Strategic Alliances as Drivers of Sustainable Innovation in MSMEs in Cauca, Colombia

Alianzas estratégicas como motor de innovación sostenible en MiPymes del Cauca, Colombia

DOI: https://dx.doi.org/10.17981/ingecuc.21.1.2025.13

Original Research.
Date Received: 07/03/2025, Date Accepted: 17/03/2025

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To cite this paper
A. Castro-Rodríguez, L. López-Castrillón, C. Rúa-Gómez & M. Piedrahita-Triviño "Strategic Alliances as Drivers of Sustainable Innovation in MSMEs in Cauca, Colombia," INGE CUC, vol. 21, no. 1, 2025. DOI: https://dx.doi.org/10.17981/ingecuc.21.1.2025.13

Abstract

This article explores the demand for innovation services by micro, small and medium-sized enterprises (MSMEs), with the aim of leveraging the capabilities of Higher Education Institutions (HEIs) and innovation transfer and support entities in the Department of Cauca, Colombia. Through the Fusióni3 Cauca project, a model was developed and proposed to identify and categorize the innovation services demanded by MSMEs, evaluating their impact on business competitiveness. The results reveal that MSMEs demand services in four fundamental pillars: i) continuous improvement, ii) technology management, iii) product development, and iv) market positioning. These services address the primary challenges faced by these enterprises, providing them with a greater likelihood of adopting sustainable practices that foster long-term innovation and enhance their competitiveness at both the regional and national levels.

Keywords
Strategic alliances, innovation capabilities, competitiveness, technological development, innovation ecosystem, technology management, sustainable innovation, continuous improvement, MSMEs, innovation services.

Resumen

Este artículo Explora la demanda de servicios de innovación por parte de las Micro, pequeñas y medianas empresas (MiPymes), con el objetivo de que sean soportados por las capacidades de las Instituciones de Educación Superior (IES) y entidades de transferencia y apoyo a la innovación en el Departamento del Cauca, Colombia. A través del proyecto Fusióni3 Cauca, se desarrolla y propone un modelo que permitió identificar y clasificar los servicios de innovación demandados por las MiPymes. evaluando su impacto en la competitividad empresarial. Los resultados revelan que las MiPymes demandan servicios en cuatro pilares fundamentales: i) mejora continua, ii) gestión tecnológica, iii) desarrollo de productos, y iv) posicionamiento en el mercado. Estos servicios responden a los principales retos de las empresas, brindándoles una mayor probabilidad de adoptar prácticas sostenibles que promuevan la innovación a largo plazo y mejoren su competitividad tanto a nivel regional como nacional.

Palabras clave
Alianzas estratégicas, capacidades de innovación, competitividad, desarrollo tecnológico, ecosistema de innovación, gestión tecnológica, innovación sostenible, mejora continua, MiPymes, servicios de innovación.

INTRODUCTION

MSMEs play a fundamental role in the economic and social development and sustainability of regions, promoting job creation and fostering social cohesion in local communities. [1] They also contribute significantly to innovation and capacity building, which positions them as key actors for market adaptation, a crucial aspect for developing economies. [2] In Colombia, MSMEs represent a crucial part of the business universe, accounting for 99.5% of the formal business fabric and contributing between 35% and 40% of Gross Domestic Product (GDP). [3] [4] In addition, they generate 79% of the total employment of the Colombian economy and 53% of formal employment in the country. [5]

On the other hand, in the business environment of the Department of Cauca, MSMEs face significant challenges in maintaining long-term relevance and sustainability due to barriers such as limited access to technological, financial, and knowledge resources. However, the ability to innovate has become a critical factor for their success, enabling them to overcome these challenges. Despite these barriers, studies show that MSMEs can generate a positive impact on both the local and national economy by adopting continuous innovation practices, which not only enhance their competitiveness but also improve their ability to adapt to changing markets, [6], [7] and even enhance performance in sectors such as manufacturing and in economies in transition. [8], [9].

In Colombia, MSMEs that have integrated innovation into their processes and products have successfully improved their competitiveness and economic performance, as evidenced by the documented open innovation practices of companies in the country.[10] In this context, strategic alliances between MSMEs, HEIs and technology transfer entities emerge as a key mechanism to overcome barriers such as limited access to technological resources or knowledge and catalyze the sustainability of innovation in MSMEs[11].

In line with the above, the Fusióni3 Cauca project focuses on how HEIs and technology transfer entities such as Reddi Colombia can support MSMEs in Cauca in their efforts to innovate sustainably— not only by implementing new technologies and processes but also by fostering a culture of open innovation that enables both companies and HEIs to adapt and foster the development of an innovative ecosystem. The Fusióni3 Cauca project, led by the Reddi Agency for Technological Development and Innovation, identified the critical innovation needs of 30 MSMEs and proposed a model for characterizing and classifying the innovation services required to address the challenges faced by MSMEs.

This article establishes a methodology to identify the demand for innovation services by MSMEs, based on a review of gray literature, particularly studies conducted at the national, regional, and departmental levels, to identify and analyze the needs, opportunities, and trends in the main productive sectors of the Department of Cauca. This is followed by the collection of data from 30 MSMEs. For the analysis of challenges, the information was grouped under four strategic pillars to develop a model that contributes to aligning the capacities of HEIs in the region and formulating strategies to build the capacities of actors involved in strengthening these companies.

This approach not only provides an in-depth understanding of how Cauca's MSMEs can overcome their innovation challenges but also highlights the critical importance of HEIs, support entities, intermediaries, and technology transfer offices as key players in the innovation ecosystem. In doing so, the study offers a roadmap for other regions and sectors seeking to foster sustainable innovation in MSMEs, with significant implications for economic development and business sustainability in Colombia.

Below, we present the state of the art to contextualize the role of strategic alliances in business innovation. We then describe the methodology used in the analysis, followed by the presentation and discussion of the results obtained. Finally, we conclude with recommendations and future work aimed at strengthening the innovation ecosystem and the sustainable development of MSMEs in similar regions.

STATE OF THE ART

Innovation in MSMEs has been widely recognized as a key driver for economic growth and competitiveness, especially in developing economies such as Colombia. Studies such as

that of Forero-Pineda et al [12] in Colombia, as well as the work of Marinho and Melo [13] in Brazil, show how small and medium-sized enterprises can overcome structural limitations by adopting innovation practices, thus achieving a positive impact on their competitiveness and the overall economy. However, these companies face substantial barriers to innovation, including limitations in access to finance, lack of technological capabilities, and a shortage of specialized knowledge.

