Journal of Entrepreneurship, Management and Innovation (2024)
Volume 20 Issue 1: 47-64

DOI: https://doi.org/10.7341/20242013
JEL Codes: D21, D83, L20

Relationship between knowledge transfer and sustainable innovation in interorganizational environments of small and medium-sized enterprises

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Abstract

PURPOSE: *The trends promoted for the strengthening of capacities that allow the interaction and valuation of knowledge as an intangible asset, deserve a management based on its transfer as a basis that drives innovation. Based on this, the purpose of the study is to examine the relationships between knowledge transfer (KT) and sustainable innovation (SI) in interorganizational contexts of small and medium-sized companies.* ***METHODOLOGY****: A process was carried out through the application of a questionnaire addressed to managers and owners of 109 small and medium-sized companies of activity in management and the development of information and communication technologies in two regions of Colombia. To show the significant differences between the two selected populations, a non-parametric Mann-Whitney test for independent samples was applied. Likewise, an application of the K-means algorithm was used to group the variables into subsets. The study of the data was complemented with the multivariate technique and the principal components analysis (PCA) to validate the contrasting of the declared hypotheses.* ***FINDINGS****: The results determine that by means of the Mann-Whitney non-parametric test for independent samples there are significant differences between the two selected populations. Likewise, the positive correlation between the variables of knowledge transfer and innovation is confirmed, as well as designing the interactions and the flow of processes between the components that support the aforementioned variables from the theoretical and empirical approach, whose interaction capacity between them has to promote the innovative potential under sustainability principles in small and medium-sized enterprises.* ***IMPLICATIONS:*** *Based on the results of the research carried out, scenarios are promoted through which it is sought to strengthen the interorganizational management of small and medium-sized enterprises, minimizing the barriers that weaken their stability. As well as promoting new ways of valuing knowledge as an intangible asset that, when transferred, generates effects in innovation management as part of the strengthening and interorganizational sustainability of small and medium-sized enterprises.* ***ORIGINALITY AND VALUE****: It is based on the generation of value through the proposal of a design of a system of relations between the components that promote the transfer of knowledge and sustainable innovation. Its structure is based on empirical results that allowed defining five strategic stages that show the relationships between the components that promote interorganizational and competitive management of tangible and intangible assets available in small and medium-sized enterprises.*

Keywords: *knowledge transfer, sustainable innovation, interorganizational environments, knowledge management, Small and Medium-sized Enterprises, SMEs, intangible assets, Colombia*

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Received 29 May 2023; Revised 29 November 2023; Accepted 8 December 2023.

INTRODUCTION

The socio-productive transformations and the advent of emerging markets in the global environment have promoted the renewal of capacities associated with knowledge and sustainable innovation in the environment of small and medium-sized enterprises. The relevance of these capabilities prevails in generating value and promoting new ways of strengthening interorganizational relationships, as well as reconfiguring resources and capabilities to adapt to new business dynamics (Centobelli, Cerchione, Maglietta & Oropallo, 2023; Teece, 2018). In this regard, knowledge as an intangible asset and the relevance of projecting its transfer are highlighted among capacities (Grant, 1996). Effective processes are required to promote both the production of the resource and its management (Nonaka & Takeuchi, 1999). Key aspects of business direction are the projection of the knowledge transfer (KT) that promotes the innovative potential and the changes towards interorganizational sustainability of companies.

Belderbos, Gilsing, Lokshin, Carree, and Fernández (2018) state that, despite its importance, there is still a limited understanding of how companies adapt their collaborative portfolio in innovation and R&D development, and which are the drivers of such adaptations. Meanwhile, the strengthening of interorganizational relations is considered as part of the strategy for production, appropriation, knowledge transfer and its development. Therefore, it is necessary to highlight the main types of knowledge: a) explicit; formal and structured, which can be shared; and b) tacit knowledge, conceived as experiential (Nonaka &Takeuchi, 1999). The latter is decisive for distinguishing the capabilities of human talent, as a way to put them into practice and the corresponding appropriation of those talents mediated through projects and programs for problem solving or new developments, which contribute to the dynamics in business environments.

Regarding the interorganizational and organizational environments represented by small and medium-sized enterprises (SMEs), it is determined that research on the subject is scarce or inconclusive despite the requirements on how to promote the stability of these companies, prioritizing innovation between other actions. Meanwhile, among the contributions of KT, new ways to strengthen the potential and human capacities of an efficient organization internally are considered (Ferraris, Giachino, Ciampi & Couturier, 2019), and from the outside, the projection on the socialization and social appropriation of knowledge to promote innovation in organizational environments (Liao & Wu, 2010).

Likewise, to generate advantages that promote sustainable innovation in addition to adopting culture, the use of environmentally friendly resources and ideation-creation through intangible assets knowledge are required. In this way, the consolidation of the so-called sustainable organizations is foreseen among the priorities. The effects of these allow transformations from interorganizational and organizational environments in small and medium-sized enterprises (SMEs). Above all, due to the belief that ecological-environmental policies and initiatives increase corporate success, only if they are implemented in all areas, with the confirmation and support of all partners (Shahzad, Qu, Rehman & Zafar, 2022). In the same order, recognizing the strategic importance of knowledge as a basis for innovation is associated with the cycle of its management for its accessibility. This is in addition to considering, among others, the social and economic factors associated with the dimensions of sustainability (Smuts & Van der Merwe, 2022). Regarding eco-innovation, from the interorganizational vision, the direction of SMEs has been strengthened through the use of green technologies, in addition to business relationships, which are decisive in service areas of scarcely consolidated companies (Fernando, Chiappetta Jabbour & Wah, 2019).

In this regard, research on the variables of KT is presented in a scare or inconclusive manner despite requirements on how to promote the stability of these companies prioritizing sustainable innovation, among other actions. Although the greatest reference in research is developed on the factors that influence the decisions of companies linked to environmental, social, and governance (ESG) policy (Ahmad, Yaqub & Lee, 2023). Undoubtedly, promoting renewed ways of consolidating interorganizational capacities allows the generation of value and reconfiguration of resources to adapt to new business dynamics that project innovation (Centobelli et al., 2023; Teece 2018).

As for the contributions of the study, the design of the relationship system between the components that promote the transfer of knowledge and sustainable innovation is mentioned, whose practice from the context of SMEs contributes to boost business management. Likewise, alternatives are exposed to the components that must be the foundation of public and business policies that strengthen the potential for the transfer of knowledge and sustainable innovation. Added to the need to mitigate risks in the social and natural aspects of innovation activities, the strengthening of business capacities and resources is warranted (Teece, Pisano & Shuen, 1997), highlighting human, material, and technological resources (tangible and intangible).

Regarding the interorganizational capacity of SMEs, the ways of valuing the production of knowledge driven by business policies that strengthen their production and management and the transfer supported by methods, techniques, and technologies that guarantee their effectiveness in the business environment are mentioned associated with team management.

Given the trends on the importance of transforming and generating strategies that promote trends for the stability of SMEs, the objective focused on examining the relationships between knowledge transfer (KT) and sustainable innovation (SI) in interorganizational contexts of small and medium-sized companies in Colombia. These are characterized by development associate activities such as the management of equipment, computer programs, applications, networks and media, which allow the compilation, processing, storage, transmission of information such as voice, data, text, video, and images (Law on the Modernity of the Information and Communication Technologies Sector -ICT 2019 and Law that defines principles and concepts on the information society and the organization of Information and Communication Technologies -ICT, 2009).

