

Innovative capacity in the department of La Guajira-Colombia. Inputs for an innovation public policy

Capacidad innovativa en el departamento de la Guajira-Colombia. Insumos para una política pública de innovación

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Abstract

The innovation processes that are carried out in the business network contribute to a large extent to a country's competitive insertion in the global economy. Similarly, regions move in the same direction, sometimes leveraged by innovation system models whose structure, behavior and reticular relationships are developed in a regulatory context involving geopolitical, legal, economic and socio-educational aspects. The objective of this study was to characterize innovation capacity in the department of La Guajira, within the framework of the corresponding legal regulations, based on the key environments and components of the Regional Innovation System, to provide inputs for an economic innovation policy. Qualitative analysis was performed based on the analysis of documentation. The results indicate that the Regional Innovation System as such is not consolidated in the department of La Guajira; however, an identity structure with characteristics specific to the region was identified, which constitutes a contribution to the possibility of consolidating and strengthening the system with actors from the scientific, technological, development and productive environment. It concludes by highlighting the importance of designing public policies that value the innovative capacity of the department. The study's results provide inputs for a public innovation policy that enables local development through the construction of knowledge, business innovation and quality of processes, and that offers spaces and mechanisms for articulation, which can lead to the effective configuration of the Regional Innovation System.

Keywords: Research and science management; innovative capacity; scientific innovation; research and development; science policy; economic policy.

Resumen

Los procesos de innovación que se llevan a cabo en el entramado empresarial de cualquier país contribuyen en gran parte a la inserción competitiva de estos en la economía global, de la misma manera las regiones se mueven en este contexto apalancado algunas veces por modelos de sistemas de innovación, cuya estructura, comportamiento y relaciones reticulares se desarrollan en un contexto regulatorio desde aspectos como el geopolítico, legal, económico y socioeducativo. El objetivo del estudio fue caracterizar la capacidad innovativa en el departamento de la Guajira, en el marco de la normativa jurídica correspondiente, a través de los entornos y componentes clave del Sistema Regional de Innovación, como insumos para una política económica de innovación. Se utilizó el análisis cualitativo, en una investigación documental. Los resultados determinan que el Sistema Regional de Innovación como tal no está consolidado en el departamento de La Guajira; sin embargo, se identificó una estructura identitaria con características propias de la región, que constituye un aporte a la posibilidad de consolidar y fortalecer el sistema con actores del entorno científico, tecnológico, impulsor y productivo. Se concluye resaltando la importancia del diseño de políticas públicas que valoricen la capacidad innovativa del departamento, por lo cual los resultados del estudio se conforman en insumos para una política pública de innovación que permitan el desarrollo local mediante la construcción de conocimiento, innovación empresarial y calidad de los procesos; además de espacios y mecanismos de articulación, que puedan conllevar a la configuración efectiva del Sistema Regional de Innovación.

Palabras clave: Administración de la investigación y de la ciencia; capacidad innovativa; innovación científica; investigación y desarrollo; política científica; política económica.



INTRODUCTION

According to the Preliminary Overview of the Economies of Latin America and the Caribbean for the reactivation of economic growth in the Region, there is a need to strengthen each country's economic policy (Economic Commission for Latin America and the Caribbean [ECLAC], 2019), developing strategies, mechanisms and instruments to learn about growth capacities and areas, such as Research, Development and Innovation (R&D+i).

The report was encouraging for countries such as Colombia and Guatemala, which displayed favorable growth with good performance in each of the components measured. Specifically, Colombia reported a strengthening of its economic activity in 2019, above the levels displayed since 2015, reflecting a growth rate of 3.1% in gross domestic product (GDP) in the first three quarters of the year (National Administrative Department of Statistics [DANE], 2015). The activities driving this growth are finance, trade and public administration. On the other hand, the industrial and agricultural sectors displayed little growth.

Colombia's challenge is to maintain and consolidate these indices, which has become particularly important during and after the crisis caused by the Covid-19 pandemic. In this sense, it is necessary to leverage the capabilities of each region and take on new objectives as an opportunity to rebuild economies in departments of the country where business realities and economic progress have not achieved the best results, as is the case of the department of La Guajira.

In this context, the Colombian government, in its quest to generate economic growth and social improvement, has established a regulatory framework that includes legal regulations for local development, through territorial planning and the dynamics of innovation in different contexts (Jiménez, 2016). Specifically, it makes use of the Science, Technology and Innovation (ST&I) policies contained in the guidelines of the National Development Plan (PND), which are therefore reflected in the Departmental Development Plans (DDP) and other legal documents that reinforce the regulations in terms of interactions between the public, private and civil sectors, aimed at consolidating productivity and economic competitiveness of the region.

Obviously, it should be considered that, "today's society requires companies to focus on innovation and systematic differentiation, given that the economy is based on resources supported by knowledge" (Vega et. al., 2023, p. 94). For this reason, theories such as those of the *Innovation System* are considered, to study from their perspective the need to develop an economic innovation policy according to local characteristics.

Specifically, the National Innovation System (NIS) is conceived as the set of a country's organizations and institutions, including financial institutions, professional groups, chambers of commerce, government agencies, research centers, companies and universities, that initiates, imports and disseminates innovations (Johnson and Lundvall, 1994), thereby establishing Regional Innovation Systems (RIS), taking into account the impact that the regional administrations have on each nation's development, and therefore on decision-making capacity for their economic growth.

In this context, [Cooke \(1992\)](#) is considered the first promoter of the concept, which, with the same elements as the concept of NIS, unifies from the economic point of view, actors, relationships and processes for the production, placement and transformation of knowledge that can be exploited in a particular region.