Strategic Alliances and Knowledge Transfer

Strategic alliances or cooperation between MSMEs and HEIs have been identified as an effective solution to overcome significant barriers in innovation. Previous research indicates that collaboration between companies and universities has a long history that involves different mechanisms or shared activities, such as the exchange of knowledge and models of co-development of new technologies, products, processes, business models and company culture [14]. In this context, universities contribute to the growth of innovation and the competitiveness of the regions in the long term, helping companies find practical solutions to specific challenges [15] by linking them as partners in research and development for the creation of novel innovations, enabling access to advanced technical knowledge, emerging technologies, trained human resources and unique capabilities that shorten the innovation process for companies.

Research has focused on understanding the importance of university-business collaboration, particularly the mechanisms of knowledge transfer [16] and on empirically demonstrating that the number of collaborations-especially the presence of previous collaborations between universities and companies-positively affects the creation of new companies [17].

In particular, the study by Gómez, Daim and Robledo [18] highlights that Colombian companies that establish strong ties with universities show significantly higher innovative performance. This improvement is attributed to direct access to technological development and learning activities, which enhances their ability to innovate and compete in dynamic markets. Furthermore, the literature underscores that the transfer of knowledge from universities to companies is crucial for the implementation of innovations that not only solve immediate problems but also ensure continuous and sustainable growth in the long term. In this regard, Flores-Tuxpan, García-Flores and Palma Martos [19] point out that technology transfer not only facilitates the adoption of scientific advances in production processes but also plays a crucial role in the generation of innovative capacities that promote sustained economic development.

Additionally, a study by Etzkowitz and Leydesdorff [20] introduces the concept of the "Triple Helix," which describes the interaction between university, industry, and government as a model for regional innovation. This model has proven to be especially relevant in regions where MSMEs play a critical role in the economy, and where collaboration with HEIs can enhance the innovation capacity of these companies, ensuring that the innovations introduced are not only effective, but also remain relevant and adaptable over time.

Sustainable Innovation in MSMEs

In this article, the concept of sustainable innovation not only refers to the ability of MSMEs to maintain their innovative dynamism in the long term but also integrates the adoption of sustainable practices related to the promotion of the Sustainable Development Goals (SDGs), in their social, environmental and economic dimensions. [21] Sustainable innovation, in this sense, is not only about adopting new technologies or processes, but also about creating a culture and a business structure that allows for continuous innovation and the development of sustainable practices that support competitive advantages.

Recent studies indicate that MSMEs that develop sustainable innovation capacities are more likely to remain competitive in the long term. [22] [23] These companies are better able to adapt to market changes and withstand economic crises due to their continuous focus on process improvement, new product development, and operations optimization. A report by the Economic Commission for Latin America and the Caribbean [24] underscores that MSMEs that integrate sustainability into their innovation strategy are more resilient and capable of sustaining their growth over time.

In addition, combining innovation with sustainability has been shown to not only improve business resilience, but also to boost organizational performance by fostering a collaborative environment and continuous innovation. [25]. Dynamic capabilities, integrated with sustainability practices, are critical to maintaining a sustainable competitive advantage, enabling companies to meet current challenges and seize new opportunities in changing markets. [26]

Innovation and Competitiveness Services

It is suggested that access to services that facilitate innovation is crucial for MSMEs seeking to stay competitive in global markets. According to De Massis et al., [27] companies that manage to innovate despite resource constraints tend to outperform their competitors by integrating strategies that focus on specific niches, closely collaborate with customers, and strongly focus on sustainability.

This approach is aligned with the findings of the Fusióni3 Cauca Project, which highlights the importance of innovation services such as continuous improvement, technology management, product development, and market positioning. These services not only transform business operations but also establish a strong foundation for future innovation. Porter [28] argues that "innovation is a key driver of competitive advantage," and that services that facilitate innovation allow MSMEs to develop an internal capacity to continuously adapt and evolve. In a context of limited resources, the ability to efficiently orchestrate these resources becomes a critical factor for long-term success. [27]

In a similar case study conducted in Brazil, [29] it was found that MSMEs that participated in collaborative innovation programs with universities and research institutions were able to establish internal processes that allowed them to maintain sustained innovation, thus ensuring their relevance in the market over time.

Emerging Trends in Innovation for MSMEs

The emerging trend in innovation for MSMEs is the adoption of digital technologies such as automation, artificial intelligence (AI) and big data analysis, which are transforming the way these companies operate to optimize their processes, reduce costs and improve decision-making. [30] Additionally, these technologies provide tools that can sustain innovation over time by allowing MSMEs to adapt to changing market demands, personalize their offerings, and make informed decisions about the supply chain. In Colombia, although the adoption of these technologies is still incipient [31], it is expected that through strategic alliances and access to innovation services MSMEs can establish a foundation for sustainable innovation in the long term.

In conclusion, the literature suggests that strategic alliances between MSMEs and HEIs and access to innovation services are critical factors not only for the implementation of immediate innovations but also to ensure that these innovations are sustainable over time. This ability to sustain innovation is what will allow MSMEs to not only survive but also thrive in an increasingly complex and demanding global marketplace.

METHODOLOGY

This case study was developed using a qualitative methodological approach with the purpose of analyzing the challenges and opportunities for innovation in MSMEs in the Department of Cauca that are beneficiaries of the Fusióni3 Cauca project. The methodological process was designed to identify, characterize and categorize the innovation needs of these companies, through the model proposed in the project, to translate them into specific innovation services that, although they have not yet been fully implemented, represent a strategy to promote the sustainability and competitiveness of MSMEs in the long term. Figure 1 presents the methodology, which includes five phases.

Definition of the Methodological Approach

A qualitative approach was selected due to the exploratory nature of the study and the need to gain an in-depth understanding of the internal dynamics of MSMEs, particularly regarding their capacity for innovation. This approach allowed not only to identify the needs

and challenges of companies, but also to understand how these perceptions translate into expectations of future impact, once the proposed innovation services are implemented.

Case Study Design

The study was structured around the Fusióni3 Cauca project, a key initiative led by Reddi's Agency for Technological Development and Innovation. The project focused on analyzing and characterizing the state of innovation in 30 MSMEs from six prioritized sectors in the department of Cauca: agribusiness, commerce, information and communications technology (ICT), manufacturing, construction and tourism. Through a detailed process of data collection and analysis, the main innovation challenges faced by these companies were identified, as well as the opportunities for their development and sustainability.