The theoretical foundation was based on the review of the literature, in addition to the statement of the hypotheses. Followed by the application of the deductive method and the correlation technique, the structure of the article was developed, whose rigor is based on obtaining the data that support the analysis of results and the discussion is based on the correlation and contrasting of hypotheses. The conclusion explores the design and argumentation of the system of relationships between the components that promote the transfer of knowledge and innovation, conceived from the theoretical approach and the empirical study developed in two regions of Colombia, the Pacific: Santiago de Cali and the Atlantic: Barranquilla.

LITERATURE REVIEW

Knowledge transfer and approximation of the components that support it

KT is considered to be one of the processes that seeks to strengthen assets and renew interorganizational and organizational capabilities from the production of knowledge. Regarding the production and management of knowledge promoted since the 1990s, it is defined as a resource capable of capturing the diversity of phenomena and interdependence with natural and social approaches that determine socio-environmental changes (Lef, 1994). Thus, the generation of advantages that promote sustainable innovation through the use of environmentally friendly resources and intangible assets knowledge, is considered as part of the priorities for the so-called consolidation of sustainable organizations.

Undoubtedly, the valuation of intangible assets (knowledge) is considered part of the actions that should be defined to promote research and innovation (Cardoni, Zanin, Corazza & Paradisi, 2020). Among business assets, knowledge is based on theories and principles that contribute to understanding the origin of causes-effects based on logical reasoning of the origin of causes-effects that arise in environments. As an intangible asset, knowledge has a high tacit component, is stored and is the domain of people, making it scarcely tangible and unstructured for its transfer (Landry, Amara & Ouimet, 2007).

Given the above, the main components that support the transfer of knowledge are highlighted: a) production of knowledge, promoted according to the competencies and the role of human talent (Ferraris et al., 2019; Nonaka & Takeuchi, 1999); b) information technologies conceived as strategic mediation resources to transfer and guarantee the accessibility of knowledge in a global environment (Ode & Ayavoo, 2019; Beesley & Cooper, 2018; Mardani, Nikoosokhan, Moradi & Doustar, 2018; Castellano, Davidson & Khelladi, 2017; Lyu, Zhou & Zhang, 2016; Nonaka & Takeuchi, 1999); and c) knowledge management, for the adoption of techniques, procedures and systems (Nonaka & Takeuchi, 1999; Sytnik & Kravchenko, 2021). Its purpose guarantees both the registration of the knowledge produced: tacit knowledge and implicit knowledge, and is strengthened through the theory of capabilities and resources (Centobelli et al., 2023; Teece 2018; Lef, 1994). For effective adaptation in business environments, it is necessary to understand and define strategies to make these components viable.

Regarding management, it implies the mediation of information technologies. Resources become part of the guarantees about IT effectiveness in a global environment (Beesley & Cooper, 2018; Mardani, et al., 2018; Lyu et al., 2016); as well as valuing intangible assets (knowledge), and support to promote actions that project the capacity to enhance research and innovation (Cardoni et al., 2020). In addition, productive projection, which promotes greater economic stability, strengthens contributions to the entrepreneurial fabric of the regions. This economy is decisive for understanding the importance of the valuation and types of knowledge, as well as its effects on the dynamics of organizations (Foray & Lundvall, 1998). In turn,

the human factor is highlighted, as a strategic actor that promotes SMEs management. The interactions of the collaborators are associated with the culture of strategic and differentiating organizational practices that promote the so-called intelligent organizations (Paredes, 2011) and their effectiveness is based on collective learning, production, knowledge transfer, as the utility to promote innovation (Espinoza & Marín-González, 2019; Flórez & Lugo, 2019; Romera, 2016).

Knowledge transfer and sustainable innovation in interorganizational environments of SMEs

The practices of knowledge transfer and sustainable innovation in SMEs deserve to be made viable by defining the adoption of structured and integrated process flows and systems. For their dynamization, the design, the adoption of process flows, and structured systems are essential for the creation, socialization and use of knowledge that support decision-making (Nonaka & Takeuchi, 1999). From the perspective of systematizing relationships, the stages of creation-production, methods, measurement capacity and ways of transferring and socializing knowledge are prioritized, using information technologies (Nonaka & Takeuchi, 1999). In this regard, the interest of companies to promote new ways of innovating under the dimensions of the socio-economic and environmental dimensions (sustainability) that promote the projection of sustainable companies (Marín-González, Senior-Naveda, Narváez Castro, Inciarte González & Paredes Chacín, 2021; Yin, Ming & Zhang, 2020).

The effectiveness of these organizations is based on collective learning, the production of knowledge, transfer, and utility to promote innovation (Espinoza & Marín-González, 2019; Flórez & Lugo, 2019; Romera, 2016). However, for its verification, the creation-production stages, methods, measurement capacity and the ways of transferring and socializing knowledge through the optimal use of information technologies are considered within the framework of the relationship system (Nonaka &Takeuchi, 1999). The same reference is made to the interest of companies to promote renewed ways of innovating considering sustainability based on the framework of the 2030 agenda (WCED-World Commission on Environment and Development 1987), which is highlighted as part of the emphasis on innovation and its projection towards the consolidation of sustainable companies.

The ability to promote sustainable innovation in companies is recognized as something weakly achieved in management, and is little considered for business stability (Sytnik & Kravchenko, 2021), in addition to a low culture to value intangible resources such as knowledge to enable innovative practices. From this perspective, notable differences prevail between R+D collaboration from an interorganizational (universities and research institutes), vertical (buyer and supplier), and horizontal (competitor) vision (Belderbos et al., 2018). Relationships that are fundamental for the projection of SMEs based on the dynamics of sustainable innovation are also known as green innovation based on eco-friendly resources to consolidate a sustainable business (Guo, Cui, Sun & Zou, 2020).

In the same order, the mastery of information technologies, human capital differentiated by its abilities, and ways of reconfiguring competencies within organizations to respond to changes in the environment are mentioned (Teece et al., 1997). Followed by the raw material to innovate and generate distinctive characteristics that give way to competitiveness and socio-productive development based on knowledge and its usefulness (Ode & Ayavoo, 2019; Preikschas, Cabanelas, Rüdiger & Lampón, 2017). The interactions between the aforementioned components promote the effectiveness of knowledge management, through which its transfer enhances innovative development (Abu-Mahfouz, Halim, Bahkia, Alias & Tambi, 2023; Baker & Yusof, 2016; Vajjhala & Vucetic, 2013). Additionally, the incidence of ignorance about the global nature of technology, and the transfer of knowledge to the weaknesses or failure of well-established companies, is raised (Castellano et al., 2017).

What has been described is proposed to highlight the importance of developing skills and the ways to reconfigure the competencies of human talent within organizations, in order to respond to changes in the environment (Teece et al., 1997). This is in addition to achieving the effectiveness of the systematization and flow of knowledge, whose standards must be governed by metrics that determine the effective transfer of knowledge from an interorganizational perspective. Likewise, the human factor is considered as a strategic actor of its production, management and promoter in SMEs, which deserves to interact under the culture of strategic and differentiating organizational practices to promote the so-called intelligent organizations (Paredes, 2011).

Hypotheses development

For the contrasting of the hypotheses, the behavior of the variables was analyzed from the review of the literature and the results of the empirical study. Likewise, the interrelation capacity between the components that support the management

for the transfer of knowledge is highlighted; which is supported by the development of a process, whose measurement indices are linked to the production of knowledge, information technologies and knowledge management systems, techniques and processes (Nonaka & Takeuchi, 1999), see Figure 1, a graphical representation of the conceptual model.

