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Original article

The role of innovation in Latin America and the Caribbean: the Cuban case

El papel de la innovación en América Latina y el Caribe: el caso cubano

O papel da inovação na América Latina e no Caribe: o caso cubano

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ABSTRACT

Most third world countries, especially Cuba, have bet on innovation to seek solutions that generate the economic and social development so longed for. For this reason, the objective of the article was to analyze the role of innovation in the economic and social development of Latin America and the Caribbean, delving into the case of Cuba based on innovation indicators. The research followed a qualitative methodology, based on documentary review, for which the analysis-synthesis and historical-logical methods were applied. The relationship between innovation and economic and social development was approached, particularly in Latin America and the Caribbean, based on the input and output indicators most used in the estimation of capacities in science, technology and innovation. The results of the innovation indicators analyzed were similar in Cuba and in Latin America and the Caribbean. Most of the investment in research and development in the region was concentrated in Mexico, Chile, Brazil and Argentina; and the establishment of the institutional framework in charge of science, technology and innovation activities is not equally developed in the countries of the region. In addition, the evolution of Cuba's policy was evidenced by the recognition of the link between innovation and economic and social development, showing a coherent, continuous policy, focused on strengthening the institutional framework, with the incorporation of figures such as science and technology parks to the Science, Technology and Innovation System.

Translated from the original in Spanish

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Keywords: innovation; economic and social development; indicators; Latin America and the Caribbean; Cuba.

RESUMEN

Los países del tercer mundo, en su mayoría, han apostado por la innovación, en especial Cuba, para buscar soluciones que generen el desarrollo económico y social tan ansiado. Por esta razón, se definió como objetivo del artículo analizar el papel de la innovación en el desarrollo económico y social de América Latina y el Caribe, profundizando en el caso de Cuba a partir de indicadores de innovación. La investigación siguió una metodología cualitativa, basado en la revisión documental, para ello se aplicaron los métodos de análisis-síntesis y el histórico-lógico. Se abordó la relación entre la innovación y el desarrollo económico y social, particularizando en América Latina y el Caribe, a partir de los indicadores de insumos y resultados más empleados en la estimación de las capacidades en materia de ciencia, tecnología e innovación. Los resultados de los indicadores de innovación analizados fueron similares en Cuba y en América Latina y el Caribe. La mayor parte de la inversión en Investigación y Desarrollo de la región se concentró en México, Chile, Brasil y Argentina; y el establecimiento de la institucionalidad a cargo de la actividad de ciencia, tecnología e innovación no tiene el mismo desarrollo para los países de la región. Además, se evidenció la evolución de la política de Cuba al reconocer el vínculo entre innovación y desarrollo económico y social, mostrando una política coherente, continua, enfocada en el fortalecimiento de la institucionalidad, con la incorporación de figuras como los parques científicos y tecnológicos al Sistema de Ciencia, Tecnología e Innovación.

Palabras clave: innovación; desarrollo económico y social; indicadores; América Latina y el Caribe; Cuba.

RESUMO

A maioria dos países do terceiro mundo, especialmente Cuba, optou pela inovação a fim de buscar soluções que gerem o desenvolvimento econômico e social que tanto se deseja. Por esta razão, o objetivo do artigo era analisar o papel da inovação no desenvolvimento econômico e social da América Latina e do Caribe, examinando em profundidade o caso de Cuba com base em indicadores

de inovação. A pesquisa seguiu uma metodologia qualitativa, baseada em uma revisão documental, para a qual foram aplicados os métodos de análise-síntese e análise histórico-lógica. A relação entre inovação e desenvolvimento econômico e social foi abordada, particularmente na América Latina e no Caribe, com base nos indicadores de entrada e saída mais comumente utilizados na estimativa das capacidades em ciência, tecnologia e inovação. Os resultados dos indicadores de inovação analisados foram semelhantes em Cuba e na América Latina e no Caribe. A maior parte do investimento em P&D na região se concentrou no México, Chile, Brasil e Argentina; e o estabelecimento da estrutura institucional responsável pela atividade de ciência, tecnologia e inovação não está igualmente desenvolvido nos países da região. Além disso, a evolução da política cubana no reconhecimento da ligação entre inovação e desenvolvimento econômico e social foi evidenciada, mostrando uma política coerente e contínua, focada no fortalecimento da estrutura institucional, com a incorporação de figuras como os parques científicos e tecnológicos no Sistema de Ciência, Tecnologia e Inovação.

Palavras-chave: inovação; desenvolvimento econômico e social; indicadores; América Latina e o Caribe; Cuba.