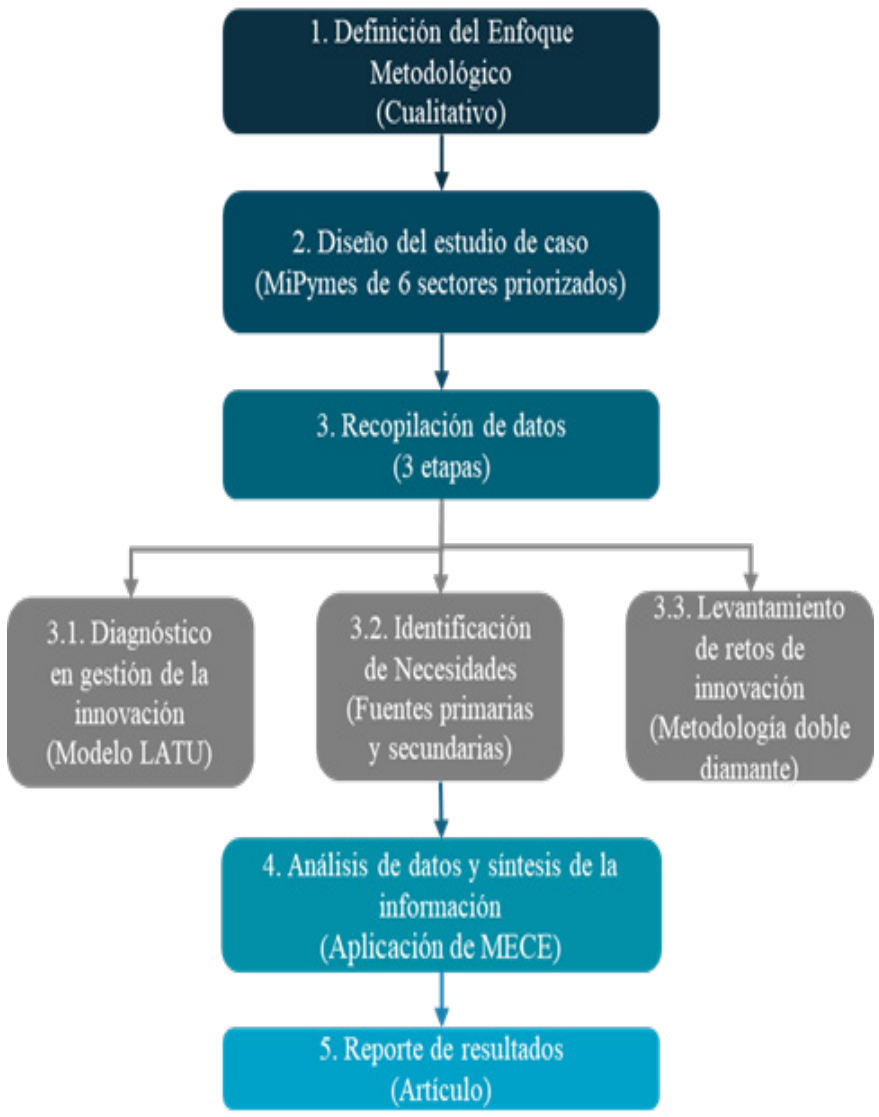

Figure 1. Methodology used. Source: Authors

1. Definition of the methodological approach (qualitative)		
2. Design of the case study (MSMEs from six prioritized sectors)		
3. Data collection (three stages)		
3.1. Diagnosis of innovation management (LATU model)	3.2. Identification of needs (primary and secondary sources)	3.3. Survey of innovation challenges (double diamond methodology)
Data analysis and synthesis of information (application of MECE)		
Report on results (article)		

Data Collection

Data collection was carried out in three stages:

- Diagnosis of innovation management at the 30 Beneficiary MSMEs, based on the Uruguayan Innovation Management Model (LATU) [32]. This diagnosis was carried out based on semi-structured interviews, where a tool was applied that evaluates six key areas: leadership, planning, people, innovation intelligence, processes and results. This diagnosis allows for characterizing the level of innovation of MSMEs and identifying their needs.
- Identification of needs, opportunities and challenges of the six prioritized sectors in the department of Cauca. This activity was carried out based on the analysis of primary and secondary sources.

The analysis of secondary sources was carried out based on the search and identification of national, regional and sector-based documents, reports, publications or studies involving research or diagnoses in the prioritized sectors, in order to obtain qualitative information on the situation of MSMEs in Colombia and in the Department of Cauca. Twenty-five documents containing information related to the objective of the study were reviewed, from which information was extracted focusing on three aspects: needs, trends and challenges of the sector.

Primary sources were analyzed in order to validate and provide feedback on the results obtained from secondary sources. First, the perceptions of key actors in the region were collected through interviews to obtain key information on each sector. Subsequently, six sectoral workshops were held, bringing together actors from the triple helix of the department of Cauca, to discuss and receive feedback on what had been developed. Their comments and opinions were received and the needs, opportunities and challenges encountered were prioritized.

- Survey of the innovation challenges at the 30 MSMEs, based on the identification of the problems, needs and opportunities they face. This process was carried out by adapting the Double Diamond methodology, [33] carrying out the five defined phases directly with each MSME: identify, build, prioritize, discover and define. For the identification phase, the concept of innovation driver is incorporated [34] to inspire the companies in four axes: problem, technology, trend and users.

The results obtained in these stages provide an overview of the profile, the current innovation capabilities in companies and the challenges they face in their competitive environment.

Data Analysis and Synthesis of Information

Based on the initial characterization, an exhaustive analysis of the needs, opportunities and challenges of innovation identified in phase 3 was carried out. For this analysis, the MECE (Mutually Exclusive and Collectively Exhaustive) methodology was used, [35] which allowed the logical classification of the innovation needs of MSMEs. These were grouped according to criteria of urgency, feasibility and potential impact, facilitating the identification of strategic solutions.

The data analysis process followed a thematic approach, in which interviews and documents were organized to detect recurring patterns and key themes in MSME innovation. The use of the MECE methodology was essential to structure the needs into clear and coherent categories, which allowed these needs to be efficiently translated into specific innovation services.

The data were analyzed in three stages: first, the specific challenges of MSMEs in terms of innovation were identified; second, the nature of these needs was categorized and possible solutions were proposed; lastly, these solutions were consolidated into a set of innovation services.

Results Report

This phase consisted of preparing a detailed report that compiles the results obtained and that are synthesized in this article, as evidence of the main findings obtained.