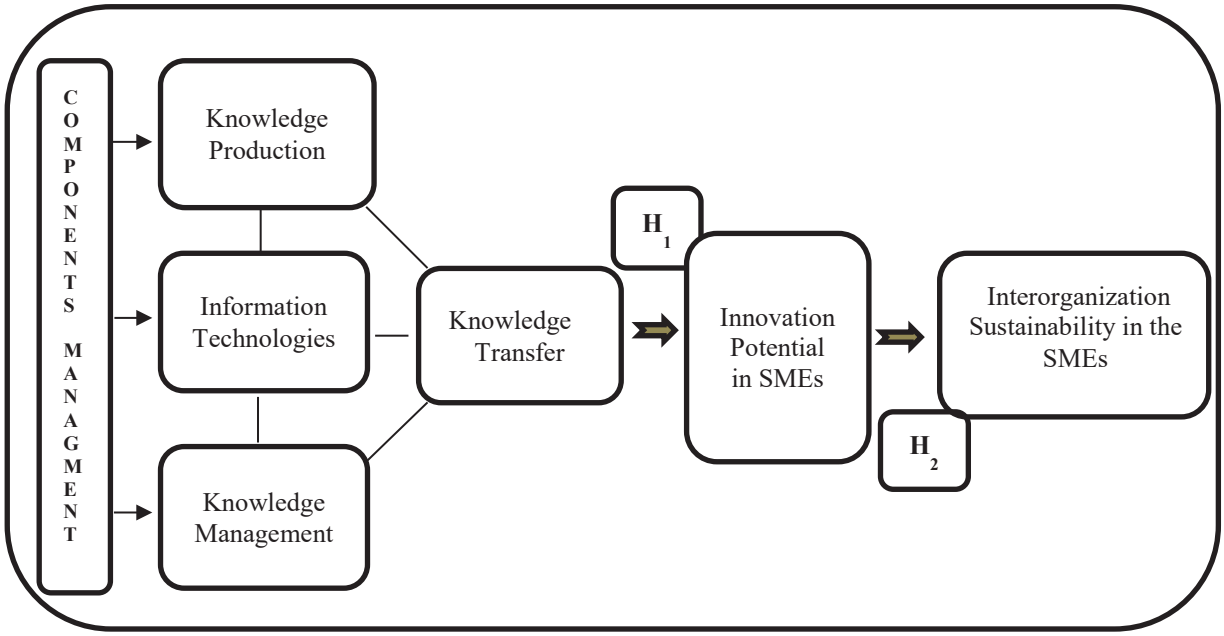


Figure 1. Graphic representation of the conceptual model

The relationship presented between the management components required for knowledge transfer supports the testing of the hypotheses.

H1: Knowledge transfer significantly affects sustainable innovation in small and medium-sized enterprises.
H2: The components that support the relationship system between KT and innovation potential strengthen the interorganizational sustainability of SMEs.

This is how the need to formalize the link between knowledge transfer and sustainable innovation in SMEs arises as one of the practices that merit knowledge about a structured system and the dynamics of the components for its management. Their systematization capacity provides for the interorganizational sustainability of SMEs, as represented in the model. In the function of which, the contrast between theory and practice are analyzed to determine their feasibility from the context of the SMEs under study, as well as from other related sectors. In this way, the effective transfer of knowledge as a basis for promoting sustainable innovation becomes part of the business challenges (Yin et al., 2020; Belderbos et al., 2018), from a vision focused on interorganizational transformation directed towards than business sustainability (Guo et al., 2020; Yin et al., 2020).

MATERIALS AND METHOD

To verify the hypotheses related to the variables of knowledge transfer and sustainable innovation, the deductive method is applied (Hammersley, 2023; Rodríguez Jimenez & Pérez Jacinto, 2017; Cisterna, 2005). Its scope made it possible to systematically articulate the behavior of the variables, which contributed to the analysis of the study context to generate propositional and renewed alternatives to promote transformations based on ideation, creation on the phenomenon studied and complemented from existing knowledge. From this perspective, it contributes to generating processes of appropriation of knowledge that allows promoting innovation on pre-established conditions. Likewise, from a documentary

review, logical reasoning on the designed conceptual model is achieved, which gives way to the grounded theory approach (Wuelser & Pohl, 2016).

Next, the development of the correlation study between the variables is continued through the analysis of principal components (PCA), allowing through the covariances to know the degree of association that exists between the transfer of knowledge and sustainable innovation from the context of the small and medium businesses.

For the selection of the sample, the non-probabilistic technique was applied, which led to the interaction with 109 small and medium-sized enterprises (SMEs). The geographical location of the companies under study is in Colombia, South America. Specifically in the city of Santiago de Cali, Pacific region; Colombian South West, 76 companies participated, distributed 11.8% in medium-sized and 88.2% small companies. And in the city of Barranquilla, Atlantic region, it is located in the north of Colombia, see Figure 2, with 33 participating companies, 18.2% corresponded to medium-sized and 81.8% small companies.

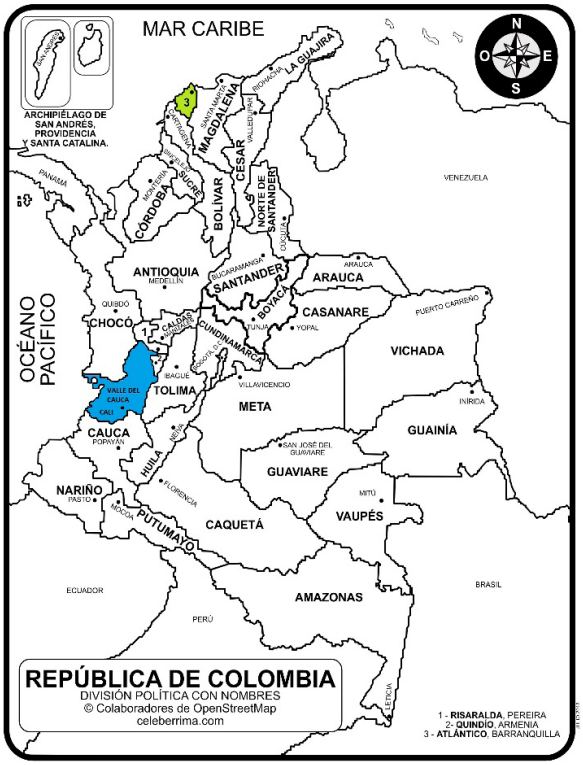


Figure 2. Location of the two selected cities in Colombia

Regarding the size and classification of companies, it is established in Article 2 of Decree 957 (2019) that these are classified into micro, small, medium and large companies, and they are determined by criteria associated with the total number of workers, value of total assets and value of annual gross sales. The latter is considered decisive for the granting of government benefits.

The commercial activity of SMEs, those dedicated to the development and managment of information and communication technologies (ICT) were considered. Their selection was based on the worldwide projection of this business activity and its effects on the global order. Its management, the growth experienced by the aforementioned companies in the global growth of 2.6% in 2016, generating a business volume of approximately 3 million euros; considering that the United States occupied the highest percentage of billing in the sector with 31.3%, followed by Europe and the BRIC countries (Brazil, Russia, India and China) with 21.8% and 18.2% respectively.