The studies of [Braczyk et al. \(1998\)](#) offer insights of great interest when they examine the theories that support the RIS approach, such as *regional science* ([Moulaert & Sekia, 2003](#)) and the degree of connectivity between system managers and innovation policies, highlighting in their analysis that regional science is immersed in economic geography in matters related to the high-technology industry and its socioeconomic impact in the regions.

At the same time, it is linked to evolutionary economics, which focuses on the analysis of the interactive processes of innovation, since it is generated in several phases driven by continuous interactions between the different actors, in a process that is non-linear, since the process also involves a succession of phases that are not necessarily mutually linked. In this view, the notion of (institutional) learning is created within a systemic framework of innovation analysis. Both theoretical orientations generate the definition of a region, in terms of economic policy, as the territory that possesses a certain capacity for self-government and cultural cohesion, conditions that favor the link between governance and the economic system, which opens the door to the use of the concept of RIS for the design of policies ([Bilbao-Osorio, 2006](#); [Jiménez et al., 2011](#)).

From this theoretical perspective, preliminary information was gathered the field, finding the absence of an organization dedicated to RIS, as indicated in the Departmental Innovation Index (IDIC) of 2020, where the department is identified as one of the “territories with incipient regional innovation systems, with major lags in terms of innovation results” ([National Planning Department \[DNP\], 2020, p. 11](#)). Consequently, the characterization work involves a significant exploratory effort to find local economic growth policies, hand in hand with the innovative capacity of the productive apparatus in the department of La Guajira.

In assessing this empirical evidence, the postulates of [Neto \(2011\)](#) are relevant, as he proposes the factors that could prevent the emergence of a RIS in regions that do not have adequate conditions for it. It is therefore important to carry out appropriate studies for the identification and treatment of the associated processes, in order to find solutions that can be adapted to the territory and whose contribution is not restricted only to the economic spheres, but that also involves educational, cultural, social and political institutions.

In this regard, it is important to highlight that a country’s business activity is an essential component of the economic growth of nations, which not only involves management of financial resources, but also human resources and intellectual capital, thus having an impact on the quality of life of society and the positioning of opportunities for prosperity at the global, regional and country level. The process involves a challenge of continuous improvement through public policies and development plans supported by research and innovation.

In this regard, and based on the conclusions reached by [Callejón \(2007\)](#) on the knowledge deficit repeatedly displayed by the public administrations of the countries of the region, this study starts out by defining and differentiating terms of research and development on innovation, because it is important for government authorities involved in economic policy to have sufficient inputs to define and characterize the capacity for innovation in their territories, in order to improve existing public policies, as well as create new ones, especially economic innovation policies.

Obviously, assessing a territory's potential to generate innovation, and translating this into productive practices that will drive local economic development from the scientific and technological perspective, is closely linked to the identification of its capacity to share knowledge and the interaction between business actors and other science and technology entities, from a systemic point of view.

Therefore, in the face of the inquiries about the capacity of the Innovation Management System (IMS) to promote sustainable development in the department, additional research questions arise, such as: What are the characteristics of the Regional Innovation System of the department of La Guajira according to its structural organization? And which are its components, its environmental factors, and participating actors?

The search for answers to these questions led to defining the objective as: characterization of the innovative capacity in the department of La Guajira, within the framework of the corresponding legal regulations, through the environments and key components of the RIS, as inputs for an economic policy on innovation. This is based on specific Latin American experiences, compiled by [Llisterri and Pietrobelli \(2011\)](#), on which a new RIS or the exploration of others that have not yet been consolidated can be founded.

DEVELOPMENT

METHODOLOGY

Methodologically, this study was developed using the qualitative method based on documentary research, where the units of analysis for the data collection process were, on the one hand, legal documents referring to ST&I policies, the DDP, Conpes 3866 ([National Council for Economic and Social Policy \[CONPES\], 2016](#)), [Law 1286 \(Congress of the Republic of Colombia, 2009\)](#) and [Law 1962 \(Congress of the Republic of Colombia, 2019\)](#), whose contents seeks to support and provide a regulatory basis for innovation activities for territorial economic development.

Institutional and governmental documents were also analyzed, such as the annual reports of the Chamber of Commerce, the reports of departmental economic profiles, the IDIC, the technical bulletins of DANE and DNP, reports of the Ministry of Commerce (MinICT), the Ministry of National Education (MEN), the Ministry of Science (MinCiencia), the National Information System for Higher Education (SNIES) and the General System of Royalties (SGR). Other important studies include those

carried out in collaboration by the [Private Competitiveness Council \(CPC\)](#) and [Universidad del Rosario \(2021\)](#), [Fundesarrollo and Guajira 360° \(2018\)](#), [Universidad de La Guajira \(Uniguajira\) \(n.d.\)](#), the [Observatory of Colombian Universities \(n.d.\)](#), the [Education Observatory of the Colombian Caribbean \(OECC\)](#), [Universidad del Norte and Guajira 360° \(2017\)](#).

Using the documentary collection technique, we worked with secondary sources obtained from official documents for the systematic analysis of their content, using two matrices as instruments to collect the necessary data on each environment and the key components, through a process of documentary surveying, review, collation and interpretation.

The diligent analysis of the literature and state of the art regarding the structural organization of a RIS allowed to select and discard elements, dimensions and indicators to manage the categories of analysis, according to the context studied in the department of La Guajira, reaching the consensus to investigate first the environment and the institutions as heterogeneous and homogeneous elements in each of the fifteen (15) municipalities; as well as the key components through the productive structure, business R&D, knowledge infrastructure, socioeconomic development and public policies. All this information, dispersed in documents, socio-economic reports, and entities specific to the region, is taken into account for its proper organization, with the aim of configuring a theoretical construction of the identity of the region, through networks of interaction to develop its own typology.