Results

The detailed analysis of the Fusióni3 Cauca project made it possible to identify and categorize the main innovation needs of the participating MSMEs, as well as to develop a series of innovation services designed to address these challenges. Even though these services have not yet been fully implemented, the results of the study offer a comprehensive view of how these companies can benefit from these interventions and the positive expectations regarding the impact of innovation on their long-term sustainability and competitiveness, which represents a robust and well-founded proposal to improve the innovation capacity and competitiveness of MSMEs in the future.

A fundamental aspect that emerges from these results is the crucial role played by Higher Education Institutions (HEIs) and development entities in the provision of these innovation services and the achievement of these objectives.

Profile of the Participating MSMEs

The MSMEs participating in the Fusióni3 Cauca project represent a wide range of economic sectors, each with its own characteristics and challenges. These companies were selected based on their potential to innovate and their need for support in developing innovation capabilities. Below are the key characteristics of the participating MSMEs:

- Size: MSMEs with between 5 and 50 employees, and an average of 20 employees per company.
- Sector: The predominant sectors include agribusiness (36.7%), commerce (20%), information technology (16.7%), manufacturing (13.3%), construction (6.7%), and tourism (6.7%).
- Age: Most of these companies have been in operation for between 5 and 15 years, and innovation is very important for their growth and sustainability.
- Level of innovation: According to the LATU Model applied to 30 MSMEs, it was found that 36.7% of the MSMEs are at an innovation implementation level, with formal management processes, objectives and clear metrics, along with a budget and assigned responsibilities. Another 36.7% are at the commitment level, with an innovation strategy and resources identified. 16.7% have reached the level of continuous improvement, evaluating and improving their innovation process. 6.7% have achieved a sustainable innovation culture, while only 3.3% have achieved excellence in innovation, being leaders in their sector and with certified management systems, as shown in Figure 2.

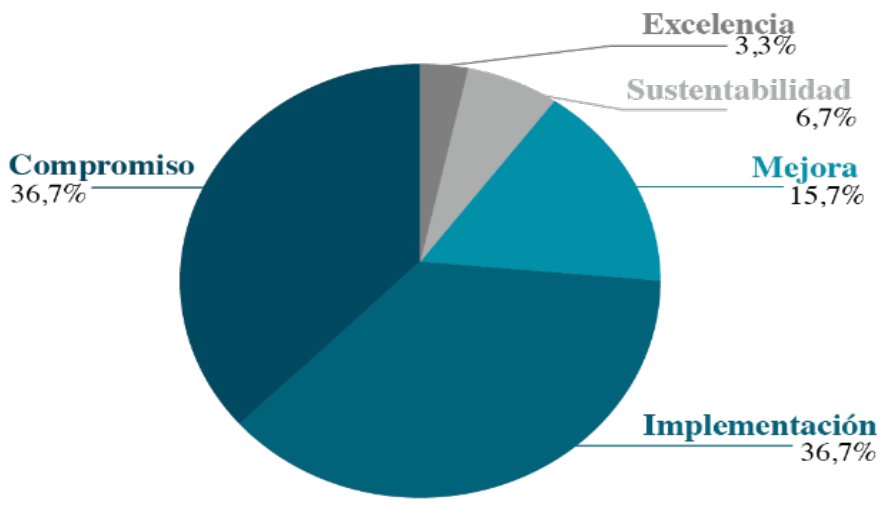

Figure 2. Distribution of MSMEs according to their level of innovation. Source: Authors.

- Innovation Challenges: Based on the proposed methodology, 78 innovation challenges of the 30 MSMEs under study were identified. The main needs identified include the modernization of production processes, the development of new products, the efficient management of technologies and the expansion into new markets. Additionally, it was identified that the main driver for the definition of challenges has been the Problem Driver (54 challenges, 44%), due to its conceptual simplicity, which makes it understandable for companies and easy to apply. On the other hand, the Trend and Technologies Driver has the same number of directly related challenges (22 challenges, 28%), given that the use of new technologies has become a trend for the improvement of processes in the business environment. Finally, the User Driver is associated with 29.5% of the challenges (23), which indicates that entrepreneurs focus their innovation needs on their customers and market demands, as shown in Figure 3.

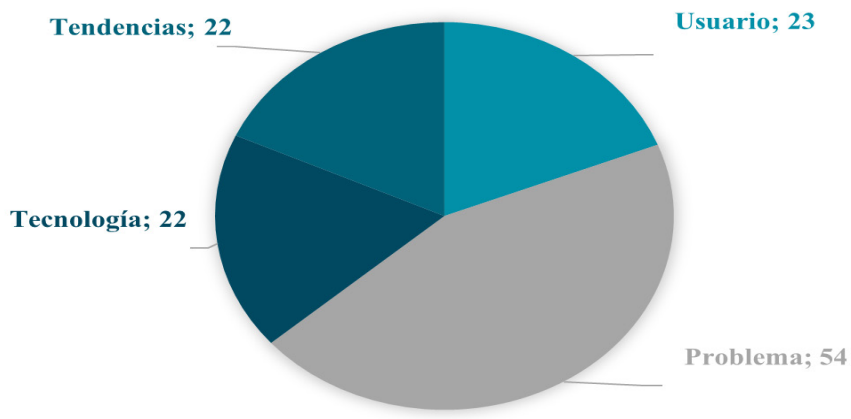

Figure 3. Driver for identifying challenges. Source: Authors

It should be highlighted that some of the challenges that are identified and commonly observed for MSMEs in Cauca are the problems of access to remote regions of the department, mobility difficulties and connections of the municipalities with the cities of central and northern Colombia.

The profile of these companies was decisive for the design of the proposed innovation services, ensuring that each service was aligned with the specific needs and operational context of the participating MSMEs.

Identification of Innovation Needs and Challenges

The analysis of the information and data collected made it possible to define critical areas in which MSMEs face significant barriers to innovation, grouped according to their nature and relationship with productive, technological and market processes. From this grouping using the MECE methodology, specific innovation services were defined, designed to address the identified challenges of MSMEs. These services were organized into four major strategic pillars: Continuous Improvement, Technology Management and Administration, Product Development, and Market Positioning. The definition of these pillars sought to ensure that the proposed solutions were both relevant and sustainable over time for the MSMEs, in this manner giving shape to the model of the Innovation Services System of the Fusióni3 Cauca Project (See Figure 4), which seeks to connect the innovation needs of the business sector with the offerings of innovation capabilities or services of HEIs or knowledge generators.