In the case of Latin America, the results determine a 4.4% growth (National Observatory of Telecommunications and the Information Society of Spain, 2017). Regarding Colombia, the National Association of Financial Information (NAFI, 2019) states that, for the first semester of 2020, the current situation and perspectives of SMEs were analyzed, given the economic situation caused by COVID-19. A significant deterioration was determined by the evolution of their

businesses and the demand in the indicated period. However, the annual growth rate in volume due to economic activity in information and communications during 2020 (provisional) - 2021 (preliminary), had an annual growth rate of 11.2%, which shows a recovery trend regarding the period 2019 - 2020, which was represented at -2.6%.

For the application of the instrument, the observational units were intentionally selected, according to the inclusion criteria: a) interaction capacity of the researchers in the geographical contexts: Santiago de Cali and Barranquilla, b) a number of companies characterized as small and medium-sized in the selected cities, c) business units with activity concentrated in the management of information and communication technologies, with more than three years in the market d) characteristics of the analysis units with positions of manager, administrator or owner of the business, regarding age and gender, it is omitted, as it is not considered a priority for obtaining information, e) a company with potential in the production of knowledge and innovation, as well as, f) the willingness of the analysis units to respond to the instrument during the second quarter of the year 2022.

The instrument used consisted of a questionnaire made up of 45 items arranged on a 7-point Likert-type scale (1 = total disagreement, 7 = total agreement), from which aspects related to the following were evaluated with knowledge transfer, information technologies, knowledge management, innovation potential in SMEs, interorganizational sustainability in the SMEs.

The content validity of the instrument was measured through the judgment of three experts, for each of the cities in which the research is carried out: Santiago de Cali and Barranquilla. Experts were selected considering their expertise and trajectory that shows the domain associated with the research variables, as well as the roles that these professionals play in the sector under study.

Regarding the evaluation criteria of the instrument, aspects such as: a) objective of the research, theory-sufficiency, b) clarity-reactive, c) coherence, and d) relevance of the items that study the variables were measured. Expert analysis was calculated using the original coefficients of agreement (BN) and the weighted coefficients of agreement (BWN) (Bangdiwala, 1988). Likewise, to establish the differences in the perception and study of the variables between the two territorial entities, and to establish the differences between the two cities, a non-parametric Mann-Whitney U test was applied.

From a quantitative approach, the data processing was carried out by applying the RStudio Desktop software version 2022.07.1. This process allowed us to contrast the theory with the empirical reality. Initially, the reduction of dimensions was carried out by means of a principal component analysis (PCA) with the objective of grouping the items or characteristics used to evaluate the different SMEs. This process allowed retaining the most relevant information and corroborating whether the components that support knowledge transfer management are identified in the sample, as reported in the literature (Nonaka & Takeuchi, 1999). Subsequently, it was tested whether the identified components showed statistically significant differences between the SMEs of the two cities analyzed, for which the Mann-Whitney U statistic was used and the magnitude of the effect was calculated with the rank biserial correlation coefficient (r_{Glass}). To ensure that the retained components presented a correct fit, Harman's test was applied, using confirmatory factor analysis (CFA), and finally, a model of functional relationships between the variables represented by the components was tested in order to test the hypothesis of influence between the elements that support knowledge transfer management.

The development of mediation models was chosen as a method of analysis because they facilitate the construction of explanations about the level of influence of an independent variable (X) on a dependent variable (Y), by means of the decomposition of the direct and indirect effects generated by the participation of a third variable (Z) that acts as an intervening or mediating variable (X→Z→Y) (Fiedler, Schott & Meiser, 2011; MacKinnon, 2008). In summary, the logic of the model involves the transmission of the effect of the independent variable to a dependent through the mediating variable. These models have been designed to understand causal mechanisms in the phenomena studied by disaggregating the total effect from that produced by the participation of other variables. This makes them preferable to other models, such as those generated using structural equation modeling (SEM), among other reasons, because SEM is a technique considered for large sample sizes given that its default estimation method is based on the asymptotic theory of large samples (Hayes, Montoya & Rockwood, 2017).

RESEARCH RESULTS

The results on the consistency of the instrument, according to expert judgment, determine the reliability of the instrument obtained from the calculation of the concordance coefficients (Bangdiwala, 1988). The data presented in Table 1 specify the original coefficients that take into account only the agreements.

Table 1. Criteria for interpreting the agreement coefficients

Matching strength	**Poor**	**Weak**	**Moderate**	**Good**	**Very good**
Coefficient value	0.0 – 0.20	0.21 – 0.40	0.41 – 0.60	0.61 – 0.80	0.81 – 1.0

The values of the original agreement coefficients ranged between 0.782 and 0.948, while the values of the weighted agreements ranged between 0.934 and 0.994. In this sense, it was found that only one of the coefficients had a value for strength of agreement classified as "Good," and all the other coefficients presented a value for strength of agreement classified as "Very good." In general aspects, the dimension that had the greatest original agreement among the expert judges was relevance (BN=0.924), followed by coherence (BN=0.873), then sufficiency (BN=0.865), and finally the clarity criterion (BN=0.851), in general, the reliability margin is 94% of the instrument.

Likewise, Principal Component Analysis (PCA) was performed, for which the data matrix showed acceptable performance in the Kaiser-Meyer-Olkin test (KMO = 0.766 $\lceil > 0.70, < 0.80 \rceil$), and appropriate performance in Bartlett's test of sphericity ($x2[df = 136] = 660.004$, $p = 0.0009 < 0.001$). The analysis retained 17 characteristics of the 45 evaluated, which were grouped into three components that explain 54.6% of the total variance, a modest result. The first component (PC1) groups seven indicators and explains 26.5% of the variance, the second (PC2) groups five indicators and explains 17.7%, while component 3 (PC3) also groups five indicators and explains 10.4%.

The quality of the representation was analyzed by calculating the squared cosines (cos2), the visualization of which is described in Figure 3. This presents the relative importance of the variables retained in the PCA, showing that the correlations between the variables and components are well defined. This graph shows the best represented variables for the first two components, which together explain 44.2% of the variability of the data.

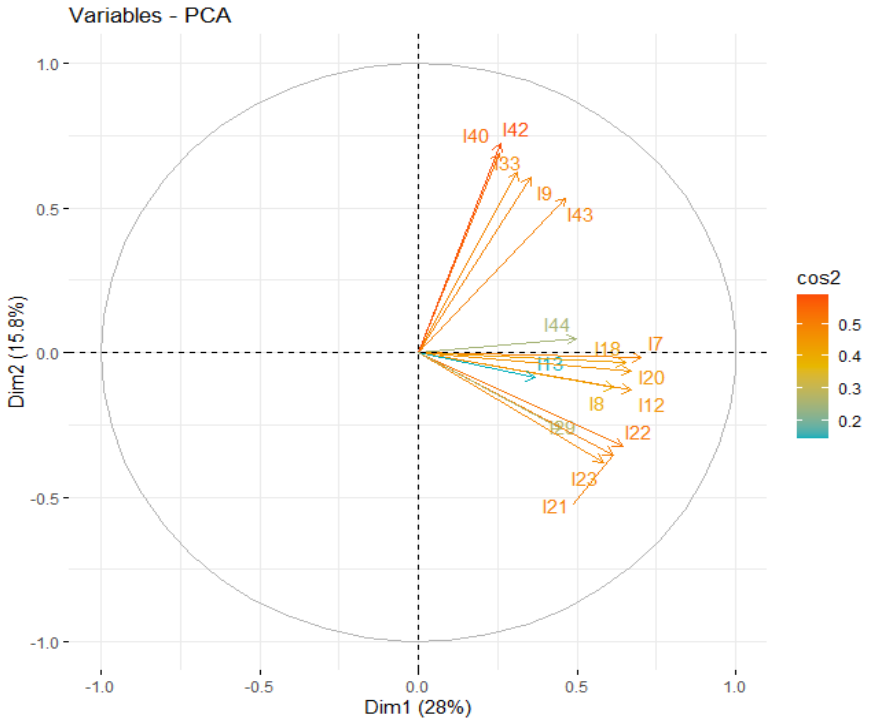


Figure 3. Graph of cosine squares of the variables retained in the PCA procedure

Table 2 contains each of the items or characteristics retained in the components, as well as their descriptive data. PC1 has integrated seven items and is called Knowledge Management and Sustainable Innovation. According to the content of the items, it is observed that they group aspects related to knowledge management, investment in information technologies, the valuation given to knowledge as an organizational asset and the application of knowledge through research and innovative strategies. This component responds to the Knowledge Transfer approach, but integrating sustainable innovation strategies in the context of SMEs.