Once the data has been processed and the information analyzed, the final product is presented, as a referential infographic of the structural organization of the RIS of the department of La Guajira, and in Table 6 on the specificity of the key components of the system, described in the behavior of the industry, investment in innovation, generation of knowledge in the region, socioeconomics of science, as well as public policies on investment in science and technology.

RESULTS

DISCUSSION

Through the methodological strategy of documentary review, diligent use is made of the data contained in legal, institutional and governmental documents, highlighting in the first place the most relevant findings in terms of the legal regulations that support the business restructuring of the department from the point of view of economic innovation.

The above highlights the purpose for which the [Congress of the Republic of Colombia \(2009\)](#) established [Law 1286](#), which is aimed at consolidating a sustainable production model that produces added value to products and services through the transformation of the national industry by proposing the incorporation of Science, Technology and Innovation (STI) as cross-cutting focus areas for the country's economic and social policy (art. 2, subsection 3); as well as establishing the transfor-

mation of the National System of Science and Technology into the National System of Science, Technology and Innovation (SNCTI) (art. 2, paragraph 5), in addition to the promotion of scientific, technological and innovation activities aimed at the improvement of competitiveness within the framework of the National Competitiveness System (SNC) (art. 2, subsection 10).

On the other hand, Law 1454 also justifies studies for economic development through innovation, especially in article 2, where the concepts and purposes of territorial planning are set out, and defined as processes of collective construction of the country ([Congress of the Republic of Colombia, 2011](#)):

[...] aimed at achieving an adequate political-administrative organization of the State in the territory, in order to facilitate institutional development, the strengthening of cultural identity and territorial development, understood as economically competitive, socially just, environmentally and fiscally sustainable, regionally harmonious, culturally relevant development, taking into account the cultural and physical-geographical diversity of Colombia (art. 2).

Regarding ST&I policies, the Conpes 3866 document includes a Productive Development Policy for the country with a territorial approach aimed at addressing “market, government and articulation failures that inhibit productivity growth or hinder the processes of sophistication of the Colombian productive apparatus” ([CONPES, 2016, p. 3](#)). It is a national regulation that transfers to the regions important decisions for their territories, such as the improvement of the productive capacities of innovation and entrepreneurship, with emphasis on the objective of this research, which is the transfer of knowledge and technology.

In this way, the Development Plan of La Guajira ([Government of La Guajira, 2020](#)) provides an analysis derived from the previous legal documents, highlighting its purpose of leveraging economic growth by taking advantage of the department’s potential with a new diversified and sustainable economy that allows the productive transformation and dynamization of different sectors from the perspective of innovation.

In the case of the analysis of technical, socio-economic and official statistical reports, the results are divided into two sections for this phase, according to the sub-dimensions:

Structural Organization and Key Components.

In order to characterize the RIS context according to its structural organization, through the bibliographic analysis carried out on the postulates of various authors, the subsystems, elements or components have been synthesized into two types: *Heterogeneous elements*, which correspond to the scientific, productive, financial and technological environments; and, *Homogeneous elements*, which are the institutions that make up each of the environments. In the first type, the productive environment consists of productive enterprises, chambers, consultants, and foundations; the financial environment consists of financial institutions, government agencies, inter-

national cooperation agencies; the scientific environment consists of universities, laboratories and research centers; the technological environment is made up of goods and equipment manufacturers, technology parks, technological innovation centers (Cooke, 1992; Cooke et al., 2003; Trippl & Todtling, 2007; Fernandez et al., 2011; Navarro, 2005).

As in the case of the structural organization of the RIS, the key components have been treated in the literature from different perspectives, particularly following the line of studies by Crespi and D’Este (2011) on the key components of RIS in Latin America, and especially the aspects estimated for Colombia in the six dimensions and the following twelve factors (Table 1):

Table 1. Percentage of companies that received public support (financial or non-financial) for innovation activities.

	Dimension	Factors
Key components of the RIS analysis in Latin America	Production structure	Industrial GDP (%).
		Manufacturing companies with medium-high and high technology (%).
		Internal R&D total spending (% of sales).
	Business R&D	Number of universities / population
	Knowledge infrastructure	Number of research groups / population.
		GDP per capita (in US\$).
	Socioeconomic development	Indigenous and Afro-Colombian population (%).
		Percentage of the population with higher education
		Employment rate
	Links	Companies that use external information sources, from the production chain (%).
		Companies that use external information sources, from outside the production chain (%).
	Public policy	Percentage of companies that received public support (financial or non-financial) for innovation activities.

Source: Crespi & D’Este (2011).

The model followed by Crespi and D’Este (2011) to analyze the RIS is more relevant in the case that concerns us, because the study was carried out in the same country; therefore, it has already been contrasted with the results of other Latin American countries.

In the case of the structural organization of the RIS in the department of La Guajira, the data were collected and organized in a double-entry matrix on the RIS environments (Table 2).