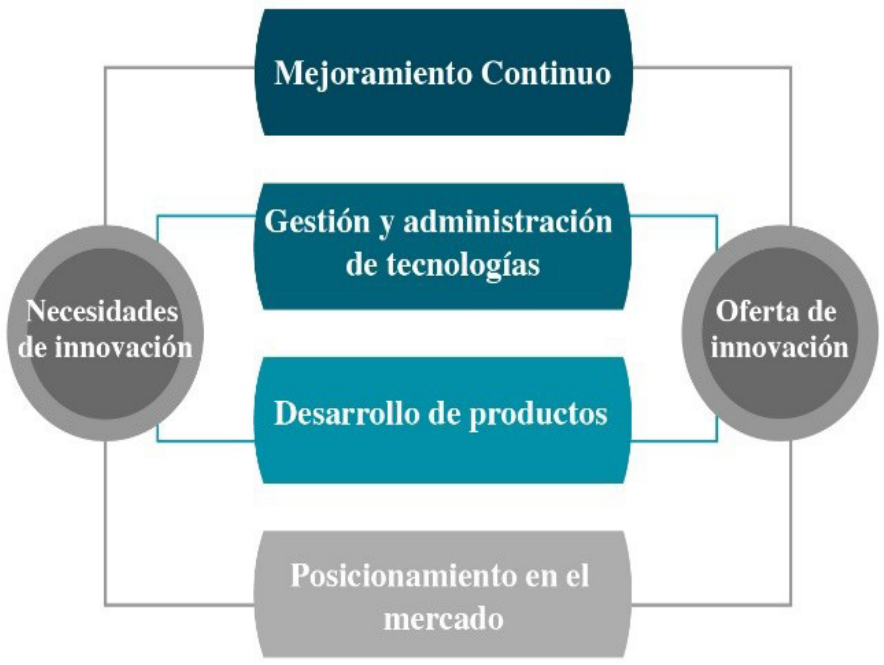

Figure 4. Innovation Services System Model - Supply and Demand. Source: Authors

Continuous improvement		
Innovation needs	Technology management and administration	Innovation offerings
Product development		
Market positioning		

Below, the needs and challenges of innovation are listed according to the defined pillars:

- Continuous Improvement: A recurring need was the lack of continuous improvement processes. The MSMEs identified the optimization of production processes as essential to reduce costs, improve product quality and increase operational efficiency. However, the effective implementation of these improvements is limited by the lack of technological resources and trained personnel. Here, HEIs and development entities like Reddi play a key role in providing training programs, consulting, and access to advanced methodologies such as Lean and Six Sigma, ensuring that these companies not only adopt continuous improvement practices, but also sustain them over time.
- Technology Management and Administration: Inefficient management of existing technologies and lack of adoption of new technologies were identified as major barriers. Many MSMEs showed a significant gap in their ability to integrate advanced technologies. HEIs and development entities are key players in this area, offering technology assessments, assistance in the selection and implementation of business management systems (ERP), and training in emerging technologies. These interventions not only facilitate the technological modernization of MSMEs but also ensure that these capabilities are maintained and evolve over time.
- Product Development: MSMEs also face difficulties in developing and launching new products, which limits their ability to compete in the market. HEIs, with their research and development capabilities, and development entities, with their market knowledge and technical resources, are critical to supporting MSMEs at all stages of the product lifecycle. These players provide access to prototyping labs, market research studies, and product design consulting, allowing MSMEs to innovate their offerings and stay competitive.
- Market Positioning: MSMEs also faced significant challenges in their ability to position their products in the market. HEIs and development entities play a critical role in this pillar, providing not only marketing and sales training, but also facilitating access to distribution networks and marketing channels. These interventions are vital to improving the visibility of MSMEs in the market and expand their reach to new consumer segments.

Definition of Innovation Services

Based on the identified needs, innovation services were designed and categorized into the four defined strategic pillars: Continuous Improvement, Technology Management and Administration, Product Development, and Market Positioning. These services not only address the specific challenges of MSMEs but are also supported by collaboration with HEIs and development entities, which are key actors in the implementation of these services as solutions to innovation needs and challenges.

TABLE 1. INNOVATION SERVICES. SOURCE: AUTHORS

Pillar	Innovation Services
Continuous Improvement	It includes training and consulting programs provided by HEIs and entities such as Reddi. These institutions offer training in advanced methodologies and consulting for the optimization of internal processes. These interventions are expected to establish a culture of continuous improvement within MSMEs, ensuring that innovations are sustainable over time. This includes: • Advice on improving operational processes • Improvement of products and services • Process automation • Human talent development • Evaluation and adoption of emerging technologies • Strategic planning
Technology Management and Administration	Services focused on the integration of advanced technologies in the operations of MSMEs. HEIs offer training and advisory programs in technology management, while development entities facilitate access to new technologies and automation systems. These services are essential to modernize the MSMEs' operations and ensure they can keep up with long-term technology trends. This includes: • Technology Infrastructure Assessment • Implementation of technological solutions • Cybersecurity and data protection • Management of technological projects associated with hardware and software • Training of personnel on the proper use of new technologies • Advice on Digital Transformation strategies • Technical support and maintenance of the technological infrastructure

Pillar	Innovation Services
Product Development	Services that focus on supporting MSMEs at all stages of the product lifecycle. HEIs provide access to research and development resources, while development entities offer technical support and market research. These services allow MSMEs to innovate in their product lines, ensuring that they can compete effectively in the market. This includes: • Market research and competitive intelligence • Feasibility and prospects for product development • Strategic planning for new product development • Design and prototyping • Quality assurance and product testing • Product Marketing and Branding • Advice on Certification and Regulatory Compliance
Market Positioning	Services aimed at strengthening the marketing and sales capacities of MSMEs. HEIs and development entities offer training in branding and digital marketing, as well as facilitating access to distribution networks. These services are critical to improving the visibility of MSMEs in the market and to expanding their reach to new consumer segments. This includes: • Market Research and Market Entry Strategy • Brand positioning • Distribution channels • Advertising and marketing • Sales team training • Prices and competitive positioning • Monitoring and analysis of the performance of market entry strategies • Post-launch support and customer service • Campaign sustainability

Evaluation and Expected Impact of the Innovation Services

Even though the proposed innovation services have not yet been fully implemented, participating MSMEs expressed positive expectations regarding their potential impact. The companies recognize that collaboration with HEIs and innovation transfer and support entities will be essential to overcome current challenges and significantly strengthen their capacity to innovate. The implementation of these services is expected to not only boost the competitiveness of MSMEs in the short term but also establish a solid foundation for the sustainability of innovation in the long term.