The second component is called Competitive Management and Responsible Innovation, because it integrates elements related to competitive management, the development and promotion of innovation through teamwork and the articulation between responsible innovation processes and knowledge management in response to corporate governance guidelines. In other words, it integrates innovation, competitiveness and sustainability, which responds quite well to the notion of Innovation Potential in SMEs described in the conceptual model considered by the experts, see Figure 1.

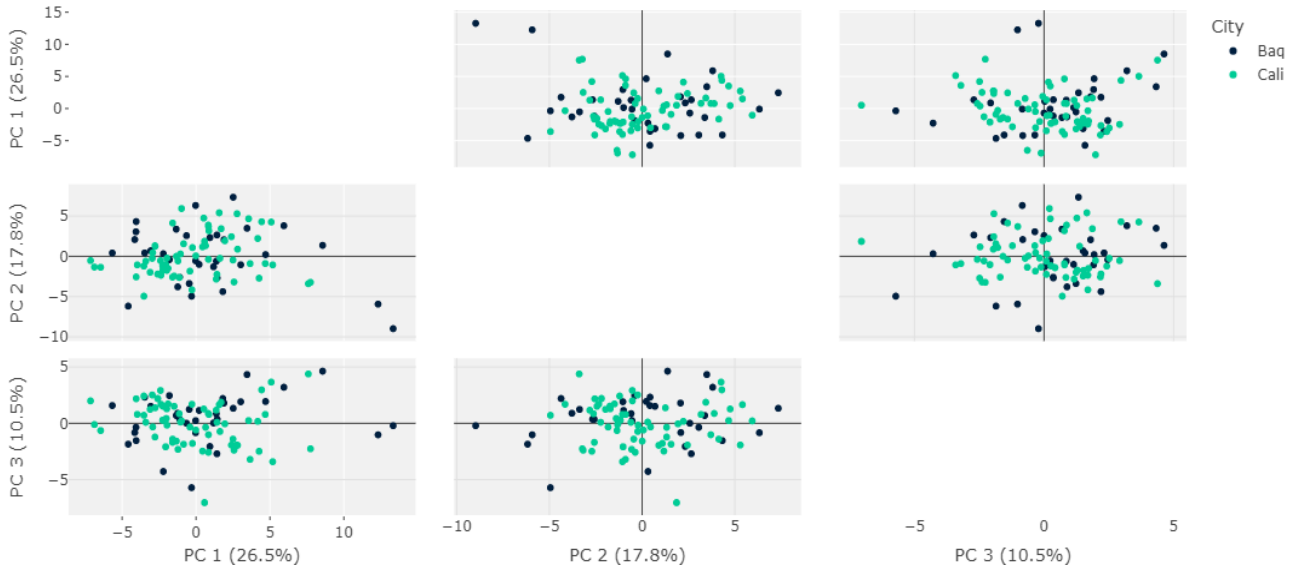
Finally, the third component was named Innovative Management and University-SME cooperation, which is based on the establishment of cooperative relations between SMEs and institutions of the university sector, to the extent that the latter are agents of innovation and development that offer valuable contributions to companies, such as the application of technology in monitoring processes, the dissemination of innovation in the international scenario, the generation of communication circuits and cooperative business networks. In this sense, the component responds well to the element of Intergorganization Sustainability in the SMEs proposed in the conceptual model of the study.

Table 2. Descriptive data of the items and characteristics retained in the components

Component 1: Knowledge management and sustainable innovation	**M**	**SD**	**Perceived Importance**
I7. Information and knowledge are systematically recorded using information systems.	5.74	1.47	84.4
I8. Organizational policies in the SME recognize knowledge as valuable assets.	5.76	1.49	87.2
I12. Financial investments support knowledge transfer by providing technological resources.	5.81	1.26	88.9
I13. All members identify various types of knowledge (empirical, technical, procedural, scientific, logical) within the SME.	5.54	1.46	82.6
I14. The SME promotes research and innovation as a strategy for enhancing product and service quality.	5.58	1.51	84.4
I18. Sustainable innovation management plans, considering economic, environmental, and social aspects, are established in the SME.	5.24	1.35	81.6
I20. Regular economic investments ensure technological support for innovation processes in the SME.	5.51	1.44	81.6
Component 2: Competitive management and responsible innovation	**M**	**SD**	**Perceived Importance**
I21. The SME excels in competitive management with ample resources dedicated to innovation.	5.56	1.15	85.2
I22. Teamwork dynamics, including Coworking, are fostered to drive innovation.	5.47	1.54	82.5
I23. Innovation in products or services is aligned with the concept of responsible consumption.	5.47	1.50	85.3
I29. Sustainable innovation management significantly enhances knowledge transfer processes in the SME.	4.92	1.82	71.5
I44. Knowledge management and sustainable innovation in the SME adhere effectively to Corporate Governance principles for optimal and transparent organizational management.	4.90	1.77	69.8
Component 3: Innovative management and University-SME cooperation	**M**	**SD**	**Perceived Importance**
I9. Management results (dashboards) are tracked using ICTs.	4.66	2.02	62.4
I33. Sustainable innovation outcomes are shared internationally.	4.06	2.04	51.4
I40. Indicators capture the University-SME relationship, focusing on degree projects, programs, and university research.	3.23	2.10	36.4
I42.The SME forges connections with universities through effective communication, facilitating knowledge and innovation accessibility.	3.82	2.01	44
I43. SMEs strategically plan to enhance interaction processes using technology, fostering networking among entrepreneurs, innovators, businessmen, and professionals for effective business promotion.	4.89	1.67	65.1

The behavior of the components was also identified according to the city where the SMEs are located; this result is described in Figure 4, which makes it possible to recover all the components by ordering them according to the variance that they are capable of explaining according to the sector of the organizations evaluated. The subplots of PC1 and PC2 are similar to those obtained in PC3, so that the division by sector does not seem capable of separating the SMEs by city, an indicator of similarity in the processes they assume.

To corroborate what was initially evidenced in the PCA, a comparison of the values of the components between the SMEs of the two cities (Santiago de Cali, Barranquilla) was carried out using the Mann-Whitney U statistic. The analysis showed the absence of values indicating differences in the comparison of PC1 ($U = 1375.500$, $p = 0.423 > 0.05$) and PC2 ($U = 1195.500$, $p = 0.701 > 0.05$) between the two cities; However, PC3 did show differences and large effect size ($U = 2045.500$, $p = 0.0001 < 0.001$, $r_{Glas} = 0.63$) with values favoring the SMEs of Barranquilla.



Note: Baq = Barranquilla.