INTRODUCTION

Economic development is a goal for any individual, organization, country or region of the world, because it guarantees the material basis for the development of society in its multiple dimensions (social, cultural, political, environmental), provided that it is directed towards sustainable development with equity. Economic and social development depends not only on a country's potential to generate and acquire knowledge, but also on its capacity to use it and thus introduce transformations in productive activities. This is where innovation plays a fundamental role. However, at the beginning, innovation was not recognized as a dynamizing factor of economies and societies, and it was authors such as Schumpeter in the 20th century who introduced this concept.

According to the Theory of Economic Development proposed by Schumpeter (1978) there are material or productive factors (means of production produced, natural resources, and labor itself) which he called "components of economic growth" because they generate a gradual change in the productive system. He defined two other elements which impact is more dynamic and transforming, and called them "factors or forces of economic development or economic evolution" (Schumpeter,

1978). These factors are: changes in technology and innovation; and changes in socio-cultural aspects. For this author, while recognizing the importance of society, technology and innovation are the fundamental generating aspects of economic development in the capitalist system. However, an appropriate relationship must be found between innovation, economic development and social development for society as a whole to benefit.

The importance and role of innovation in the development of countries is not exclusive to this century. There have been six Technological Revolutions to date, always in a developed capitalist country or countries (Pérez, 2010) and to date this behavior has been maintained, these being the main drivers of innovation. On the other hand, globalization has generated greater competitiveness in international markets, increasingly demanding that the main strategy of companies be differentiation based on the development of products with high added value, and this can only be achieved through innovation.

Despite this, globalization has led to technologies that are not free for those who want to replicate them. This means that whoever develops them protects them from a legal point of view and, therefore, has the right to demand payment for them. On the other hand, it is becoming increasingly necessary to have financing in order to generate highly competitive technologies.

In other words, whoever has access to capital will be able to protect his technology and obtain large profits from it. The fundamental problem lies in the fact that, in this way, the first feature of capitalism, the concentration and centralization of wealth, is demonstrated, widening the gap between developed and underdeveloped countries.

The Theory of the Unequally Developed, proposed by Amin (1978), states that the world is divided into central countries and peripheral countries when analyzing the capitalist production system. The peripheral countries are subjected, in the capitalist mode, to the functionality of the central countries. The capitalist mode of production constitutes a world system, in which all formations (central and peripheral) are arranged in a single organized and hierarchical system. This implies that "the impact of industrialization on the peripheries is annulled, devaluing their productive work and overvaluing the supposed added value derived from the activities of the new monopolies from which the center benefits" (Amin, 1978). It supports the analysis of industrial or technological revolutions carried out by Pérez (2010), where he shows that underdeveloped countries, capitalist or not, are notably behind developed countries in terms of technology and innovation.

It is an indisputable reality that there are significant differences between the economies of the world's most backward regions, such as Latin America and the Caribbean (LAC) (ECLAC, 2021). Some countries have numerous and valuable natural resources, while others have opted to invest in science, technology and innovation activities, i.e., in knowledge. Some have a society with a higher academic level and have exploited these resources to position themselves among the top countries in the world. However, there are countries with significant disadvantages in achieving this development in all sectors, whose path is longer and more tortuous.

In Latin American countries where poverty and inequality have increased significantly in the last five years, especially since the Covid-19 pandemic, it is essential that governments generate policies aimed at comprehensive development based on innovation.

One of the countries in the Latin American and Caribbean region that is working to achieve economic and social development, where innovation plays a fundamental role, is Cuba. This is a country that shows significant progress in the social sphere, education, culture and health, so it is urgent to sustain them with economic development through productive transformation and international insertion, as a macro program approved for the socioeconomic development strategy until 2030.

In 2011, with the VI Congress of the Communist Party of Cuba (PCC), the Cuban nation began the process of updating its economic, political and social model, defining a series of guidelines, among which innovation is included, being pointed out in its VII Congress the main problems related to its implementation, such as: lack of comprehensiveness in the policy, bureaucratic barriers, insufficient participation of other social actors, lack of systematicity in the practical implementation of the proposed actions, among others. Taking into account these approaches, the objective of the article is to analyze the role of innovation in the economic and social development of Latin America and the Caribbean, focusing on the case of Cuba.

To fulfill the objective stated, the article is structured as follows: first, the research methods and materials are presented, followed by the relationship between innovation and economic and social development, particularly in the LAC region, based on the input and output indicators most commonly used to estimate the science, technology and innovation capabilities of the Latin American and Caribbean region. Finally, the results of these indicators achieved by Cuba in the area of innovation are presented in relation to the policy and regulatory framework in force.

