that seek to maximize operational efficiency, reduce costs, and improve responsiveness to changes in the global market (Turnes, 2015). Furthermore, digitalization and the use of emerging technologies such as artificial intelligence, blockchain, and big data enhance visibility and traceability within the chain, contributing to greater transparency and sustainability (Marriaga & Bonfante, 2023).

Foreign market entry strategies are the methods and approaches that companies use to establish their presence in new international markets. These strategies include direct and indirect exporting, licensing, franchising, joint ventures, strategic alliances, and foreign direct investment (FDI), each with specific advantages, risks, and requirements depending on market conditions and business objectives (Convenit Consultants, 2024; Smartling, 2025).

Regulatory Policy and Administrative Simplification: The country has adopted a regulatory policy framework inspired by international standards, with requirements for regulatory impact analysis, public consultation, and administrative burden management, as evaluated by the OECD. Regulatory bodies and economic agencies acting as independent regulators (INDA, SUTRAN, OSITRAN, among others) oversee strategic sectors, enforcing regulations that affect international investments and operations (infrastructure, transportation, public services).

Regulations on investment and foreign trade: Laws and decrees on investment promotion, customs regulations, technical standards, and non-tariff barriers shape the environment in which global businesses operate in Peru.

The appropriate selection of a strategy allows companies to adapt to the economic, cultural, and regulatory conditions of the target market, facilitating competitiveness and sustainable growth on a global scale. Furthermore, these strategies reflect different levels of control, investment, risk, and commitment, with exporting being the option requiring the least investment and FDI being the most capital- and management-intensive (Smartling, 2025).

Transparency is a cross-cutting factor that affects corporate governance and social responsibility

Transparency is a cross-cutting factor that comprehensively affects corporate governance and social responsibility in global business because it fosters trust and accountability among all involved stakeholders . By making their processes, decisions, and results visible, companies build credibility with shareholders, consumers, governments, and society at large, which strengthens their reputation and legitimizes their actions. This openness helps ensure that

corporate governance—understood as the system through which companies are managed and controlled—functions more effectively and ethically, enabling the detection and prevention of corrupt or irresponsible practices (UN Global Compact Spain, 2024).

In terms of social responsibility, transparency allows companies to clearly communicate their social, environmental, and economic impact, not only as a legal requirement but as an ethical and strategic commitment. This involves sharing relevant information about their sustainability policies, labor conditions in the supply chain, and contributions to the community, which in turn puts pressure on other organizations to adopt responsible practices. Transparency thus facilitates dialogue and collaboration with stakeholders, promoting a more inclusive and sustainable business model that responds to the demands of an increasingly aware and demanding global market (Gerged, 2023; HazRevista, 2023).

Finally, in a global context, transparency becomes an essential mechanism for harmonizing regulations and expectations across different countries and business cultures, serving as the foundation for effective governance and genuine social responsibility in transnational business. By operating with high standards of transparency, companies not only comply with international regulatory frameworks but also contribute to building fairer and more equitable markets, minimizing legal and reputational risks, and promoting sustainable development (OECD, 2021; RICG, 2025).

The theoretical framework also addresses concepts such as trust, ethics, and sustainability, linked to transparency as a practice that reduces uncertainty and promotes a culture of integrity in the global environment.

Global Business and Corporate Transparency in Peru

preferential trade agreements (Baena and Cardona, 2019). One of these practices is trade liberalization, which has grown alongside trade agreements (Rodríguez et al., 2019). Starting in the 1980s, the Mexican government promoted trade policies aimed at Trade Liberalization (TL). During this decade, Mexico joined the General Agreement on Tariffs and Trade (GATT), reducing tariff restrictions (Rodríguez, 2009). And to strengthen its trade strategy, Mexico negotiated trade agreements such as Bilateral Investment Treaties (BITs) starting in 1995 (beginning this series of trade relations with Switzerland); the North American Free Trade Agreement (NAFTA) in 1994 (replaced in 2020 by the United States-Mexico-Canada Agreement (USMCA); the Free Trade Agreement between Mexico and the European Union (TLCUEM) in 2000 (Gazol, 2016; Foreign Trade Information System [SICE], 2022); and the Pacific Alliance in 2012 (Cazallo and Salazar, 2018). Based on these, Mexico's trade relations with developed and developing economies have intensified. Corporate transparency in global business in Peru is a key component for strengthening corporate governance and improving competitiveness in an increasingly demanding and globalized market. The growing adoption of international standards related to the disclosure of financial and non-financial information is driving a shift toward more responsible and sustainable practices in Peruvian companies. According to Benavides (2023), the implementation of sustainability reporting and environmental, social, and governance (ESG) practices enables Peruvian companies to enhance investor confidence and facilitate their integration into global value chains. Furthermore, Córdova-Herrera (2025) highlights that transparent corporate governance contributes significantly to business sustainability and the creation of shared value, which are crucial for economic and social development in Peru.

However, challenges persist regarding organizational culture and the practical application of transparency, which limits its full scope in many sectors. A lack of transparency can affect corporate reputation and the ability to attract investment, underscoring the importance of strengthening regulatory frameworks and fostering a genuine ethical culture (Córdova-Herrera, 2025). In this regard, research on transparency and global business in Peru is relevant for analyzing and proposing strategies that enhance governance and social responsibility, contributing to a fairer and more competitive business environment at the international level.

Conclusions

Therefore, studies focused on the Peruvian context reflect the urgency of promoting transparency as a cross-cutting theme that spans from financial management to social and environmental commitments, enabling companies not only to comply with regulations but also to generate positive impacts in their communities and markets (Benavides, 2023; Córdova-Herrera, 2025). The analysis of transparency in global business in Peru constitutes a relevant and necessary field of research for understanding the current dynamics of the national economy and its integration into globalization. Adopting international standards for disclosure and transparency not only improves external perception but also drives internal improvements in management and governance—key elements for achieving sustainable and competitive business development over time (Huaraca Pacheco, 2023; Córdova-Herrera, 2025).