Figure 4. Visualization of the main components according to the city where the SMEs are located

Model testing

In order to ensure that the retained components responded sufficiently to the measurement model, the procedure known as Harman's Test was applied to rule out the existence of Common Method Variance Bias, that is, that variance that is not attributable to the study variables but to the measurement method used, which in this case corresponds to the survey used for data collection, since it measures both the independent variables (PC1, PC2) and the dependent variable (PC3).

To comply with Harman's test, Confirmatory Factor Analysis (CFA) is applied, initially calculating a unidimensional model and then the theoretical measurement model that corresponds to the one identified with the PCA (three dimensions). Subsequently, the fit indices of both models are compared. The theoretical model is expected to show a better fit to rule out the existence of the Common Method Variance Bias. Table 3 summarizes the outcome of this procedure, whose results support the solution obtained with the PCA procedure.

Table 3. A Harman test to discard the variance bias of the common method in the two-component model calculated with PCA

		Models	
Fit statistics	**Acceptable threshold**	**One-dimensional**	**Three dimensions**
x^2	$p > 0.05$	331.188, $p > 0.05$	146.231, $p > 0.05$
gl	—	119	116
x^2/gl	≤ 3	2.78	1.26
Comparative Fit Index (CFI)	≥ 0.95	0.838	0.977
Tucker Lewis Index (TLI)	≥ 0.95	0.815	0.973
Normed Fit Index (NFI)	≥ 0.95	0.771	0.899
Non-normed Fit Index (NNFI)	≥ 0.95	0.815	0.973
Goodness of Fit Index (GFI)	≥ 0.95	0.977	0.990
Root Mean Square Error of Approximation (RMSEA) [IC90%]	≤ 0.08	0.128 [0.112 - 0.145]	0.049 [0.017 - 0.072]
Root Mean Square Residuals (SRMR)	≤ 1.0	0.142	0.094

Only the NFI metric does not meet the expected values. However, the rest of the measures support that the model's fit statistics are good. Average Variance Extracted (AVE) was also calculated for each component, whose results were below the expected fit by obtaining values <0.50. These values were 0.443 for PC1, 0.467 for PC2 and 0.439 for PC3, which indicate

that the levels of variance explained by the variables obtained are not high, which we already noticed when showing the overall percentage of variance corresponding to the PCA. However, the three-component model showed discriminant powers as reported by the Heterotrait-monotrait ratio (HTMT), where all off-diagonal values are < 1 (HTMT = PC1↔ PC2 = 0.465, PC1 ↔ PC3 = 0.239, PC2 ↔ PC3 = 0.163).

Model of functional relationships between variables

The hypotheses guiding the study proposed, on the one hand, that knowledge transfer (in this study PC1) affects sustainable innovation (in this study PC2) in SMEs (H1), and on the other hand, the system of relationships between knowledge transfer and innovation potential reinforces the interorganizational sustainability (in this study PC3) of SMEs (H2). Table 4 summarizes the data resulting from testing these assumptions by designing a predictive functional model between PC1 and PC3 mediated by PC2.

Table 4. Model of functional relationships between knowledge transfer and interorganizational sustainability mediated by the innovation potential of SMEs

Mediation estimators									**95%CI**	
Effect					**Estimate**	**SE**	**Z**	**p**	**Lower**	**Upper**
Directs	PC1	→	PC3		0.255	0.109	20.345	0.019*	0.042	0.468
Indirects	PC1	→	PC2	→ PC3	-0.002	0.049	-0.045	0.964	-0.099	0.094
Totals	PC1	→	PC3		0.253	0.090	20.794	0.005**	0.075	0.430
Path coefficients									**CI 95%**	
					Estimate	**SE**	**Z**	**p**	**Lower**	**Upper**
	PC2		→	PC3	-0.005	0.117	-0.045	0.964	-0.235	0.224
	PC1		→	PC3	0.255	0.109	2.345	0.019*	0.042	0.468
	PC1		→	PC2	0.422	0.121	3.476	0.0005***	0.184	0.660

Note: * $p < 0.05$, *** $p < 0.001$, SE = Standard Error; CI = Confidence Interval. PC1 = Knowledge management and sustainable innovation, PC2 = Competitive management and responsible innovation, PC 3 = Innovative management and University-SME cooperation.

The procedure shows that PC1 (analogous to Knowledge Transfer in the conceptual model) predicts PC3 (analogous to Intergorganization Sustainability in the SMEs), as it also directly predicts PC2 (analogous to Innovation Potential in SMEs), however, PC2 does not predict PC3 nor does it mediate the initial relationship of this with PC1. Figure 5 summarizes the relationship paths and shows that the percentage of variance explained by the model is modest, reaching 18% for PC2 and 6% for PC3.

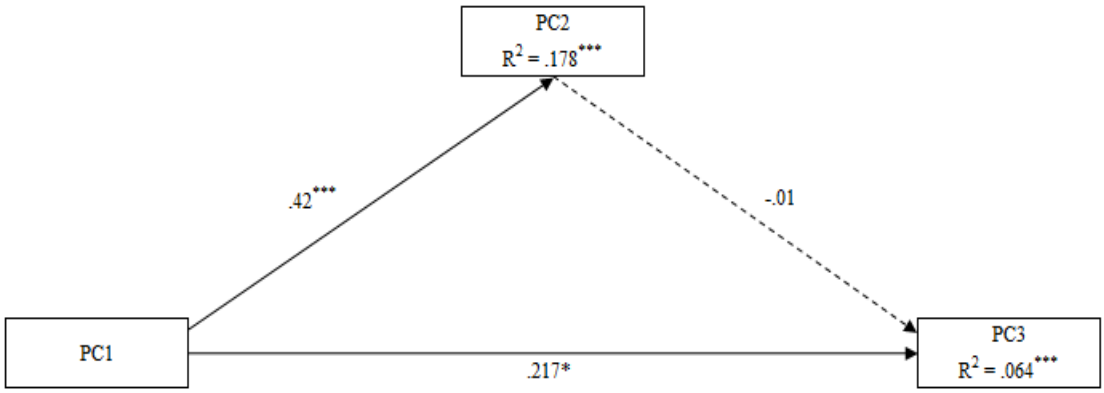


Figure 5. Patch diagram

In this sense, we see how the elements that involve knowledge management can influence the development of innovation in SMEs as well as their interorganizational integration with actors that serve as collaborative support to generate a favorable impact on innovation and sustainability. According to Grabowski and Stawasz (2023) the benefits

of using new knowledge depend on the knowledge absorption capacity of enterprises. Consequently, the design of the relationship system between the components that promote knowledge transfer and sustainable innovation is based on the results described, see Figure 5. Its design was based on a four-stage structure to promote the strengthening of potential innovative under principles of sustainability. The process flows highlight each stage. These make it possible to determine the interactions that have to project the innovative potential in small and medium-sized companies from a sustainability and interorganizational projection approach.