Table 2. Survey of the scientific environment in the department of La Guajira

Municipality	Scientific Environment			Total
	Higher Education Institution	Research Center	Scientific Laboratory	
Albania	3	0	0	3
Barrancas	1	2	1	4
Dibulla	0	0	0	0
Distracción	0	0	0	0
El molino	0	0	0	0
Fonseca	3	1	1	5
Hatonuevo	0	0	0	0
La Jagua del Pilar	0	0	0	0
Maicao	3	1	1	5
Manaure	1	0	0	1
Riohacha	8	1	1	10
San Juan del Cesar	2	0	0	2
Uribe	0	0	0	0
Urumita	0	0	0	0
Villanueva	1	1	0	2
Total	22	6	4	32

Source: Based on official documents and websites (2023)

In this matrix, the analyzed data and information were mainly taken from the websites of MEN, MinCiencia, Min-CIT and the Government of La Guajira, the Colombian Business Directory, the Departmental Council of Science, Technology and Innovation (CODECTI), the Center for Research and Popular Education (CINEP), the Chamber of Commerce, as well as information obtained with the collaboration of the Research Group of Universidad de La Guajira and the Office of the Departmental Secretary of Education, together with that provided by key informants from the mayors' offices in each of the municipalities, in order to determine the number of institutions for each type of environment. In this context, Table 2 shows the number of institutions counted in the scientific environment of the entire department of La Guajira, in terms of institutes of higher education, research centers and laboratories.

First of all, it should be noted that Higher Education Institutions (HEIs) include universities, technological and technical institutions, as well as professional institutions. In this regard, Table 2 shows a total of 22 public and private HEIs in the department of La Guajira, with the largest number concentrated in Riohacha, while in the municipalities of Dibulla, Distracción, El Molino, Hatonuevo, La Jagua del Pilar, Uribia and Urumita, there are none. Consequently, HEIs are present in 8 of the 15 municipalities, considering that in some cases it is the same HEI with offices or campuses in other municipalities. Some of the HEIs include: Universidad de La Guajira (Uniguajira), National Learning Service (SENA), Universidad Antonio Nariño (UAN), National Open and Distance University (UNAD), Technical Institute of La Costa (INTECO), National Institute of Professional Technical Training (INFOTEC), Systematized Technical Educational Corporation (CETSCA), Technological Institute of Soledad Atlántico (ITSA), Regional Centers for Higher Education (CERES), among others.

In terms of research centers, with a total of six (6) in the department of La Guajira, they are present in five (5) municipalities (one each in Fonseca, Maicao, Riohacha and Villanueva, and two in Barrancas). In the academic field, research centers act as systemic units for directing research group projects, as well as scientific activities that allow them to be productively linked to interrelated scenarios between academia-business-state-community.

In the reality of the context, the Government of La Guajira has presented in Riohacha the project for the construction of the Regional Center for Research, Innovation and Entrepreneurship (CRIIE), which focuses on energy from renewable sources as a new economic chapter in the department, which will allow taking advantage of wind energy and native intellectual capital, developing alliances with the Nation and universities, in which research groups will play a high-impact role in the production and appropriation of knowledge ([Gobernación de La Guajira, 2020](#)).

In the case of scientific laboratories, there are only four (4) at the departmental level, that is, one (1) each in Barrancas, Fonseca, Maicao and Riohacha. The dynamics in this environment are evidenced with emphasis in the opinions expressed by Min-Ciencia on technology and innovation, highlighting the solid investment made for the enablement and endowment of the Biomolecular Laboratory of La Guajira, to expand the benefits in the health sector in the fight against Covid-19 ([Guerrero, 2020](#)).

Table 2 shows the dynamics in the scientific environment, which is concentrated in Riohacha with ten (10) institutions, followed by Fonseca with five (5), Barrancas with four (4), Maicao with five (5), Albania with three (3), San Juan del Cesar and Villanueva with two (2) each, and Manaure with one (1). Seven (7) municipalities are totally excluded from this field. This information is critical in the framework of the configuration and organization of the RIS, since the main elements that generate scientific knowledge are located in this environment.

When characterizing the RIS in the first heterogeneous element or around its homogeneous elements, it should be noted that it is not the quantity that is important from this perspective, but to know which institutions make up each scenario, where they are located, and which can be counted on to make the most of each resource, both materially and intellectually, to contribute to local economic development and to structuring or restructuring a relevant, binding, interactive, competitive and identity-based RIS.

Table 3 presents data on the technological environment in the department of La Guajira as transformative elements of innovation. Particularly, in the case of technology parks, La Guajira has the Jepírachi EPM Wind Farm in Uribia. However, the document of the Draft Development Plan 2020-2023 indicates plans for 25 technology park projects (1 in El Molino, 1 in Fonseca, 3 in Maicao, 2 in Riohacha, 8 in San Juan del Cesar and 10 in Uribia), specifically wind and solar power generating parks. Likewise:

The project proposes that by 2022 the first wind farms will begin operating and, according to plans in progress, by 2031 in the Wayuu territory of the Alta and Medio Guajira there will be 65 parks with more than 2,500 wind turbine towers ([Gobernación de La Guajira, 2020, p. 88](#)).

In the same way, official documents were analyzed to find figures of goods and services companies in the technological environment, with a total of 1501 companies analyzed, which are mainly concentrated in Maicao with 289, followed by Riohacha with 283 and Fonseca with 267. They are located in almost all municipalities except Dibulla and Distracción ([Table 3](#)).

Table 3. Survey of the Technological Environment in the Department of La Guajira

Municipality	Environment			Total
	Technology Parks	Goods and services companies	Technology innovation center	
Albania	0	116	2	118
Barrancas	0	161	0	161
Dibulla	0	0	0	0
Distracción	0	0	0	0
El molino	0	2	0	2
Fonseca	0	267	0	267
Hatonuevo	0	68	0	68
La Jagua del Pilar	0	6	0	6
Maicao	0	289	1	290
Manaure	0	52	0	52
Riohacha	0	283	2	285
San Juan del Cesar	0	138	0	138
Uribia	1	117	1	119
Urumita	0	1	0	1
Villanueva	0	1	0	1
Total	1	1501	6	1508

Source: Based on official documents and websites (2023)

On the other hand, there are six (6) innovation and technology centers, among which the SENA Industrial and Alternative Energy Center in Riohacha stands out. These centers are transformative elements within the RIS due to their exchange function to create an innovative culture among companies through collaboration mechanisms and alliances, with a view to achieving satisfactory levels of competitiveness in the region’s economy.