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Transformational Leadership and Business Resilience in International Socioeconomic Contexts Santander Salmon

Santander Salmom, Erika Stephania
Luis Vargas Torres Technical University of Esmeraldas, Ecuador erika.santander@utelvt.edu.ec
https://orcid.org/0000-0003-3279-5250
Gongora Cheme, Roxana Katherine
Luis Vargas Torres Technical University of Esmeraldas, Ecuador roxana.gongora.cheme@utelvt.edu.ec
https://orcid.org/0000-0001-9299-6885
Chamorro Quiñónez, Joshelyn Germania
Luis Vargas Torres Technical University of Esmeraldas, Ecuador joshelin.chamorro.quinonez@utelvt.edu.ec
https://orcid.org/0000-0003-0076-9429
Cifuentes Quiñónez, Luz Marina
Luis Vargas Torres Technical University of Esmeraldas, Ecuador luz.cifuentes@utelvt.edu.ec
https://orcid.org/0000-0002-0514-8616

Introduction

Currently, various organizations operate in environments marked by instability and competitiveness, which requires the implementation of strategies aligned with the changing demands of the market and the local context. In this regard, Díaz-Calderón et al. (2025) argue that the integration of technological innovation, sustainability, and leadership is essential for strengthening resilience in contexts of deep crisis. For their part, Mhlanga and Dzingirai (2024) argue that the concept of business resilience has gained unprecedented traction in strategic management, given that global socioeconomic and health crises have forced many companies to the brink of liquidation. In this scenario, Virgana and Fitriani (2025) maintain that the synergy between management models and intellectual stimulation is what enables work teams to improve their effectiveness in the face of uncertainty.

Business resilience, therefore, should not be understood as a static state, but rather as a dynamic and multidimensional attribute of organizations, and specifically of companies. Barrón Torres and Sánchez Limón (2022) consider it a condition through which an organization maintains or recovers its optimal functioning following a significant adverse event. In line with this idea, Bai et al. (2025) argue that this phenomenon encompasses early warning capabilities, real-time adaptation, and a post-crisis growth process based on learning. Under the Resource-Based View (RBV), it is emphasized that the competitive advantage of firms lies in the management of strategic intangible resources— —which enable them to capitalize on opportunities and mitigate threats in volatile environments (Barrón Torres & Sánchez Limón, 2022). Similarly, Duchek (2020) argues that resilience emerges as an adaptive capacity that allows systems to navigate complex interdependencies between ecological constraints and institutional performance.

In the face of these challenges, transformational leadership (TL) has established itself as the primary driver for enhancing human capital and generating sustainable value. Marin-Rodriguez et al. (2025) demonstrate that TL exerts a positive and far-reaching impact on corporate culture, promoting employees' individual growth and team cohesion in dynamic environments. On the other hand, Ayala et al. (2025) highlight that managers who adopt transformational behaviors contribute to creating more favorable work environments, where inspirational

motivation acts as a key predictor of a positive organizational climate. This strategic approach is distinguished by its emphasis on a shared vision and mutual growth between leaders and followers, enabling the organization to maintain robust internal strength to project itself successfully externally (Caicedo Basurto et al., 2025).

In the specific context of small and medium-sized enterprises (SMEs), socioeconomic vulnerability becomes a determining factor in their survival. Gutiérrez-Zambrano et al. (2025) argue that, in the case of Ecuador, SMEs play an essential role by providing employment to 62% of the labor force, although they face structural barriers that have hindered their functional development for years. In this context, ECLAC (2025) argues that overcoming development traps in Latin America requires a profound digital transformation that allows companies to adapt to the knowledge era. However, the reality for many of these businesses is that their strategic decision-making remains dependent on the intuition of their managers, often lacking technical tools to minimize risk in highly uncertain environments (Cruz Fajardo et al., 2025).

The province of Esmeraldas represents a critical case study due to its unique biophysical and social profile. The GADPE (2015) notes that the territory faces a concerning situation regarding unmet basic needs, with poverty rates among the highest in the country. Likewise, the Municipal GAD of the Esmeraldas Canton (2022) notes that the area faces latent risk from natural hazards such as floods, landslides, and seismic events, which directly impact infrastructure and productive areas. This institutional and environmental precariousness compels local business leaders to transcend traditional management functions and become facilitators of collective survival in an environment of "improvised growth" (GADPE, 2015).

The role of the resilient leader is, therefore, the primary mitigating factor in the face of business unpreparedness for disasters. Olivas Lara et al. (2025) analyze the factors influencing business survival in VUCA environments (volatile, uncertain, complex, and ambiguous), concluding that self-confidence and personal competence are the most significant traits in resilient leadership. In this regard, Bai et al. (2025) confirm that a leader's responsiveness is strengthened through "dual innovation," which balances the exploitation of current resources with the exploration of new strategic alternatives. In this process, family and social support in the Ecuadorian context acts as essential emotional and financial support for coping with external shocks, allowing leaders to maintain a positive mindset despite adversity (Olivas Lara et al., 2025).

In conclusion, this research is grounded in the need to understand the relationship between transformational leadership and resilience in highly vulnerable contexts. The study aims to determine how the dimensions of motivation, influence, and intellectual stimulation affect the adaptive capacity of Esmeraldas-based SMEs, providing a technical perspective on crisis management (Marin-Rodriguez et al., 2025; Olivas Lara et al., 2025). The analysis is justified on the premise that, in regions with structural limitations, business success does not depend solely on physical assets, but on the manager's ability to foster internal cohesion and operational flexibility in the face of recurring threats in the region (GADPE, 2015; Ayala et al., 2025). This study provides relevant data for the "Business Strengthening Program to Support MSMEs, Startups, and Social Organizations in the Province of Esmeraldas" as well as for the research project titled "Quality of University Management: A Comparative Study of Organizations Located in Planning Zones 1 and 4 of Ecuador" conducted by the Luis Vargas Torres Technical University of Esmeraldas.

The research adopted a quantitative approach at the explanatory level and with a cross-sectional scope, based on the collection of numerical data processed using statistical methods to test hypotheses regarding the impact of leadership on adaptive capacity (Hernández et al., 2014; Marin-Rodriguez et al., 2025). The design was non-experimental, as the variables of transformational leadership and business resilience were analyzed as they occur in their natural setting, without deliberate manipulation by the researchers (Cruz Fajardo et al., 2025; Olivas Lara et al., 2025).