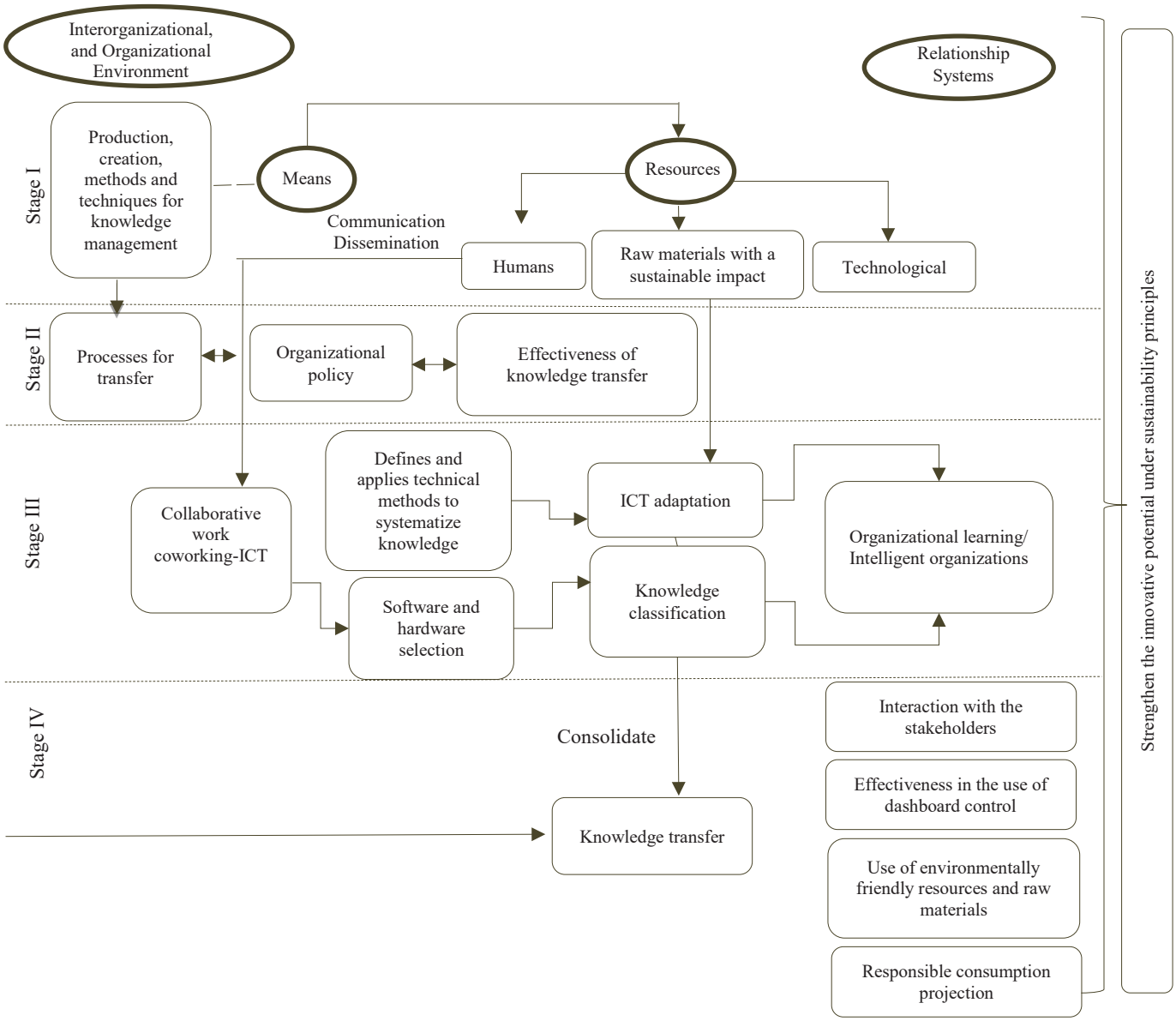


Figure 6. System of relationships between the components that promote the transfer of knowledge and innovation

The scope of the relationship system in stage I shows the importance of strengthening interorganizational capacities in SMEs, starting from production, such as knowledge management for its transfer. Stage II is conceived within the framework of two classifications, the capacity for appropriation and production of new knowledge, considered as the basis for achieving both the production or absorption, and the organization-resources necessary for knowledge management, which is consistent, as stated by Anjaria (2020) as well as the importance of viability of the definition of policies that govern the process.

Stage III shows the relationship between resource management: human and teamwork (coworking). Their interrelation promotes added value, the development of tangible and intangible capacities as long as the transfer and appropriation of knowledge consolidates a culture to innovate and undertake (Méndez-Picazo, Galindo-Martín, & Castaño-Martínez, 2020).

On the other hand, it is proposed to understand how IT flexibility, collaboration with partners, and environmental business factors lead to improved innovation capabilities oriented towards sustainability (Van de Wetering, Mikalef, & Helms, 2017). The relationships of the first three stages give viability to the effectiveness of the system flows in stage IV, based on the empirical vision in which the work and projection of SMEs prevail in the face of the need to renew their management to transcend the use of information technologies to maximize the transfer and appropriation of knowledge as part of the capacities to innovate.

DISCUSSION

The results obtained allowed, from the initial phase of the study associated with the validation of the instrument, to obtain a concordance in each stated construct, which guaranteed the measurement of the study variables, as for the application of principal component analysis (PCA). Likewise, the data facilitated the grouping of relevant items or characteristics for the evaluation of SMEs, in order to identify the key components that support the management for knowledge transfer, aligning with the principles established by Nonaka and Takeuchi (1999). The relative importance of the variables retained in the PCA is added, observing that the correlations between the variables and the components are well defined. Thus, the model obtained with the PCA allowed the identification of three relevant components for the analysis of knowledge transfer and, therefore, of knowledge management, understood as crucial elements in the framework of the development of SMEs in the cities under study, as well as in the advances associated with the knowledge society.

In the same order, the data derived from the comparison of each of the components identified in the study according to the city of origin of the SMEs analyzed were relevant, since the data indicate variations in the local contexts related to the proximity and cooperation with the innovative sector of the academy, which is crucial to understand the effects on the transfer of knowledge in the regional context. An aspect that is exposed to the need to promote favorable interactions with the actors that make viable and have to strengthen innovative development as part of the distinctive characteristics of companies (Franco & Pinho, 2019; Belderbos et al., 2018; Del Giudice, Carayannis & Maggioni, 2017).

As for the result of H1, the data from the model studied show the existence of functional relationships between knowledge transfer and sustainable innovation. At the same time, the model proves that these effects are direct, indicating that a greater transfer of knowledge predicts higher levels of sustainable innovation. However, the adoption of practices that add to the strengthening of integrated knowledge management as a strategic basis for promoting innovation under sustainability principles from the business contexts is required. From this perspective, to mitigate the risks associated with the weak development and stability of SMEs. Thus, it is foreseen from the literature that knowledge management is developed as a voluntary and conscious act between individuals and organizations, in addition to having as a result the joint acquisition of intellectual property between the source and the recipient (Del Giudice et al., 2017; Franco & Pinho 2019; Fukugawa, 2016; Rossi, Rosli & Yip, 2017).

These approaches suggest agreement with the information obtained; however, it is evident that the SMEs studied in the two cities differ in terms of performance in terms of innovative management and University-SME cooperation, as shown by the analysis of comparison between groups, a situation that generates significant gaps in terms of ways to promote innovation and undertake new developments. Similarly, anticipate the importance of generating potential in human talent to adopt technological trends that contribute to business sustainability, which implies a marked differentiation among the rest of these companies, in terms of developing innovation and development capabilities, learning, and strategic direction.

Undoubtedly, innovation is relevant as a priority activity that deserves to be granted in modern organizations (Ferraris et al., 2019), in addition to characterizing ways to promote innovation to overcome barriers that limit the adoption of sustainable practices. On the other hand, the results that allow contrasting H2, confirm, on the one hand, that knowledge transfer directly predicts Interorganizational Sustainability in the SMEs, but this relationship is not mediated by the effect of sustainable innovation. Thus, although KT affects the integration potential of SMEs with organizations from other sectors, no complete connection between the elements of the conceptual model is identified, insofar as sustainable innovation does not contribute to interorganizational integration. In view of the above, it is important to overcome the gaps that weaken the aforementioned interaction. To this end, it is necessary to emphasize that the synergistic relationships of companies, with and among different actors, allow boosting innovative capacity and development (Dukic, Ljiljana & Vinko, 2015).