MATERIALS AND METHODS

The research followed a qualitative methodology, based on documentary review. The methods of analysis-synthesis and the historical-logical method were applied to address the relationship between innovation-economic and social development, particularly in the LAC region, based on the input and output indicators most commonly used to estimate the science, technology and innovation capabilities of the Latin American and Caribbean region, as well as to analyze the results of these indicators achieved by Cuba in the area of innovation in relation to the policy and regulatory framework in force.

The analysis was structured in two parts. The first part analyzed the relationship between innovation and economic and social development in Latin America and the Caribbean using innovation indicators. The second part dealt with the case of Cuba, using the same innovation indicators of the first part and relating them to the Science, Technology and Innovation Policy and the current regulatory framework.

To obtain data and indicators on innovation and economic and social development in Latin America and the Caribbean and Cuba, publications of national and international institutions were studied, such as: the Economic Commission for Latin America and the Caribbean (ECLAC); the Development Center of the Organization for Economic Cooperation and Development (OECD); the World Intellectual Property Organization (WIPO); the Network of Science and Technology Indicators -Ibero-American and Inter-American- (RICYT) and the National Statistics and Information Office (ONEI in Spanish). In order to identify the guiding documents of the Innovation Policy in Cuba and its regulatory framework, a search was made of the main institutions and/or publications linked to the innovation policy in Cuba, these are: the National Assembly of People's Power; the Ministry of Science, Technology and Environment (CITMA in Spanish); the Communist Party of Cuba and the Official Gazette of the Republic of Cuba. The Council of State, the Council of Ministers and CITMA are the main issuers of legal provisions to strengthen the regulatory framework and innovation policy in the country.

The main categories of the research are the terms: Innovation, economic and social development and innovation indicators. After a first content analysis, the category "science, technology and innovation" was included because in the conception of Cuban policy these three concepts go hand in

hand. Likewise, a documentary review of scientific publications on Cuba was made using the aforementioned categories.

The guiding documents studied that contain the innovation policy were: The Conceptualization of the Cuban Economic and Social Model of Socialist Development; the National Economic and Social Development Plan (PNDES in Spanish) until 2030: Proposed Vision of the Nation, Strategic Axes and Sectors and the Guidelines of the Economic and Social Policy of the Party and the Revolution. In the article, each of these documents is analyzed on the basis of the categories defined above and a link was made between the policy and the regulations in force to show how it has materialized. Likewise, the results achieved by Cuba in terms of innovation were analyzed based on the information provided by the National Statistics and Information Office.

RESULTS AND DISCUSSION

Innovation in Latin America and the Caribbean: policy and main indicators

There is a marked innovation gap between regions at the global level, especially LAC and Africa. With the exception of Asia and Africa, the rest of the regions decreased their level of investment in Research and Development (R&D) in 2019 compared to 2010. In the case of LAC, R&D investment represented 2.6% of the total, and in relative terms to Gross Domestic Product (GDP) investment reached only 0.56%, while Asia increased its investment to represent 43.4% globally (ECLAC, 2021, p. 19). The level of investment in LAC suggests that there is a high degree of external dependence on science, technology and innovation, given that the region is mainly focused on the export of *commodities*.

"In the last two decades, 76% of the average GDP growth achieved in LAC was generated by employment accumulation and only 24% by labor productivity growth" (OECD, 2021, p. 21). This can be explained by the level of investment in R&D in the region compared to other regions. It is important to note that such investment is concentrated in Brazil, Mexico, and Argentina, which account for 88% of regional investment, while the rest of the countries of Latin America and the Caribbean accumulate 12%, meaning that the intra-regional gap in innovation becomes more significant (RICYT, 2021, p. 18).

For ECLAC (2021), the evolution of R&D spending in absolute terms between 2011 and 2019 was not homogeneous in the region, highlighting Cuba, Peru and El Salvador as the countries that steadily increased their investment to double it.

Another differentiating element between the LAC region and the rest is the distribution of R&D financing by sector. The greatest weight of financing falls on the government with 57% and in second place on companies with 37%, while in China companies finance almost 80% of R&D spending, and in the United States, the European Union and OECD countries, this indicator exceeds 60% (ECLAC, 2021, p. 20) and RICYT (2021), the sector where most of the funding for R&D is executed is Higher Education with 42%, with the government as its main source.

Meanwhile, foreign investment continues to be insufficient as a source of financing for R&D in the region, representing only 1% of total R&D investment in the region. These figures demonstrate the need to dynamize its productive sector, ensuring that companies occupy a greater space within the innovation ecosystem.