The research population consists of small and medium-sized enterprises (SMEs) located in the Esmeraldas canton, registered in the Business Directory of the National Institute of Statistics and Censuses (INEC) and included in the Development and Land Use Plans of the Decentralized Provincial Autonomous Government of Esmeraldas (GADPE) (INEC, 2013; GADPE, 2015).

According to these official records, the Esmeraldas canton has 613 SMEs, which constitute the core of the local productive fabric. This business structure consists of 523 small enterprises and 90 medium-sized enterprises, the latter classified into 66 "Category A" enterprises and 24 "Category B" enterprises. These productive units play a fundamental role in generating employment and stimulating economic activity in the region.

From a sectoral perspective, the canton's SMEs are primarily concentrated in the services sector, which accounts for approximately 52.30% of local economic activity, with wholesale and retail trade, education, and transportation standing out in particular. Likewise, there are strategic production chains linked to artisanal fishing, tourism, and cocoa processing—activities that constitute important pillars of Esmeraldas' economy (GADPE, 2015; GADMCE, 2021).

Given this business structure, the unit of analysis for the study consists of the managers, owners, or executives of SMEs, as these actors are responsible for making strategic decisions related to business leadership and the ability to adapt in the face of uncertainty.

To ensure the statistical representativeness of the research, a sample was determined using probability sampling, based on the total population of 613 SMEs in the Esmeraldas canton of Ecuador. Considering a 95% confidence level and an 8% margin of error, a sample of 114 SME executives or managers was selected, who participated in the administration of the research instruments.

Table 1 *Distribution of the SME sample in the Esmeraldas canton*

Type of company	Population (N)	Sample (n)	Percentage
Small businesses	523	97	85.1%
Type A medium-sized companies	66	12	10.5%
Type B medium-sized companies	24	5	4.4%
Total	613	114	100%

Source: Prepared by the author based on INEC (2013) and GADPE (2015).

The economic structure of SMEs in the Esmeraldas canton shows a predominance of the service sector, which accounts for 52.30% of business activity, with commerce, education, and transportation standing out as the main drivers of the local economy. Second, productive activities account for 27.70%, with artisanal fishing, cocoa processing, and some agro-industrial

initiatives linked to regional value chains standing out. Meanwhile, the tourism sector and related activities account for 12.00%, highlighting the region's potential in tourism and gastronomic services. Finally, 8.00% corresponds to other economic sectors, reflecting the diversity of the business landscape in the Esmeraldas canton.

For data collection, we used instruments validated in applied business research conducted in Latin American contexts, which ensure adequate levels of internal consistency, with Cronbach's alpha values exceeding 0.70 (Ayala et al., 2025; Marin-Rodriguez et al., 2025). These instruments allow for the assessment of both the sociodemographic characteristics of managers and the study's main variables: transformational leadership and business resilience. The measurement was structured using standardized questionnaires that facilitate the collection of reliable information on the managerial capacity and business response of SMEs in the Esmeraldas canton in the face of environments characterized by uncertainty and vulnerability. The technical configuration of the instruments used is presented below:

Table 2 *Technical specifications of instruments and measurement scales*

Dimension	Base instrument	Number of items	Level of measurement
Sociodemographic factors	Ad-hoc questionnaire	10	Nominal / Ratio
Transformational leadership	MLQ-5X adapted by Morales (2023)	24	Likert scale (1–5)
Business Resilience	RESI-M Scale (Palomar & Gómez, 2010)	25	Likert scale (1–4)

Source: Author's own work.

Note: The selection of these instruments responds to the need to assess both the leader's personal competencies and the organization's ability to respond to VUCA (volatile, uncertain, complex, and ambiguous) environments (Olivas Lara et al., 2025; Terlato, 2019).

In particular, the MLQ-5X measures dimensions of transformational leadership such as idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration—key aspects for understanding managers' ability to guide their organizations in changing contexts. For its part, the RESI-M scale assesses business resilience through indicators related to personal competence, resilience in the face of adversity, and social support—factors that influence companies' adaptive capacity in crisis situations. In addition, the ad-hoc questionnaire collects sociodemographic and business information from SME managers or owners, allowing the results to be contextualized within the business reality of the Esmeraldas canton.

Finally, the collected data were analyzed using descriptive and inferential statistics, employing SPSS version 27 and Stata version 17 (Marin-Rodriguez et al., 2025). To analyze the relationship between the variables of transformational leadership and business resilience, Spearman's correlation coefficient (ρ) was used, since the data obtained come from Likert-type scales and correspond to ordinal measurements. This nonparametric statistical method allows for the evaluation of the degree of association between two variables without requiring strict assumptions of normality in the data. The analysis was conducted using statistical software,

which allowed us to identify the strength and direction of the relationship between the variables studied in the sample of 114 SME managers from the Esmeraldas canton.

Transformational Leadership

Transformational leadership (TL) is conceptualized as a model of strategic leadership that transcends the exchange of rewards for performance, focusing instead on implicit motivation and the holistic development of employees (Caicedo Basurto et al., 2025). This model, whose theoretical foundations were established by Burns (1978) and expanded by Bass (1985), defines the leader as an agent of change who shapes corporate culture to promote innovation and commitment (Olivas Lara et al., 2025; Caicedo Basurto et al., 2025).

Under this approach, business success does not depend solely on tangible assets, but on the leader's ability to inspire followers to set aside their personal interests in favor of higher collective goals (Marin-Rodriguez et al., 2025). The fundamental dimensions of LT include idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration (Caicedo Basurto et al., 2025).

Furthermore, idealized influence allows the leader to act as an ethical role model who generates trust and respect, while inspirational motivation is based on articulating challenging visions that mobilize team enthusiasm (Olivas Lara et al., 2025; Caicedo Basurto et al., 2025). Similarly, intellectual stimulation encourages employees to challenge the status quo through creative problem-solving, and individualized consideration ensures that the leader addresses the specific professional growth needs of each team member (Caicedo Basurto et al., 2025).