The impact of organizations in the technological environment is based on their position between the knowledge-generating environment and the *development* and *financing environments*, to successfully implement the acquired knowledge in the productive environment.

The department of La Guajira has technological development and innovation projects that can potentially be used for the regional economy in terms of productivity, and investments through these homogeneous elements of RIS, with the ultimate goal of disseminating and applying knowledge.

Table 4 shows the size of the financial environment in the department of La Guajira, with a total of 144 entities, of which 78 are financial institutions, 57 are governmental organizations and 9 are international cooperation agencies.

Table 4. Survey of the financial environment in the Department of La Guajira

Financial		Environment		
Municipality	Financial entities	Government organizations	International cooperation agencies	Total
Albania	7	1	1	9
Barrancas	8	2	0	10
Dibulla	1	1	0	2
Distracción	6	3	1	10
El molino	0	1	0	1
Fonseca	6	2	1	9
Hatonuevo	3	1	0	4
La Jagua del Pilar	1	1	0	2
Maicao	11	10	1	22
Manaure	5	4	0	9
Riohacha	19	16	2	37
San Juan del Cesar	9	10	2	21
Uribia	1	1	1	3
Urumita	0	1	0	1
Villanueva	1	3	0	4
Total	78	57	9	144

Source: Based on official documents and websites (2023)

In this environment there are both public and private financial, venture capital and seed capital institutions. Special mention should be made of SENA's entrepreneurship nursery units, which support academic and entrepreneurship projects, as well as the Departmental Economic Secretariat, which actively supports these innovation initiatives.

Other institutions that are listed in this environment are the Fund for the Financing of the Agricultural Sector (FINAGRO), which supports projects in the Agro-industrial Cluster; the Territorial Development Finance Agency (FINDETER), which finances projects to reactivate the economy, and of course MinCiencia, with the unrestricted support of the government.

When analyzing some recent reports of the Chamber of Commerce of La Guajira, the news story published at the beginning of the current year in the stage of economic reactivation is considered, which mentions the approval of ten (10) programs that would benefit companies "in the manufacturing, agribusiness, service and alternative energy sectors" (Martínez, 2021, para. 5). Specifically, it is interesting to identify the alliances between national and international entities that would finance subsequent projects in order to know the financing capacity that could maintain a presence in the RIS.

Within this proactive framework, support and financing alliances were identified for the ST&I Ecosystem, tourism cluster, renewable energy cluster, manufacturing, services, agro and microbusiness sector, with the joint participation of: MinICT, the European Union, the Adelco Network, INNpulsia Colombia, COLINNOVA, Swiss Foundation for Technical Cooperation for Development (Swisscontact), Bogotá Chamber of Commerce, Farming Data Colombia through the British Embassy; whose programs are operationally managed by the Chamber of Commerce of La Guajira (Martínez, 2021).

The concrete identification of this environment is significant due to its indispensable role as an enabler of the processes developed by the other environments, through financial support, tools and assistance, as explained by Komninos (2002) in his theory regarding the systematization in blocks of the entire inclusive process for the structuring and effective functioning of the RIS. Evidently, the construction of scientific knowledge, the process of technological transformation and the productive end product would not have continuity without the presence and activation of the financial environment and the government as drivers for the RIS. At the same time, as Cooke (1992) points out, in addition to economic empowerment, government public entities play the role of supervisory, controlling and binding agents in the network of RIS agents, through public policies related to innovation. In general, the identification of this environment has led to its characterization in this research as a "development environment", considering that this term is inclusive and encompasses the objectives of the three types of organizations: financial, economic, and advisory and enabling.

Finally, in the productive environment shown in Table 5 below, 405 organizations from the department of La Guajira are present, according to the Business Directory of the Chamber of Commerce of La Guajira, registering 199 companies from various

productive segments (committed to the innovation process) in the 15 municipalities, 84 consultants and 122 foundations. An example of this productive environment is undoubtedly Cerrejón, which is a significant part of the business ecosystem that gives a substantial economic boost to the department of La Guajira, with a wide value chain in the mining sector, coal industry, promoter of sustainable development in the region and innovation and quality processes which drive expansion and competitiveness in the environment. This and other large and medium-sized companies, consultancies and foundations such as Fundación Guajira Competitiva, indicate a scenario potentially available for the consolidation of the RIS, joining efforts to make visible and available to the economic society the products of the entire system.

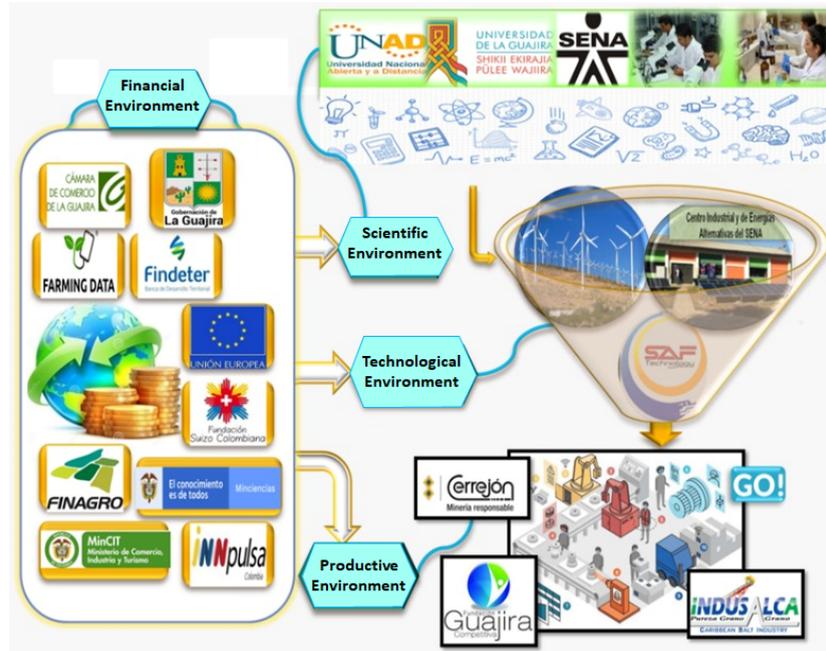
Table 5. Survey of the production environment in the department of La Guajira