In particular, it is expected that the continuous improvement and technology management services provided by HEIs and innovation transfer and support entities will be essential to optimize MSMEs' operations and reduce costs, while product development and market positioning services will allow them to innovate in their offerings of goods or services and reach new markets.

Implications for the Sustainability of Innovation

The development of these innovation services and their alignment with the specific needs of MSMEs in Cauca underscore the importance of HEIs and development entities as key actors in the innovation ecosystem. These institutions not only provide the resources and knowledge needed to implement innovations but also play a crucial role in ensuring that these innovations are sustainable. By establishing a culture of continuous improvement, technology optimization, and product development, MSMEs will be better positioned to meet future challenges and maintain their relevance in the marketplace.

This methodological approach and the results obtained provide a solid basis for the future implementation of innovation services and offer a roadmap for other regions and sectors seeking to foster sustainable innovation in MSMEs. The lessons learned and strategies developed in the Fusióni3 Cauca project can serve as a model for similar initiatives in regional and national contexts, contributing to economic development and business sustainability in Colombia.

DISCUSSION

This case study, focused on MSMEs in the Department of Cauca that are beneficiaries of the Fusióni3 Cauca project, offers a detailed vision of how strategic alliances with Higher Education Institutions (HEIs) and development entities can catalyze the sustainability of innovation in these companies.

The concept of sustainability of innovation, as articulated in this study, goes beyond the simple implementation of new technologies or processes. It involves the creation of a business culture aimed at the adoption of sustainable practices related to the promotion of SDGs, enabling continuous improvement, adaptability and responsiveness to market and technological changes, in its social, environmental and economic dimensions.

The results obtained highlight several key points of discussion that reinforce the importance of an integrated and collaborative approach within the regional innovation ecosystem. The expectations of companies on the impact that working with HEIs and innovation support entities can generate for the implementation of innovation services reflect a shared understanding that innovation should be a continuous and evolutionary process. Figure 5 presents the proposed conceptual map for the management of innovation sustainability in MSMEs.

Figure 5. Conceptual map of managing the sustainability of innovation in MSMEs. Source: Authors.

Access to information	Strategic alliances	Transfer of knowledge
Promote collaboration		Four strategic pillars
Implications for public policy and development	Sustainability of innovation in MSMEs	Design of innovation services
Investment in innovation		Long-term sustainability
Facilitators of change	Role of HEIs and development entities	Internally developed capabilities

Importance of Strategic Alliances

A key finding of this study is the relevance of strategic alliances as a central axis to overcome the barriers to innovation faced by MSMEs. These partnerships allow companies to access knowledge, technologies, and resources that would otherwise be inaccessible. Collaboration with HEIs not only facilitates the transfer of technical knowledge and the adoption of new technologies but also establishes a foundation for sustainable innovation.

Innovation transfer and support entities, on the other hand, play a crucial role in the provision of financial and technical resources, as well as in the generation of strategic connections that enhance the innovative capacity of MSMEs to create social, economic and environmental value.

Design of Innovation Services

The categorization of innovation services into four strategic pillars (Continuous Improvement, Technology Management and Administration, Product Development, and Market Positioning) reflects a deep understanding of the specific needs of MSMEs and a strategic approach to address these needs holistically. This design is particularly relevant because it considers not only the implementation of innovations, but also their long-term sustainability. The role of HEIs and development entities in the design and potential

implementation of these services is a key factor in ensuring that the proposed solutions are effective and sustainable.

Role of HEIs and Development Entities

The study underlines the importance of HEIs and innovation transfer and support entities as main actors in the innovation ecosystem. These institutions not only provide the resources and knowledge needed to implement innovations but also act as facilitators of organizational change and internal capacity building in MSMEs. This role is particularly relevant in regions such as Cauca, where structural constraints can limit access to resources and knowledge. These organizations, by providing training, consulting, and access to innovation networks, are positioned as key players in the strategy to promote sustainable innovation.

Implications for Public Policy and Regional Development

Finally, the findings of this study highlight valuable implications for the design of public policies and regional development strategies, particularly in the promotion and connection of innovation services that address the identified needs of MSMEs. Evidence suggests that policies or mechanisms that promote articulation between MSMEs, HEIs and support entities are crucial to improve business competitiveness and regional development. Likewise, HEIs and support organizations are in a strategic position to offer specialized innovation services, which facilitates the transfer of knowledge and technology to MSMEs and strengthens their capacity to adapt to market changes.

Likewise, policies that promote the creation of formal collaboration mechanisms, such as innovation networks, can maximize the impact of these interventions by facilitating access to specialized human talent, infrastructure, financing, and advanced technology and promoting more equitable and sustainable economic development in Colombia.

Finally, the results underscore the need for an integrated and collaborative approach to boost the innovation capacity of MSMEs and foster more equitable economic development, capable of generating quality employment and promoting sustainability in the regions. Policies that facilitate and strengthen collaboration between these actors could transform the regional innovation ecosystem, enhancing its capacity to face global challenges and generate competitive solutions in the national and international markets.

CONCLUSIONS AND RECOMMENDATIONS

The case study of the Fusióni3 Cauca project shows how strategic alliances with HEIs and technology transfer support entities emerge as critical drivers for sustainable innovation in MSMEs in the Department of Cauca. Throughout this analysis, it has been highlighted that, although MSMEs face significant challenges to innovate, these collaborations can transform such barriers into tangible opportunities for long-term growth and competitiveness.

Conclusions

The article suggests that strategic alliances between MSMEs, HEIs and technology transfer and development support entities are essential to promote sustainable innovation in the department of Cauca.

The Fusióni3 Cauca project identifies and classifies the demand for innovation services by MSMEs, highlighting that those that have access to services focused on continuous improvement, technology management, product development and market positioning have a higher probability of adopting sustainable practices. Although the direct impact of the project is still in the implementation phase, it highlights the potential of these collaborations to strengthen the innovation capacity and competitiveness of companies in the long term. By providing access to expertise, infrastructure, and emerging technologies, HEIs and development entities are positioned as strategic partners in creating an innovation ecosystem that can transform the regional and national economy.

One of the most important findings of this study is that the sustainability of innovation in MSMEs is not only a matter of technological implementation, but rather that it involves a profound transformation in the business culture, which must be continuously fed by the knowledge and resources provided by HEIs and support entities. This transformation takes

shape through the creation and supply of specific innovation services that, although still in their preliminary phase, have the potential to redefine the way in which MSMEs in Cauca operate and compete in the market.