In addition to understanding the critical role of innovation in the generation of competitive advantages, as well as the improvement of operational performance (Zhou, Zhou, Feng & Jiang, 2019) and the direction of their productive activity towards sustainability (Hansen, Grosse-Dunker & Reichwald, 2009).

Given the above, determining the components that underpin the system of relationships from the empirical study became the basis for the design of the system, whose interactions are determined by process flows that give greater meaning to the correlating components. From this perspective, it helps to overcome barriers in the management of SMEs based on practices associated with knowledge transfer and sustainable innovation. Both are represented in stage I, which shows the importance of strengthening interorganizational capabilities in SMEs. In turn, it considers the production and management of knowledge according to the results of the empirical study, prioritizing the understanding of the behavior of business environments and the impact on the viability of the resources associated with the variables.

In stage II, organizational policies and the strengthening of human capacities are priorities. The human factor is highlighted as a promoter of knowledge (Ode & Ayavoo, 2019; Rossi et al., 2017). As such, the human resource management practice of empowered leaders and knowledge-intensive teams can significantly promote team knowledge sharing (Han, Ren, Yang & Han, 2021). In this way, the knowledge transfer and its exchange through the use of information technologies are the basis for the development of skills and abilities of collaborators (Fink & Ploder, 2009). Regarding the process of capturing and transferring knowledge, it still represents one of the barriers to be overcome. Among the reasons that determine them are the weak importance given to the investment required to create mechanisms that support KT from the organizational environment and its interorganizational projection. Besides requiring the production of knowledge, through which research, new developments, innovations, and ventures are promoted (Giraldo-Pinedo, Paredes-Chacín & Núñez-Velasco, 2021). Then in stage III, the emphasis is centered on collaborative work and information technologies are shown from two strategic nodes - soft and hard. The former tends to transfer tacit knowledge, through the interface that allows person-to-person interaction. The second mainly transfers explicit knowledge, allows codification - management - and the transfer of knowledge using this grounded resource (Jasimuddin & Zhang, 2009).

The flows described, and the information technologies in a transversal way, are conceived as a base that facilitates the systematization and transfer of knowledge. In addition to considering their transformation to strengthen the intangible asset - knowledge - as a determining factor for organizational competitiveness (Grant, 1996); also promote their practice for the projection of the so-called intelligent organizations, characterized by promoting research and innovation to generate permanent and systematic transformations, in which the management and intelligent use of knowledge and technologies support the development of processes and products as a determining part to innovate (Romera, 2016; Liao & Wu, 2010; Paredes, 2011).

Giving priority to the ways of dynamizing knowledge transfer management is considered as one of the strategies to promote sustainable innovation from a comprehensive vision, which is complemented, in addition to the results presented, by the definition of metric standards that determine the progress in the execution of the proposal and therefore the effects of these on the goals of sustainable development; for which the adoption of green technologies by SMEs is decisive (Hilkenmeier, Fechtelpeter & Decius, 2021; Jahanshahi, Al-Gamrh & Gharleghi, 2020), and in turn leads to the strengthening of capacities to direct strategies focused on new ways of appropriating knowledge from an interorganizational vision and innovate the transforming reality of SMEs. The results obtained from the empirical perspective and its statistical basis, project valuable implications from the functional, technical and operational aspects of the business contexts, regardless of their size, as well as for the scientific-technical development in a global order.

CONCLUSION

Determining the relationships between knowledge transfer (KT) and sustainable innovation (SI) in interorganizational contexts of small and medium-sized enterprises responds to the objective of the research. Its development was based on an empirical descriptive correlational study in 109 enterprises in Colombia. The results represent the positive contrast of the hypotheses, which determine the favorable incidence of knowledge transfer on innovation, for which the representation of a system of relationships between the components that determine it, promotes the need to renew ways of transferring knowledge, as well as promoting its production and management. It is a situation that implies overcoming gaps that minimize the innovative potential of SMEs. On the other hand, consolidating an interorganizational vision in these enterprises is considered as part of the challenges that have to stimulate the management and sustainability of resources in SMEs in Colombia.

Although the valuation of knowledge is rarely conceived as a determining asset for the transformation of business management, today it requires effective processes that promote its production and transfer mediated by ICTs. From an empirical perspective, the trend is focused on overcoming weaknesses arising from ignorance of ways to transfer and achieve the appropriation of knowledge with impact towards innovative management in SMEs. In addition to the low or null interaction between the knowledge that promotes interorganizational relationships for the use of intangible assets in an assertive way and according to the nature of the markets in which they participate.

Therefore, the ability achieved to demonstrate the correlation between the components described in the system of relations between KT and SI, allows promoting sustainable innovation management that deserves to be strengthened or, failing that, created to generate differentiating characteristics and promote the competitiveness of SMEs in the sectors that participate. Likewise, it is considered among the priorities to put into effect the practice of the relationship system that prioritizes renewed ways of transferring knowledge to promote sustainable innovation in business environments that transcend not only technological activity companies, but also for related sectors that participate in markets in a global order.

Regarding the limitations of the study, it is highlighted that despite studying SMEs whose activity is focused on information technology management, weaknesses were found both in the availability of cutting-edge technologies, with greater emphasis on the small ones, and in the innovative capacity of the collaborators. It is an approach that generates risks to respond to the requirements of business digitization, under disruptive processes that allow mitigating the effects of the 21st century pandemic on SMEs. In addition, the demands of the global market environment, which affects their stability.

From the point of view of the presentation of the results, it is important to consider the functional analysis model applied, based on a mediation analysis, which assumes causal relationships of a sequential nature, which is not necessarily valid for all phenomena; it is possible other causal explanations exist or that the influence on relationships are bidirectional. It is also important to recognize that they do not offer metrics that inform about the level of fit of the models obtained, in deference to SEM procedures in which statistics are obtained arranged for this purpose (CFI, RMSEA, among others.) that indicate how well or poorly the model explains the data analyzed (Hayes et al., 2017). However, mediation models compensate for their certain limitations by adding metrics that contribute to understanding the proper fit of the estimates such as confidence intervals or conditional spillovers, which provide estimates of the effects of the variables based on the hypotheses formulated.

In this sense, it is possible to consider the application of alternative methods such as PLS-SEM (Partial Least Squares Structural Equation Modeling) models; however, mediation and PLS-SEM models are guided by different approaches to perform causal and structural relationship analysis. Consequently, these models do not overcome the sensitivity related to sample size, since they can provide estimates that are less accurate when the data set analyzed is small, whereas mediation models have been shown to perform quite well even with small samples such as the one considered in this study. In view of the above, promoting the development of future research linked to SMEs in various activities in Latin America becomes a reference that, as an empirical study, can generate added value, both for business decision-making and for the management of public policies in the regions.

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Conflicts of interest

The authors declare no conflict of interest.

Citation (APA Style)

Paredes-Chacín, A.J., Díaz-Bejarano, S., Marín-González, F., & Vega-Ramírez, E. (2024). Relationship between knowledge transfer and sustainable innovation in interorganizational environments of small and medium-sized enterprises. *Journal of Entrepreneurship, Management and Innovation, 20*(1), 47-64. https://doi.org/10.7341/20242013