More specifically, in contexts of profound uncertainty (VICA)—an acronym that describes environments characterized by volatility, uncertainty, complexity, and ambiguity—transformational leadership emerges as a critical pillar for strengthening organizational resilience (Díaz-Calderón et al., 2025; Olivas Lara et al., 2025). Applied research demonstrates that this style is a key predictor of a positive organizational climate, fostering work environments characterized by autonomy and cohesion (Ayala et al., 2025; Rascón Chávez et al., 2025).

It should be noted that, to assess these capabilities, the scientific literature validates the use of the MLQ-5X questionnaire, which allows for measuring the impact of these behaviors on collective performance (Ayala et al., 2025). Finally, in the SME sector, the transformational leader facilitates dual innovation and strategic adaptability, enabling the organization to regenerate after facing significant external shocks (Díaz-Calderón et al., 2025; Olivas Lara et al., 2025).

Business Resilience in Vulnerable International Environments

Business resilience in vulnerable environments was defined as a dynamic and profound capacity that enables organizations to maintain or restore their operations in the face of various adverse events—not as a passive state, but as a multidimensional process of proactivity, adaptation, absorption, and reaction to instability (Barrón Torres & Sánchez Limón, 2022; Conz & Magnani, 2020). In VICA contexts, this capacity manifests itself in risk anticipation, real-time adaptation, and learning for sustainable growth (Duchek, 2020; Bai et al., 2025). In regions such as Esmeraldas, such resilience is constrained by insecurity, structural weaknesses, limited planning, and low or non-existent government incentives (GADPE, 2015; Municipal GAD of the

Esmeraldas Canton, 2022). Therefore, from the perspective of Resource-Based View (RBV), business survival depends on intangible assets such as transformational leadership, internal cohesion, and human capital (Barrón Torres & Sánchez Limón, 2022; Caicedo Basurto et al., 2025), as well as support from the social fabric and managerial self-confidence (Olivas Lara et al., 2025), often taking the form of a reactive response that transforms crises into opportunities (Mhlanga & Dzingirai, 2024).

At the international level, business resilience is theoretically grounded as a strategic capacity to sustain competitiveness and financial soundness in uncertain environments, based on the reconfiguration of resources (Teece et al., 1997; Eisenhardt & Martin, 2000) and continuous reinvention (Hamel & Välikangas, 2003). This approach is expanded by conceiving it as a multilevel construct that integrates strategic, operational, and financial dimensions, supported by organizational learning, knowledge management, and flexibility (Hillmann & Guenther, 2021; Bhamra et al., 2011), as well as the ability to anticipate and recover from crises (McManus et al., 2008).

In the case of Latin America, various regions exhibit conditions of vulnerability similar to those observed in the province of Esmeraldas, characterized by institutional weakness, socioeconomic inequality, and high exposure to environmental risks. In Colombia, particularly in the Pacific region (Chocó and Nariño), high levels of poverty, social exclusion, and dependence on informal economies prevail. Similarly, in Peru, especially in Amazonian and rural areas, there are limitations in infrastructure and access to basic services, along with high exposure to various natural hazards.

Similarly, in Brazil, regions such as the Amazon face challenges related to territorial inequality and economic informality, while in Bolivia, structural gaps linked to poverty and low productive diversification persist. In the case of Argentina, several areas exhibit vulnerability associated with historical economic crises and regional imbalances. Meanwhile, in Honduras and Guatemala, SMEs operate in environments marked by climate vulnerability, structural inequality, and constraints on productive development. These conditions allow the case of Esmeraldas to be situated within a broader regional context, where business resilience emerges as a key factor for the adaptation, survival, and sustainability of enterprises in the face of scenarios of structural uncertainty.

Small and Medium-Sized Enterprises (SMEs)

There is no universal consensus on the definition of small and medium-sized enterprises (SMEs), as their parameters vary according to geographical context and criteria such as the size of the workforce, the value of assets, and turnover (Dini & Stumpo, 2018; Ogechukwu, 2011). Globally, these entities are recognized as strategic drivers of economic development, contributing substantially to Gross Domestic Product (GDP) and the massive generation of employment (Gbandi & Amissah, 2014; World Economic Forum, 2023).

From a strategic perspective, SMEs are distinguished by their adaptive flexibility and flat organizational structures, which facilitate rapid decision-making in response to changes in the environment (Ibidunni et al., 2020; Quiñónez & Parada, 2013). However, they face significant structural fragility characterized by limited access to financing and low levels of technological adoption, resulting in a failure rate of up to 80% within their first five years (Olivas Lara et al., 2025; Vivanco, 2016). It is concluded that their sustainability depends on leadership capable of

transitioning from intuitive models to resilient and technologically advanced management (Acuña et al., 2019; Díaz-Calderón et al., 2025).

In Ecuador, the regulatory framework is based on the regulations of the Andean Community of Nations (2009), which classifies small enterprises as those with 10 to 49 workers and medium-sized enterprises as those with 50 to 199 employees (INEC, 2013; PDOT Esmeraldas, 2015). This sector constitutes the backbone of Ecuador's business fabric, representing 95% of productive units and generating 60% of national employment (Quiñónez & Parada, 2013; GADMCE, 2021).

In the specific context of the Esmeraldas canton, the business structure of SMEs reflects a significant concentration within the provincial territory (INEC, 2013; GADPE, 2015). According to records from the Business Directory and local development plans, the canton has a total of 613 SMEs, which break down into 523 small enterprises and 90 medium-sized enterprises (66 in category "A" and 24 in category "B") (INEC, 2013; GADPE, 2015; Scientific Article Transformational Leadership, 2026).

With regard to the predominant types of businesses and activities in the canton, these organizations are primarily concentrated in the service sector, which accounts for 52.30% of the local economy (GADMCE, 2021). Within this sector, the main sectors are wholesale and retail trade, education, and transportation. Likewise, strategic value chains have been identified in artisanal fishing, tourism, and cocoa processing, which constitute the pillars of Esmeraldas' small and medium-sized industry (GADPE, 2015; GADMCE, 2021).