Despite the progress in science, technology and innovation shown by countries such as Chile, Mexico, Brazil and Argentina, the paradigm that science and technology is a matter for universities, while innovation is a matter for companies, remains latent in the region. This has resulted in: "projects with little funding, low socioeconomic impact and limited market access; a wide dispersion of projects, which hinders the creation of intensive innovation capabilities; prioritization of short-term projects, conditioned by political cycles, which do not address strategic thematic areas; and weak local capabilities to address priority challenges" (ECLAC, 2021, p. 13).

Therefore, achieving alliances and productive linkages between the different actors of the economy, where academia contributes with high value-added products through the different mechanisms of technology transfer will allow progress on the road to technological independence in the region, which is a pending challenge for most LAC countries.

In 2018, the region primarily funded basic research, while in the rest of the regions experimental development predominated, with Mexico and Argentina investing the most in this type of research. This is another behavior that must be modified in order to boost innovation in the region.

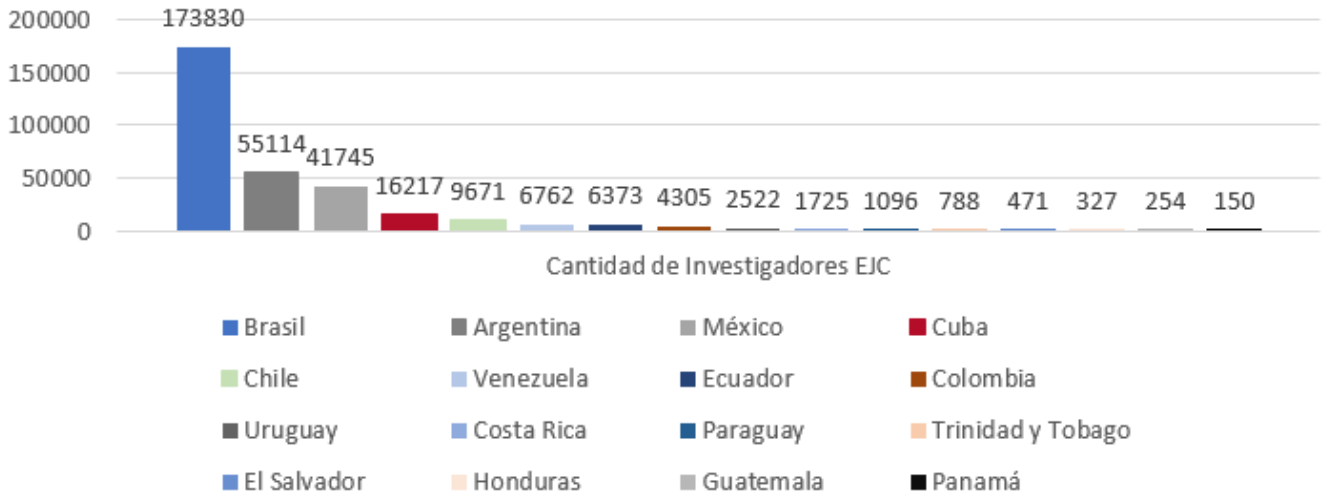
Another example of the differences in innovation within the Latin American and Caribbean region is provided by the Global Innovation Index (GII). According to WIPO (2021), Chile, Mexico and Costa Rica are the countries in the LAC region that occupy the Top Three innovation economies.

The ranking developed by WIPO (2021) does not include all the countries of LAC, so it is not possible to know the real development in innovation of the region or of each country individually, particularly Cuba, but it is possible to see the distances between the countries analyzed. Brazil should be highlighted as the country in the region that allocates the highest percentage of its GDP to R&D, but it is not the first in the *GII 2021*, this position is occupied by Chile. The effort of the countries to maintain the levels of investment in innovation has been significant, but they have been decreasing.

Since 2019, with the pandemic generated by Covid-19, the economic, political, and social situation in the region has deteriorated significantly, and therefore the resources to finance Research, Development and Innovation (R&D&I), including the strengthening of the institutional framework. According to ECLAC (2021), only 13 of the 21 countries studied have a ministry, an agency with ministerial rank or a body in charge of science, technology and innovation policies, Cuba being part of this group.

LAC GDP contracted by 6.8% (ECLAC, 2021, p. 9), generating devastating economic and social effects for smaller economies, increasing the poverty rate and unemployment in all countries of the region. "It is estimated that in 2020 the extreme poverty rate rose by more than one percentage point, to 12.5% of the population, and that the poverty rate rose by three percentage points, to 33.7%" (OECD, 2021, p. 15), but at the moment it is impossible to determine the actual effect of the pandemic on the regional economy and by country, the data available for analysis are from 2019 and those offered from 2020 are based on estimates.