Production		Environment		
Municipality	Companies	Consultants	Foundations	Total
Albania	6	4	6	16
Barrancas	4	9	9	22
Dibulla	0	0	0	0
Distracción	1	0	10	11
El molino	2	0	0	2
Fonseca	17	6	10	33
Hatonuevo	8	0	6	14
La Jagua del Pilar	2	0	2	4
Maicao	16	25	14	55
Manaure	11	3	9	23
Riohacha	56	30	14	100
San Juan del Cesar	19	4	8	31
Uribia	54	2	30	86
Urumita	1	0	0	1
Villanueva	2	1	4	7
Total	199	84	122	405

Source: Based on official documents and websites (2023)

The identification of all heterogeneous elements (environments) and all homogeneous elements (institutions) of the department provided sufficient information to design the following infographic ([Figure 1](#)), where the four (4) environments are contextualized in a referential map of the innovation system according to the ST&I behavior in the department of La Guajira.

Figure 1. Referential map of RIS environments for the department of La Guajira.



Source: Authors (2023)

The analysis of each reviewed document, the contents of official news stories and the collaboration of key informants demonstrates a vocabulary of business innovation with identity connotations, according to the cultural profile and geoeconomic conditions of the territory; however, according to the terms used in this research, it is important to note that the map of environments presented in Figure 1 is also consistent with the theories discussed in this study, according to meanings and signifiers for a RIS of four environments (Cooke, 1992; Komminos, 2002; Fernández et al., 2011).

Likewise, it should be noted that innovation processes do not start up in a single environment, since innovations may arise from calls for specific business innovations from the financing environment, or they may arise from the scientific environment with ideas and research that will require grants for their development. The process can also be initiated in the other two environments. However, in the map outlined above, a specific path is drawn based on the researchers' critical analysis of the behavior observed in large departmental economic development projects (Figure 1).

In this sense, the referential map of RIS environments for the department of La Guajira is outlined, linking the environments and their functions, such as those of generation, transformation, promotion, enablement and exploitation or final production (Doloreux, 2002), presenting in the first place, as a heterogeneous integrating and enabling element, the financial environment, including financial institutions, government agencies and international cooperation agencies in the field of innovation for the development of economies.

This financial environment performs several functions in the RIS, acting as a promoter of the innovative culture, and as sponsor, financier, supervisor and guarantor of each scientific project, with relevant rules and policies, which would be immersed in

the system to promote and subsidize the scientific environment for the generation of scientific knowledge, which would be transformed by the technological environment, with which it would also interact, as well as the productive environment. In this sense, here we have identified the financial environment as the initial driving environment.

The scientific environment is represented by the HEIs, which include their research centers made up of the research groups and their scientific and technical laboratories. Centers and laboratories of the public or private sector that are not necessarily components of the HEIs are also part of this environment. These generate the scientific knowledge that will be adopted by the other scenarios of the system; however, they also develop other interactions with the institutional learning environments and the system itself, in all the innovation processes and activities.

The technological environment is responsible for implementing the knowledge generated from the previous environments, but at the same it continuously exchanges knowledge during technological transformation processes with innovation and technology centers and the goods and service companies dedicated exclusively to the technology sector, and maintains collaborative interaction with the dynamic learning of the RIS.

In the case of the Department of La Guajira, the technology parks, another element of the innovation environment, also involve the two previous environments, since they include educational and technological development institutions and companies in the same field, in a manner that maintains the synergy of the system. Given the region's economic behavior, the productive environment is represented by the manufacturing companies that materialize the products, promoting competitiveness and regional economic growth with national and international repercussions, but above all with a socio-community impact through the quality of life generated by innovation for the department's population.

On the other hand, the second dimension of the characterization of the key components of the RIS is based on data collated from several official national documents and documents of the department of La Guajira, taking figures mostly from the years 2018 and 2019 (the data from 2020 and 2021 are considered atypical in some cases, due to the effect of the Covid-19 pandemic; however, they have been taken into account in some situations that do not distort everyday reality). The specific information of these components is represented in [Table 6](#), in which the names of some indicators have been adjusted to reflect the names given to them in the respective documents and according to the characteristics of the region.

Table 6. Description of the key components of the RSI of the Department of La Guajira

Component	Indicator	Information
	Industrial GDP (%).	0.02%
Production structure	Manufacturing companies with medium-high and high technology (%)	6.6%
Business R&D	Intensity of business R&D spending	3.74%
Knowledge infrastructure	Number of universities / population.	6 univ/ pop. 927506
	Number of research groups recognized by MinCiencia.	55
	GDP per capita (in US\$).	GDP per capita 2019 (p)*: US\$ 4336. (p) Provisional figures. DANE population forecasts
	Indigenous and Afro-descendant population (%).	**1067063 total pop. 278212 (42.41%) indigenous 91674 (13.98%) Afro-Colombian
Socioeconomic development	Percentage of higher education graduates by technological/ university level (2010-2018).	1.30% of total inhabitants in 2018 of 1040193. Number of graduates (2010-2018): 13603 (4821 technical and 8782 university level).
	Employment rate (at 2018).	62.3%.
Public policy	Regional public investment in science & technology derived from national STI investment.	Of the SGR budget: 10%. Approximate budget allocation for 2021-2022: 160 billion pesos.