However, the services proposed in this study also represent a key input for HEIs, to enable their research groups to strengthen their lines of research as well as their service offerings to the business sector. In addition, it is important to recognize that these services, due to constant technological evolution and market dynamics, can adapt, transform or change over time, ensuring their relevance in a continuously changing business environment.

The analysis also reveals that the real disruption lies not only in technical solutions or improved processes, but in the ability of MSMEs to constantly adapt and evolve. This dynamism is facilitated by an innovation ecosystem where HEIs and development entities are not only service providers, but strategic partners in the process towards business sustainability.

Recommendations

Based on the findings, it is recommended that public policies be oriented towards the creation and strengthening of collaboration networks between MSMEs, HEIs and development entities. This approach would not only facilitate access to innovation services but also contribute to the creation of a more robust and resilient environment for sustainable innovation in the regions. In addition, it is crucial that these collaborations be supported by financing mechanisms that encourage applied research and technology transfer, which are essential elements for MSMEs to maintain their competitiveness in the long term.

It is also suggested that MSMEs adopt a proactive approach in the search for strategic alliances, recognizing that success in sustainable innovation does not depend only on internal resources, but on the ability to integrate and leverage external knowledge effectively. This paradigm shift is essential for MSMEs in Cauca and other regions to face global challenges with greater agility and adaptability.

Future Work

This study opens the door to future research that can empirically evaluate the impact of the implementation of the proposed innovation services. A longitudinal approach that measures MSMEs' progress in terms of competitiveness, sustainability, and innovation, once the services are implemented by the MSMEs, would provide valuable inputs to refine and improve these interventions.

It is also recommended to explore the replicability of the studied collaboration model in other regions of Colombia and in different economic sectors. Such comparative studies could identify best practices and adapt innovation strategies to specific contexts, thus contributing to more equitable and sustainable economic development across the country.

Additionally, it is suggested to undertake empirical studies on the role of digitalization and emerging technologies in the integration of innovation services to further enhance the capacity of MSMEs to innovate in a sustainable way. This approach could offer new insights into how MSMEs can not only survive but thrive in an increasingly digital and globalized economic environment.

In conclusion, this study not only contributes an in-depth analysis of the current state of innovation in MSMEs in Cauca but also offers a transformative vision of how these companies can become protagonists of their own sustainable development, with the strategic support of HEIs and support entities. New research approaches in this field will be of great interest.

Limitations of the Study

Although this study provides a detailed analysis of the process of identifying needs and designing innovation services, it is important to recognize certain limitations. First, the proposed innovation services have not yet been fully implemented, so the conclusions are based on theoretical analyses and expectations about their future impact. In addition, the generalizability of results may be limited by the focus on a single project and region. Future research could address these limitations through longitudinal studies that assess the real impact of the implementation of these services on the sustainability of innovation in MSMEs.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

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REFERENCES

[1] OECD, "Micro, Small and Medium Enterprises (MSMEs) and the Regional Development Policy," OECD iLibrary. Accessed: Aug. 08, 2024. [Online]. Available: https://www.researchgate.net/publication/123456789

[2] M. K. Aranda, "The Role of MSMEs in Economic Development and Sustainability," ResearchGate, Accessed: Aug. 08, 2024. [Online]. Available: https://www.researchgate.net/publication/123456789

[3] "Mipymes constituyen 99,5% de las empresas y aportan 35% al Producto Interno Bruto." Accessed: Sep. 18, 2024. [Online]. Available: https://www.larepublica.co/empresas/mipyme-constituyen-99-5-de-las-empresas-y-aportan-35-al-producto-interno-bruto-3644977

[4] BBVA Research, "MiPymes en Colombia: Desempeño y perspectivas," 2024. Accessed: Sep. 18, 2024. [Online]. Available: https://www.bbvaresearch.com/wp-content/uploads/2024/02/202401_MiPymes_Colombia-1.pdf

[5] World Bank, "Micro, Small, and Medium Enterprises Economic Indicators (MSME-EI) Analysis Note," 2021. Accessed: Sep. 18, 2024. [Online]. Available: https://documents1.worldbank.org/curated/en/873301627470308867/pdf/Micro-Small-and-Medium-Enterprises-Economic-Indicators-MSME-EI-Analysis-Note.pdf

[6] M. Marchese, E. Giuliani, J. C. Salazar-Elena, and I. Stone, "Enhancing SME productivity: Policy highlights on the role of managerial skills, workforce skills and business linkages," OECD. Accessed: Oct. 06, 2024. [Online]. Available: https://www.oecd-ilibrary.org/economics/enhancing-sme-productivity_825bd8a8-en

[7] Z. Zhongming, L. Linong, Y. Xiaona, Z. Wangqiang, and L. Wei, "OECD SME and Entrepreneurship Outlook 2021," OECD, Paris, France, Jun. 2021. doi: 10.1787/97A5BBFE-EN.

[8] S. Radas and L. Božić, "The antecedents of SME innovativeness in an emerging transition economy," *Technovation*, vol. 29, no. 6–7, pp. 438–450, Jun. 2009, doi: 10.1016/J.TECHNOVATION.2008.12.002.

[9] M. Terziovski, "Innovation practice and its performance implications in Micro, small and medium enterprises (MSMEs) in the manufacturing sector: a resource-based view," *Strategic Management Journal*, vol. 31, no. 8, pp. 892–902, Aug. 2010, doi: 10.1002/SMJ.841.

[10] J. B. Moya, "Open Innovation Practices in Colombian MSMEs: Current State, Barriers, and Pathways to Success KTH ROYAL INSTITUTE OF TECHNOLOGY Industrial Engineering and Management Entrepreneurship and Innovation Management."

[11] F. Hilkenmeier, C. Fechtelpeter, and J. Decius, "How to foster innovation in MSMEs: evidence of the effectiveness of a project-based technology transfer approach," *The Journal of Technology Transfer* 2021, pp. 1–29, Dec. 2021, doi: 10.1007/S10961-021-09913-X.

[12] C. Forero-Pineda, D. Laureiro-Martinez, and A. Marín, "*innovar innovation patterns and intellectual property in MSMEs of a developing country*."

[13] B. F. D. Marinho and I. Costa Melo, "Fostering Innovative MSMEs in a Developing Country: The ALI Program Experience," *Sustainability (Switzerland)*, vol. 14, no. 20, Oct. 2022, doi: 10.3390/su142013344.