Although the canton is positioned as a "consolidated productive enclave" due to the presence of strategic industries, local SMEs operate with limited technological advancement and a low-skilled workforce (GADMCE, 2021). This situation exacerbates their vulnerability to infrastructure deficiencies and the territory's biophysical risks, resulting in management that often relies on intuition and family support in the absence of formalized technical tools (GADMCE, 2021; Scientific Article on Transformational Leadership, 2026).

Results of the analysis of transformational leadership and business resilience in SMEs in Esmeraldas, Ecuador.

Analysis of the results obtained provides insight into the characteristics of leadership and business resilience present in small and medium-sized enterprises in the Esmeraldas canton. Based on information collected from 114 managers, relevant patterns are identified that help explain how leaders' personal characteristics and management styles influence business adaptability in the face of uncertain environments.

In this context, the study examines three main dimensions: the sociodemographic profile of managers, transformational leadership, and business resilience. These variables allow us to interpret how the strategic decision-making process is shaped within the Esmeraldas business community and how leaders mobilize human and organizational resources to address environmental challenges.

Sociodemographic Factors of Managers

The sociodemographic analysis provides insight into the basic characteristics of those who lead SMEs in Esmeraldas. These factors influence leadership style, experience in crisis management, and business adaptability.

Table 3. *SME Managers in Esmeraldas (n = 114) - Ad-hoc Questionnaire*

Variable	Category	Frequency (f)	Percentage (%)
Gender	Female	63	55.3
	Male	51	44.7
Age	25–34 years	36	31.6
	35–54 years	78	68.4
Experience	1–10 years	31	27.2
	11–20 years	56	49.1
	Over 20 years	27	23.7

Source: Author's own analysis.

The results show a predominant presence of female leadership, accounting for approximately 55% of the executives surveyed. This finding is significant because various studies indicate that female leadership tends to promote more participatory and collaborative management styles, which helps strengthen organizational cohesion in complex business environments.

Regarding the age of executives, the majority are concentrated between the ages of 35 and 54, reflecting a stage of professional maturity characterized by greater experience in business management. This stage is often associated with a greater ability to navigate uncertain scenarios, due to the knowledge accumulated throughout one's career.

Likewise, an analysis of work experience indicates that nearly half of the executives have between 11 and 20 years of experience, suggesting that many of them have navigated economic crises or structural changes within the business environment. This experience helps strengthen the company's ability to respond and promotes the adoption of adaptive strategies in uncertain contexts.

Transformational Leadership

Transformational leadership is one of the central variables of the study, as it allows us to analyze how managers influence their employees to generate positive changes within the organization and promote work environments oriented toward learning and innovation.

Table 4. *Descriptive Statistics - MLQ-5X*

Dimension	Mean (M)	Standard Deviation (SD)	Perceptual Level
Inspirational Motivation	3.71	0.92	Good
Individualized Consideration	3.84	0.79	Very good
Idealized Influence	3.65	0.87	Good
Intellectual Stimulation	3.58	0.85	Acceptable

Source: Prepared by the author.

The results show that the dimension receiving the highest rating is individualized consideration, indicating that leaders of SMEs in Esmeraldas tend to pay special attention to the personal and professional development of their employees. This approach fosters the creation of work environments based on trust, commitment, and motivation—fundamental elements for strengthening business performance.

Similarly, inspirational motivation receives a high rating, demonstrating managers' ability to convey a shared vision that generates enthusiasm and a sense of belonging among the organization's members. This ability is key to maintaining team cohesion in the face of economic and social uncertainty.

However, the intellectual stimulation dimension has the lowest average within the analyzed model. This result suggests that there are still opportunities to strengthen the promotion of innovative thinking and the generation of new ideas within organizations—aspects that are fundamental for addressing the challenges of increasingly dynamic and competitive business environments.

Business Resilience

Business resilience refers to the ability of companies to adapt, withstand, and recover from adverse situations. In the context of SMEs in the Esmeraldas canton, this variable takes on particular relevance due to the multiple social challenges facing the region, notably high levels of insecurity, economic instability, limited productive investment, and uncertainty in the business environment. These conditions generate a sense of demotivation and business burnout among many managers, as engaging in economic activiti ly in this context involves facing constant risks that affect both profitability and business stability.

However, despite these difficulties, many SMEs continue to operate in the province. This is largely explained by cultural and family factors deeply rooted in the Esmeraldas population, where community ties and responsibility toward the family act as driving forces that encourage entrepreneurs to maintain their productive activities. In this sense, business resilience is built not only on the organizational structure but also on social, emotional, and cultural elements that strengthen leaders' commitment to the region.

Table 5. *Factors of Business Resilience in SMEs in Esmeraldas - RESI-M*

Resilience Factor	Mean (M)	Standard Deviation (SD)	Interpretation
Confidence / Self-confidence	3.42	0.48	High average
Personal competence	3.35	0.44	High average
Family and cultural support	3.60	0.39	High
Formal organization	3.05	0.57	Moderate

Source: Author's own work.

The results show that family and cultural support is the main factor of resilience among Esmeraldas SMEs, achieving the highest average among the factors analyzed. This result reflects that many entrepreneurs continue to carry out their productive activities not only for economic reasons, but also out of a commitment to their families, their community, and their cultural identity—elements that strengthen their continued presence in the region despite adversity.

Second, the trust and self-confidence of leaders remain relatively high, demonstrating that, although there is a context of business demotivation stemming from the social conditions of the environment, managers retain a certain degree of confidence in their ability to face market challenges. This self-confidence enables decision-making processes aimed at maintaining business continuity.

Meanwhile, personal competence reflects that leaders possess the knowledge and experience to manage their companies in complex scenarios. However, the regional context imposes limitations that affect business motivation, as management and efforts must often be directed toward resolving issues external to the business, such as security, logistics, or market stability.

Finally, the formal organization factor shows the lowest level, indicating that many SMEs operate with flexible and adaptive administrative structures. In environments characterized by high levels of social and economic uncertainty, companies tend to prioritize survival strategies based on strategic improvisation, family cooperation, and rapid adaptation to environmental changes.