Source: Based on official documents ([DANE, 2020](#)).

1. In the first place, the *production structure* of the department is presented in Table 6, with industrial GDP of 0.02% for 2017. Here we highlight the disparity of employment rates between the various industrial sectors of La Guajira, and the region's contribution to national GDP: "the manufacturing industry, with 22.8% of the employed, barely generates 0.02% of GDP," while at the other extreme, "the mining and quarrying industry, with only 1.9% of the employed, manages to contribute approximately 44% of GDP" ([Guajira 360°, 2018, p. 4](#)).

In this way, it can be observed that the department is characterized by being a region with little diversification and a low contribution to national GDP, especially the industrial sector. Such data indicate that for the establishment or performance of a RIS, innovation processes are key components as a driving force to rescue a low-weight productive structure.

In the same way, the percentage of low to medium-tech manufacturing companies (not considered high-tech), according to the [Chamber of Commerce of La Guajira \(2019\)](#), are “the result of the statistical analysis of business behavior in the department based on information from the Mercantile Registry of the Chamber of Commerce” (p. 4), for the two-year period 2016-2018. It is indicated that 6.6% were accounted for, corresponding to a total of 1180 records of these active companies, among which those of “clothing manufacturing, manufacture of metal products for structural use and production of bakery products” stand out ([Chamber of Commerce of La Guajira, 2019, p. 11](#)). This contrasts with the 45.7% of companies engaged in commerce, which is the region’s leading economic activity.

Both indicators show that the department’s production structure is characterized by a low percentage of manufacturing companies with technology, which in turn is considered low to medium, as well as a weak contribution to GDP from the industrial sector, in a context where the *mining and quarrying sector* accounts for 43.8% of total GDP in La Guajira, but whose contribution to employment is quite low.

2. The second key component of the RIS is investment in *business R&D* ([Table 6](#)). In this case it is measured through the intensity of business expenditure on R&D, which is 3.74% ([DNP, 2020](#)). For the IDIC, it is an indicator of the *research and development* sub-pillar whose behavior declined from 8.93% in the previous period. This categorizes the department as a low performer, indicating little tendency to invest in R&D, which represents the weakness of a key component for the formation of the innovative system in the region. Likewise, this is corroborated by the fact that investment in activities conducive to innovation in companies is zero as a percentage of GDP, linked to a low performance in Private Expenditure on R&D, at 0.05%, and in Gross Expenditure on Research and Development (R&D), at 5.31% as a percentage of GDP, although the latter improved compared to the 0.70% reported the previous year ([DNP, 2020](#)).

3. Thirdly, the *Knowledge Infrastructure Component* is presented ([Table 6](#)), whose documentary analysis was supported by data obtained from the [Observatory of Colombian Universities \(n.d.\)](#), the Departmental Competitiveness Index (IDC) 2020-2021 ([CPC and Universidad del Rosario, 2021](#)) and the IDIC ([DNP, 2020; 2019](#)). In the same way, it is important to highlight the information obtained from various websites of universities such as [Universidad de La Guajira \(n.d.\)](#), the [National Open and Distance University -UNAD- \(n.d.\)](#), the [Claretian University Foundation -Uniclaletiana- \(n.d.\)](#), [ITSA \(n.d.\)](#), among others. In the first indicator of the component, a total of six (6) universities were found in the department, for a population of 927506 inhabitants, according to the latest National Population and Housing Census ([DANE, 2018](#)); with a coverage rate in Higher Education of 24.87, corresponding to a medium-low performance. These data allow us to reflect on the conclusions

presented in the study by the [OECC, Universidad del Norte and Guajira 360° \(2017\)](#), which states that “a coverage rate in higher education that is less than 25% reveals the urgency to implement actions that facilitate access to this level of education.”

Also, in the context of the third key component, it was determined that the number of research groups is 55, according to data derived from [MinCiencia \(2019\)](#), referring to research groups recognized by Colciencias. In this sense, it is observed that 55% of the groups focus on the Social Sciences (30 groups), 25% on Engineering and Technology (14 groups), 11% on Natural Sciences (6 groups), 4% on Agricultural Sciences (2 groups), 4% on Humanities (2 groups) and 2% on Medical and Health Sciences (1 group). Of the total number of research groups, only one (1) is in the recognized category, which is the Biological Sciences category; while 22 of these groups (40%) are in category C, 19 (35%) are in category B, 12 (22%) in category A, and only one (1) (2%) in category A1.

The information analyzed from the contents of the documents studied allows us to conclude that the number of universities is low compared to the number of inhabitants, which determines that the production of knowledge will be equally low, having an impact on the weak presence of qualified personnel to strengthen the department’s productive apparatus.

4. From the perspective of *Socioeconomic Development*, which is the fourth key component of a RIS, Table 6 indicates the estimates for the four indicators: the first indicator is GDP *per capita* (in US\$), measured in order to show the degree of well-being (economically speaking), wealth or poverty of the inhabitants of the region. In this regard, the document consulted was the Report on Profiles Departmental Economic Studies of the Department of La Guajira ([MinICT, 2020](#)), which specifies how for the year 2019 GDP per capita was US\$4336, which characterizes it as a department of weak productive behavior, with little economic activity. This translates into a low standard of living and compromised purchasing power, viewed in a general manner and without considering socioeconomic inequality.