[14] E. Tereshchenko, E. Salmela, E. Melkko, S. K. Phang, and A. Happonen, "Emerging best strategies and capabilities for university–industry cooperation: opportunities for MSMEs and universities to improve collaboration. A literature review 2000–2023," *Journal of Innovation and Entrepreneurship* 2024 13:1, vol. 13, no. 1, pp. 1–45, May 2024, doi: 10.1186/S13731-024-00386-4.

[15] P. O. of the E. Union, "The state of university-business cooperation in Europe: executive summary.," Jun. 2018, doi: 10.2766/254490.

[16] A. M. Petruzzelli, "The impact of technological relatedness, prior ties, and geographical distance on university-industry collaborations: A joint-patent analysis," *Technovation*, vol. 31, no. 7, pp. 309–319, 2011, doi: 10.1016/j.technovation.2011.01.008.

[17] H. Martínez-Ardila, Á. Castro-Rodriguez, and J. Camacho-Pico, "Examining the impact of university-industry collaborations on spin-off creation: Evidence from joint patents," *Heliyon*, vol. 9, no. 9, pp. 2405–8440, Sep. 2023, doi: 10.1016/J.HELIYON.2023.E19533.

[18] F. A. Gomez, T. U. Daim, and J. Robledo, "Characterization of the Relationship Between Firms and Universities and Innovation Performance: The Case of Colombian Firms," 2014. [Online]. Available: http://www.jotmi.org

[19] K. Flores-Tuxpan, V. García-Flores, L. Antonio, and P. Martos, "Facilitando la Innovación desde Instituciones de Educación Superior Públicas: Determinantes y Desafíos en la Transferencia Tecnológica en México," 2018. [Online]. Available: http://jotmi.org

[20] H. Etzkowitz and L. Leydesdorff, "The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university–industry–government relations," *Res Policy*, vol. 29, no. 2, pp. 109–123, Feb. 2000, doi: 10.1016/S0048-7333(99)00055-4.

[21] M. A. Roffé and F. A. I. González, "El Impacto De Las Prácticas Sostenibles En El Desempeño Financiero De Las Empresas: Una Revisión De La Literatura," *Visión de Futuro*, no. 28, No 1 (Enero – Junio), pp. 201–227, Jun. 2023, doi: 10.36995/j.visiondefuturo.2023.28.01.006.

[22] M. A. Roffé and F. A. I. González, "El Impacto De Las Prácticas Sostenibles En El Desempeño Financiero De Las Empresas: Una Revisión De La Literatura," *Visión de Futuro*, no. 28, No 1 (Enero – Junio), pp. 201–227, Jun. 2023, doi: 10.36995/j.visiondefuturo.2023.28.01.006.es.

[23] A. Urbinati, Z. Shams Esfandabadi, and A. Messeni Petruzzelli, "Assessing the interplay between Open Innovation and Sustainability-Oriented Innovation: A systematic literature review and a research agenda," *Business Ethics, the Environment & Responsibility*, vol. 32, no. 3, Apr. 2023, doi: https://doi.org/10.1111/beer.12540.

[24] Comisión Económica para América Latina y el Caribe (CEPAL), "La innovación en América Latina y el Caribe: Políticas para una transformación productiva sustentable," Santiago, Chile, 2018. Accessed: Aug. 20, 2024. [Online]. Available: https://innovalac.cepal.org/3/es/documentos/innovacion-desarrollo-la-clave-recuperacion-transformadora-america-latina-caribe

[25] S. S. M. Yuen and H. Y. Lam, "Enhancing Competitiveness through Strategic Knowledge Sharing as a Driver of Innovation Capability and Performance," *Sustainability (Switzerland)* , vol. 16, no. 6, Mar. 2024, doi: 10.3390/su16062460.

[26] N. Bari, R. Chimhundu, and K. C. Chan, "Dynamic Capabilities to Achieve Corporate Sustainability: A Roadmap to Sustained Competitive Advantage," *Sustainability (Switzerland)*, vol. 14, no. 3, Feb. 2022, doi: 10.3390/su14031531.

[27] A. De Massis, D. Audretsch, L. Uhlaner, and N. Kammerlander, "Innovation with Limited Resources: Management Lessons from the German Mittelstand," *Journal of Product Innovation Management*, vol. 35, no. 1, pp. 125–146, Jan. 2018, doi: 10.1111/jpim.12373.

[28] M. E. Porter, The Competitive Advantage of Nations. New York, NY: Free Press, 1990.

[29] A. Wright, "Innovation in Brazil: Public policies and business strategies," Washington, D.C., 2008.

[30] M. Kotarba, "Digital transformation of business models," *Foundations of Management*, vol. 10, no. 1, pp. 123–142, 2018, doi: 10.2478/FMAN-2018-0011.

[31] Consejo Privado de Competitividad, "Informe Nacional de Competitividad 2022-2023," Bogotá, Nov. 2022. Accessed: Oct. 08, 2024. [Online]. Available: https://compite.com.co/wp-content/uploads/2024/03/CPC_INC_2022_InformeFinal_Pagindividual.pdf

[32] M. Almansa et al., "Modelo Uruguayo de Gestión de la Innovación," Montevideo, Aug. 2012. Accessed: Oct. 08, 2024. [Online]. Available: https://inacal.org.uy/wp-content/uploads/2018/08/Modelo_Gestion_Innovacion.pdf

[33] Design Council, "The 'double diamond' design process model," Design Council. Accessed: Oct. 16, 2024. [Online]. Available: https://www.designcouncil.org.uk/our-resources/the-double-diamond/

[34] A. Salazar Yusti, "La estrategia emergente: y la muerte del plan estratégico / Alejandro Salazar Yusti.," 2022, Accessed: Oct. 16, 2024. [Online]. Available: https://search.ebscohost.com/login.aspx?direct=true&db=cat06493a&AN=sab.000286970&site=eds-live

[35] B. L. Voss, "The McKinsey mind: Understanding and Implementing the Problem Solving Tools and Management Techniques of the World's Top Strategic Consulting Firm. (Stack Attack).," *Journal of Business Strategy*, vol. 23, no. 2, pp. 44–46, Mar. 2002, Accessed: Oct. 16, 2024. [Online]. Available: https://go.gale.com/

Financing: This study was financed by the General Royalties System (SGR) and performed by Reddi Colombia in the framework of the Fusióni3 Cauca Project – "Strengthening of Innovation in MSMEs based on research results of Higher Education Institutions (HEIs) of the Department of Cauca," with BPIN No. 2021000100371.