Taken together, these results show that business resilience in Esmeraldas is deeply influenced by social and cultural factors, where territorial roots, family responsibility, and community identity act as driving forces that enable entrepreneurs to continue developing their productive activities, even in contexts marked by demotivation and insecurity. These elements demonstrate that strengthening the local business fabric requires not only economic strategies but also public policies aimed at improving conditions of security, social stability, and territorial development in the province.

Correlation Analysis Between Transformational Leadership and Business Resilience

To identify the relationship between the variables of transformational leadership and business resilience, Spearman's correlation coefficient (**ρ**) was applied, given that the data come from Likert-type scales and do not necessarily meet normality assumptions. This analysis allows us to determine the degree of association between both variables among the 114 SMEs analyzed in the Esmeraldas canton.

Table 6

Spearman's correlation between transformational leadership and business resilience

Variables	Correlation Coefficient (ρ)	Significance (p)	Interpretation
Transformational leadership – Business resilience	0.58	0.000	Moderate positive correlation

Source: Author's own work.

The results show a moderate positive correlation (**ρ** = 0.58) between transformational leadership and organizational resilience, indicating that as managers exhibit greater transformational leadership traits, the resilience of SMEs also increases. This finding suggests that leaders who foster motivation, support the development of their employees, and build

shared visions contribute significantly to strengthening companies' adaptive capacity in the face of adverse environments.

Conclusions

The study's results lead to the conclusion that the business fabric of the Esmeraldas canton is primarily composed of small and medium-sized enterprises, which play a fundamental role in local economic revitalization. However, these organizations operate in an environment characterized by structural limitations, economic uncertainty, and social challenges that directly influence their capacity for growth and sustainability. In this context, the characteristics of the leadership exercised by managers become a determining factor in strengthening the stability and continuity of businesses.

Regarding the sociodemographic profile of managers, there is a significant presence of leaders with established business experience, which constitutes an important resource for strategic decision-making. The presence of managers with professional careers spanning more than a decade suggests that many of them have developed skills to navigate crisis situations and environmental changes, which helps strengthen the organizations' adaptive capacity.

Furthermore, the analysis of the dimensions of transformational leadership shows that SME executives in Esmeraldas demonstrate favorable levels in aspects such as inspirational motivation and individualized consideration, reflecting a focus on human talent development and the building of work relationships based on trust and cooperation. However, opportunities for improvement are identified in the dimension of intellectual stimulation, highlighting the need to place greater emphasis on promoting innovation, strategic thinking, and the generation of new business solutions.

Regarding business resilience, the results show that factors such as self-confidence, personal competence, and, especially, family and cultural support play a fundamental role in companies' ability to remain active in the face of adverse conditions. In many Esmeraldas SMEs, family and community ties constitute an important source of emotional and operational support, enabling managers to sustain their productive activities even in complex scenarios.

Likewise, the correlation analysis revealed a moderate positive relationship between transformational leadership and business resilience, confirming that leadership practices focused on motivation, supporting the work team, and building shared visions contribute significantly to strengthening companies' adaptive capacity. This finding underscores the importance of promoting leadership styles that prioritize human development and organizational cooperation.

In the specific case of Esmeraldas, where companies operate in a context marked by insecurity, economic uncertainty, and business demotivation, transformational leadership becomes a key factor in maintaining organizational cohesion and promoting adaptation strategies. Managers who succeed in inspiring trust, fostering cooperation, and strengthening human bonds within the company enable organizations to develop resilient mechanisms that allow them to continue operating despite the difficulties of the social and economic environment.

In summary, the study demonstrates that the sustainability of SMEs in Esmeraldas does not depend solely on economic or structural factors, but also on the strengthening of managerial capacities and the building of resilient organizational cultures. Therefore, it is essential to

promote public policies, training programs, and institutional strategies aimed at strengthening business leadership and improving conditions of security, stability, and territorial development in the province.

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Embedded system with PIC18F4550 for document delivery: The CUNorte case study

Moisés Margarito Piñón Murillo
Universidad de Guadalajara (México), moises.pinon4365@alumnos.udg.mx
Edgar Alexander Morelos Nuñez
Universidad de Guadalajara (México), edgar.morelos6573@alumnos.udg.mx
Leticia Lemus Cárdenas
Universidad de Guadalajara (México), leticia.lemus@academicos.udg.mx, https://orcid.org/0000-0001-9139-5666
Ana Rosa Carrillo Avila
Universidad de Guadalajara (México), ana.cavila@academicos.udg.mx, https://orcid.org/0000-0002-7334-0378

Introduction

The growing demand for efficient administrative processes in educational institutions underscores the need for innovative technological solutions. Manual document delivery—often slow and prone to errors—constitutes a significant bottleneck in academic operations. Embedded systems, which integrate microcontrollers, sensors, and actuators, offer a cost-effective approach to automating such tasks, thereby improving productivity and reducing human effort. At the Northern University Center (CUNorte), the manual transfer of documents between administrative units, such as the Academic Services building, lead to inefficiencies, with staff walking more than 600 meters daily to complete deliveries.

This project, developed within the framework of the Microprocessors and Minimal Systems course at the University of Guadalajara, proposes an autonomous robot for document delivery based on embedded systems. An embedded system is the integration of hardware and software designed to perform multiple tasks simultaneously within a single device. The prototype employs a PIC18F4550 microcontroller mounted on a four-wheeled mobile base and incorporates infrared and ultrasonic sensors for orientation, along with motor drivers for mobility. It also features a secure access system using a numeric keypad and an LCD display. This proposal aligns with the growing trend of the Internet of Things (IoT), in which interconnected devices contribute to enhancing the efficiency of various tasks.

The research aims to (1) analyze inefficiencies in the manual document delivery process at CUNorte, (2) design a scalable embedded system prototype using adaptable and cost-effective components, and (3) evaluate the prototype's performance in a controlled environment. The methodology combines hardware design, software development, and empirical testing, drawing upon content analysis approaches that integrate academic knowledge with practical applications.

Case Study: CUNorte

This case study focuses on the implementation of an autonomous robot for document delivery at CUNorte. The prototype addresses the logistical challenges associated with document transportation on campus, emphasizing efficiency, safety, and technological innovation. By automating delivery tasks, the system aims to reduce staff workload, minimize errors, and enhance operational sustainability aligning with the principles of socio-technical transitions.