The second indicator is the *Indigenous and Afro-descendant population (%)*. According to DANE and DNP Terridata (cited by the [United Nations Development Program \[UNDP\], 2019](#)), in the Statistical Sheets related to the challenges faced by La Guajira for sustainable development, a total of 278212 indigenous inhabitants and 91674 Afro-Colombians are registered, who represent 42.41% and 13.98% of the total department’s population, respectively (the total ethnic population of the department is 56.41%, including 0.02% of the Raizal population, with 99 people). These figures represent a high level of ethnic and cultural diversity. Particularly, in the department of La Guajira, this indicator is taken into consideration for a commitment to preserving ethnic and traditional knowledge, which can have an impact on the capacity for innovation through the internal development of personnel with a focus on their characteristic heritage. This contrasts with the views of [Crespi and D’Este \(2011\)](#), who state that “a strong presence of native population exhibits significant barriers to innovation” (p. 56) in the RIS.

On the other hand, the third indicator of the fourth key component is the *percentage of graduates from HEIs by level of technological and university training (2010-2018)*. This data was calculated and analyzed comparatively from the ‘List of Departmental Reports on Higher Education’ (SNIES, 2019). The figures indicate 4821 graduates at the technological level and 8782 university graduates, for a total of 13603 graduates, which represents 1.30% of the total population in 2018 of 1040193, according to information from the Territorial Files of DANE and DNP Terridata (UNDP, 2019).

These results of the analysis reveal weaknesses in socio-cultural conditions, particularly due to the low percentage of the population with university degrees, which constitutes an indicator of great impact for the development of innovation activities and local economic development.

Regarding the *employment rate* for the department of La Guajira, due to the Covid-19 pandemic effect, the figures for 2020 and 2021 can be considered to have been skewed by the atypical behavior of the work environment. In this sense, the figures for 2019 are considered, analyzing the Great Integrated Household Survey (GEIH) of 2020 on the labor market by department (DANE, 2021), revealing an employment rate of 62.3% for the year 2019 and an unemployment rate of 6.5% in 2020, which continues to characterize the department as one with a low unemployment rate and high occupancy.

5. Finally, analyzing the *Guajira 360° (2020)* information and the SGR website (www.sgr.gov.co) on the distributions of the new royalty system, the fifth key component is detailed, corresponding to *public policies (Table 6)*, specifically to regional *public investment in science and technology derived from national investment*, for the development of programs and projects that boost productivity through the SGR, which according to a recent reform approved by the Congress of the Republic improves the allocation of resources to the department of La Guajira (Law 2076, 2021). For the period 2021-2022, an approximate budget of 160 billion pesos is assigned, specifically, for ST&I, which will account for 10% of total investment. Of this percentage, approximately 2% should be dedicated to research or investment in projects related to or with an impact on the environment and sustainable development.

The SGR, derived from the exploitation of non-renewable natural resources, provides substantial resources for investment in ST&I (Gobernación de La Guajira and Colciencia, 2015). The new regulations highlight the design of public policies that value the department’s innovative capacity, to enable technological development through the construction of knowledge, business innovation and the quality of processes; but above all, it constitutes a concrete foundation for the key components studied, considering its cross-cutting commitment to institutional strengthening for ST&I, in spaces and mechanisms of articulation, which can lead to the effective configuration of the RIS.

In summary, the general analysis of the key components of the RIS of the department of La Guajira reveals a productive structure of low industrial GDP, and an equal percentage of manufacturing companies that possess medium-high or high technology, in addition to the presence of a poorly diversified industry. In the same way,

the percentage of business R&D remains low. The need to strengthen the knowledge infrastructure is evident, in terms of the number of universities per population and the creation of recognized research groups that subscribe to the development of the economic scenarios and competitive capacities of the territory.

CONCLUSIONS

The analysis of the results allows us to conclude that the Colombian State offers sufficient support for the strengthening of the country's economy through the dynamics of ST&I, and that the corresponding laws are in place, with innovation being one of the strategic variables that stand out in the legal regulations studied. In the same way, the DDA displays a certain orientation towards the articulation of efforts aimed at developing an innovative, sustainable and competitive economy with democratic interactions between the public and private sectors.

On the other hand, the characterization of aspects such as the structure and components of the RIS of the department indicates that in some cases they follow the recommendations of RIS studies in Latin America. However, the critical interpretation of the contents allowed considering a different treatment for some indicators which, based on the statistics of the region, and the absence of the term RIS in the official departmental vocabulary, could be considered RIS components.

Some points of positive evolution are found in the components of socioeconomic development and public policies that should be taken advantage of in the organization of the RIS, such as the ethnic differential approach, the employment rate and the public policies in terms of support for business innovation, contained in the new distribution of resources and improvement in the allocation to ST&I in accordance with Law 2056 ([Congress of the Republic of Colombia, 2020](#)), in which the SGR promotes innovation and the creation of added value in the department's own economy.

The results do in fact achieve the proposed research objective, demonstrating that a RIS as such is not consolidated in the department of La Guajira and is not visible in all its components. However, it is possible to identify an identity structure with characteristics specific to the region, which gives it the possibility of forming, consolidating and strengthening the system with actors from the scientific, technological, development and productive environment.

It is worth highlighting the dynamic actions of the Government of La Guajira and the ministries involved in these scenarios of knowledge and economic growth, as a driving and financial environment that encourages the concentration and deployment of the entities and institutions of the technological and productive environments that remain passive to the work that is undertaken by the scientific environment and the development-financial environment.

Finally, the findings of this study suggest the need to further explore actors that have emerged as each environment was scrutinized, and we recommend following up with an analysis of networks and their interactions, relationships and mechanisms to promote such interactions, which would represent new inputs for the development of economic policies towards the advancement of the region.

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