Context description

In recent decades, the use of microcontrollers for various devices has gained importance both in industry and academia. Several recent studies implementing the same version of the microcontroller used in this study are described in this section.

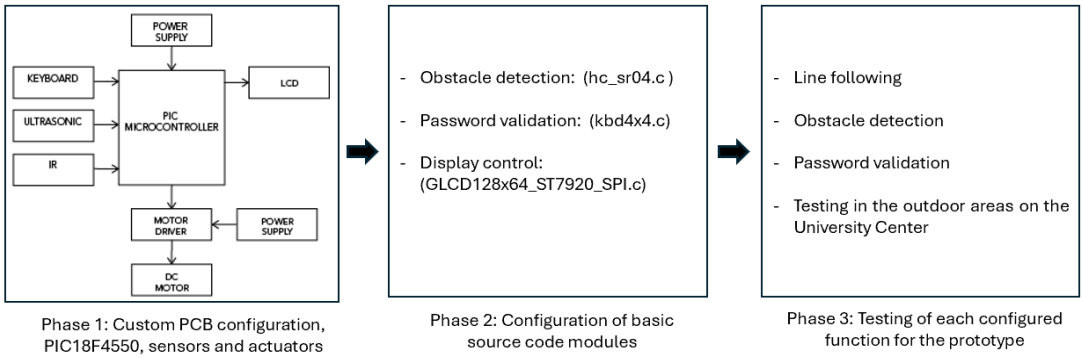
Visan and Lita (2021) present a thermal analysis system based on the PIC18F4550 microcontroller, which collects data from multiple temperature sensors placed at critical points of electronic modules. The system supports up to ten analog inputs, measures temperatures from -35°C to 140°C and transmits the data via USB to a LabVIEW application for graphical display and analysis. Similarly, Guillen Bonilla *et al*. (2025) designed, simulated, and fabricated a gas detector using the PIC microcontroller. The device can detect three gases: O_2, C_3H_8, and CO_2, with a sensor that has a response time of 3 seconds. This device was designed for implementation in industrial settings following a network-based paradigm.

On the other hand, Akshata *et al*. (2022) propose a low-cost Engine Control Unit (ECU) for UAVs, in which a microcontroller communicates with the flight control system via a serial interface and receives throttle commands. A similar project is proposed by Forero Salas *et al*. (2023), who developed a Cartesian robotic system actuated by a microcontroller. This system employs a trapezoidal motion profile to operate a vehicle-positioning crane in an underground parking lot. The entire system is assisted and controlled by a PIC18F4550.

To achieve the objectives of this research, three main stages were structured: (1) Identification of a specific problem—optimizing the transportation of physical documents between administrative areas at CUNorte to improve logistical efficiency and the productivity of administrative processes; (2) Exploration and implementation of technological solutions that are adaptable, configurable, and scalable within the university context; and (3) Experimental design and functional testing, including the construction of a controlled vehicle capable of moving safely across different surfaces.

Figure 1 provides a generalized representation of the methodology, outlining the specific procedural steps implemented in the development of the robot prototype. During the first phase, a printed circuit board (PCB) was designed for the microcontroller, incorporating interfaces for the connection of sensors, actuators, and peripheral devices. In the second phase, the microcontroller was programmed through the configuration of the various functions integrated into the prototype. Finally, in the third phase, the system's capabilities—line following, obstacle detection, and access control—were tested and validated.

Figure 1. Block diagram of experimental design and functional testing.



Phase 1: Custom PCB configuration, PIC18F4550, sensors and actuators

Phase 2: Configuration of basic source code modules

Phase 3: Testing of each configured function for the prototype

In addition, the modules were programmed using the C language, the native development environment for the microcontroller. It is worth highlighting that the choice of materials and electronic components is based on criteria such as compatibility, energy efficiency, reliability, and local market availability, as shown in Table 1.

Table 1. *List of main materials for the prototype*

Component	Quantity	Description
PIC18F4550 Microcontroller	1	8-bit MCU, Harvard architecture
L298N Driver	2	Dual H-bridge module
6V DC Gear Motors	4	Used in 4WD configuration
4WD Chassis	1	Used for the load system
TCRT5000 Infrared Sensor	2	For line and edge following
HC-SR04 Ultrasonic Sensor	1	For obstacle avoidance
4x4 Matrix Keypad	1	For password activation
GLCD 128x64 Display	1	To display the system's operating status
Powerbank (5V/2A)	1	Power supply for the system
Custom PCB	1	Component integration
MDF Box	1	Tray for document transport

Printed Circuit Board (PCB) and Configured Components

The design corresponds to a single-sided printed circuit board (PCB), manufactured using the tools available in the institution's Electronics Laboratory. This PCB complies with the IPC-2221: Generic standard on printed board design ensuring a reliable and standardized construction [IPC-2221]. The base material is FR4 (woven fiberglass reinforced with epoxy resin) and includes a USB Type-B connector for interfacing with the system. The board design adheres to conductor spacing guidelines (clearance and creepage) to prevent phenomena such as electrical arcing or corona discharge, under the peak voltage requirements (both Direct Current and Alternating Current) specified in Figure 2.

Figure 2. The PCB Trace Spacing Regulation Standards.

Voltage Between Conductors (DC or AC Peaks)	Minimum Spacing							
	Conductors (Creepage on Same Layer, Internal or External)					Component Lead (Corona Effect)		
	B1	B2	B3	B4	B5	A6	A7	A8
0-15	0.05 mm [0.002 in]	0.1 mm [0.004 in]	0.1 mm [0.004 in]	0.075 mm [0.003 in]	0.075 mm [0.003 in]	0.13 mm [0.00512 in]	0.13 mm [0.00512 in]	0.13 mm [0.00512 in]

Nota. Adapted from *Harnessing the power of effective PCB routing: Strategies, best practices, and future trends*, by **PCB Runner** (s. f.), https://www.pcbrunner.com/rigid-pcb-routing-depanelization/

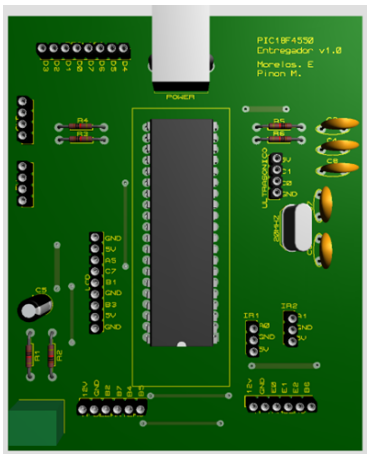
The design process is grounded in international standards applicable to embedded systems, particularly ISO/IEC/IEEE 12207:2017 – Systems and software engineering – Software life cycle processes (International Organization for Standardization (ISO, 2017), which defines software lifecycle processes. Additionally, practical design criteria were drawn from

IPC-2221A: Generic standard on printed board design (Class 1), which covers general PCB design, as well as from the NOM-I-121-1989 and NOM-I-125-1989, which regulate the use of FR-2 phenolic laminates. Track spacing values were also based on Figure 2, corresponding to PCB trace spacing regulations. All these guidelines were adapted to the context of non-industrial, small-scale fabrication (IPC, 2003; Secretaría de Economía, 1993).

The board includes multiple functional stages, such as an oscillation circuit to stabilize the microcontroller, a reset stage for system rebooting, and power supply sections that manage the required voltage levels, complying with minimum internal conductor spacing (B1) and uncoated external spacing (B2/B3). Additionally, the board design features wire bridges that correspond to terminations of external components with conformal coating (A7), allowing connections between components and optimized trace routing (see values in Figure 2). The layout strategically allocates dedicated areas for the connection and installation of sensors and actuators.

Figure 3 shows the design and three-dimensional (3D) view of the top side of the printed circuit board (PCB) developed in Proteus for the robot prototype. This representation clearly illustrates the arrangement of the electronic components, which form the central system of the prototype. Once the board is integrated into the chassis and connected to the other modules, functionality tests are conducted to verify the system's performance.

Figure 3. 3D design of the PCB and its components.



Note: Labcenter Electronics. (2023). Proteus Design Suite (Version 8.15) [Electronic simulation software]. https://www.labcenter.com

The robot prototype was tested in a controlled environment at CUNorte, following predefined routes within the administrative areas. The key findings are as follows:

- Movement: In this case, movement refers to the vehicle's ability to follow lines. The sensors accurately detected 2 cm black lines, enabling the robot to follow paths with deviations of less than 5 mm. The ultrasonic sensor successfully stopped the robot upon detecting obstacles at 20 cm of distance, with an average response time of 50 milliseconds. These values demonstrate high actuation efficiency, effectively preventing collisions (see Figure 4).

Figure 4. Robot testing on surfaces.



- Security: The robot prototype incorporates a security mechanism for activation, meaning it can only be operated through an authentication process. Figure 5 shows the 4x4 keypad and LCD system, which ensures access by validating a predefined password. Testing showed that the authentication system responds in under one second.

Figure 5. Testing the configured security key entry. Incorrect key entry (item a) and system response to the key entered (item b).



a) Password entry b) Incorrect key response

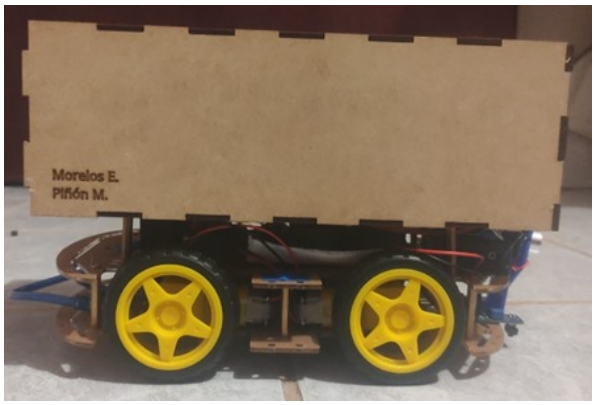
Table 2 summarizes the values obtained from the various tests conducted, as well as the dimensions of the final prototype.

Table 2. *Experimental results*

Metric	Specification	Measured Result	Observations
Turning Accuracy (TCRT5000)	0.5 mm to 15 mm	3 mm (0.118 in)	Stable during 120° turns on both smooth and rough surfaces.
Obstacle Stopping Time (HC-SR04)	<100 ms for obstacles at 20 cm	50 ± 5 ms for obstacles at 20 cm with optimal angle <15°	Fast response in dynamic environments.
Password Validation Time	<1 s	0.8 s	Efficient in repetitive access scenarios.
Surface Robustness	Stability on smooth reflective white and rough surfaces	Stable	Operates reliably on surfaces like light-colored concrete and ceramic tiles.
Sunlight Interference (TCRT5000)	Tolerance up to 50,000 lux	Reduced accuracy	TCRT5000 sensors showed decreased reliability in outdoor environments.

For the case of dimensions and weight, the prototype measures 30 cm (length) × 20 cm (width) × 15 cm (height) and has an approximate total weight of 943 g, as shown in Figure 6.

Figure 6. Hardware model of the proposed system



Conclusions

This case study demonstrated the feasibility of using embedded systems to address logistical challenges in educational institutions. The integration of cost-effective components, such as the PIC18F4550 and TCRT5000 sensors, highlights the scalable potential of this approach in academic settings. The development of the robot prototype resulted in a solution designed to reduce delivery times and enhance security, enabling staff to focus on higher-value tasks. This outcome meets the second objective outlined in the project.

Testing confirmed the achievement of the third objective, demonstrating high accuracy in turns (particularly on 120° curves), rapid obstacle response (50 ± 5 ms at a 20 cm distance), and secure authentication within 0.8 seconds. Although precision decreased under direct sunlight conditions exceeding 50,000 lux, the prototype maintained stable performance on both concrete and ceramic surfaces.

Future work will focus on enhancing sensor robustness for outdoor environments and integrating higher-performance motors for scalability. This project not only addresses a practical need but also reinforces the role of academic programs in promoting technological innovation, in alignment with the principles of sustainability-oriented innovation

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