Another comparative element is the number of researchers engaged in R&D activities. According to RICYT (2021), Asia, Africa and LAC were the regions that showed growth in the number of researchers. In the period 2010-2019 LAC went from 3.5% to 4% of the total number of researchers worldwide. Graph 1 shows the number of researchers in Full Time Equivalent (FTE) in some LAC countries.



Graph 1 - Number of researchers in Full Time Equivalency by country in LAC, year 2019
Source: Adapted from RICYT (2021), ONEI (2021)

"The number of FTE researchers in Ibero-America has experienced a growth of 37% between 2010 and 2019, from 422676 to 580072" (RICYT, 2021, p. 12), and as shown in graph 1, Cuba was in 2019 among the five countries with the highest number of FTE researchers. Despite the increase in FTE researchers, the gap between LAC and the rest of the world's regions remains significant, even within the region. Beyond the number of inhabitants per country, it is a reality that there is much work to be done to increase these figures.

Encouraging the incorporation of professionals in R&D&I activities, as well as increasing the number of graduates in related careers and reducing the migration of professionals to other sectors or countries are essential objectives for LAC if it is wanted to improve innovative capacity and productive linkages, where innovation is the center of the ecosystem in a sustained manner over time, which would contribute to the development of each country.

The Covid-19 pandemic has highlighted the lack of professionals in such important sectors as health, biotechnology and pharmaceuticals, to mention those directly related to the disease. This has led to the collapse of most LAC economies, mainly in the health sector. It has also significantly affected other sectors such as education, agriculture and energy, among others. One of the problems in LAC, aggravated by SARS-CoV-2, lies in the need to draw up public policies that link R&D&I activities in a comprehensive manner in all sectors of the economy in order to face future crises, health or otherwise, in a proactive manner (ECLAC, 2021).

It should be noted that, in the case of patents, LAC has decreased this indicator from "2.8% in 2010 to 1.6% in 2020" at the global level (ECLAC, 2021, p. 27), with foreign applications dominating over regional ones, reaching values of 92% in 2019 as is the case of Mexico. This behavior reinforces the argument that developed countries continue to dominate the production of patentable technologies worldwide, with the United States standing out as the main non-resident applicant.

Despite the efforts made by the region to increase results in science, technology and innovation, there are a group of elements that continue to have a negative impact on its development, which were present long before the pandemic.

For example, the lack of continuity and coherence in science, technology and innovation policy due to the change of governments, as well as the absence of formal documents defining the policy to be followed and differences between countries in terms of the institutional framework responsible for guiding and controlling this activity. On the other hand, in LAC there is a need to "direct public support in the field of science, technology and innovation (or at least part of it) towards areas of knowledge related to the main challenges faced by each country" (ECLAC, 2021, p. 32), and the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) constitute a guide in this regard.

Innovation in Cuba: policy, regulatory framework and main indicators

Following the analysis of LAC, a study was made of the Science, Technology and Innovation Policy, the regulatory framework and the main indicators of innovation activity in Cuba. The results obtained are presented below.

Unlike most countries in the LAC region, Cuba has prioritized social development in its policies since 1959, linking it to economic development and placing it at a higher level within development itself. Subsequently, these concepts were linked to science, technology and innovation as a fundamental means of achieving development. However, to date, numerous obstacles have had to be faced that have affected the country's development in every sense, among which are: the sustained intensification of the economic, commercial and financial blockade imposed by the United States; the collapse of the socialist camp in the 1990s and its consequences for the national economy; the world economic crisis of 2008; and, most recently, the Covid-19 pandemic.

A clear effect of the pandemic and the tightening of the blockade has been the decrease in GDP as of 2019, reaching a rate of -10.9% in 2020 according to ONEI (2021), higher than the contraction of LAC GDP. In the specific case of science and technological innovation activity, it shows a growth of 0.3% in 2020, being one of the three economic activities that grew from one year to another. Conversely to the decrease in GDP and the situation generated by Covid-19, the unemployment rate in Cuba for 2019 was the lowest in the region, going from 1.2% to 1.4% in 2020, a non-significant increase if it is considered the values reached and estimated for LAC.

The crisis generated by the pandemic, together with the intensification of the blockade and the undesired effects of the economic reorganization, caused havoc in all sectors of the economy, being more significant in the health, social and economic sectors. The government focused its resources on these three spheres to avoid the collapse of the country. A group of measures was taken to preserve the health of the population, as well as the most important social services to protect the most vulnerable sectors of society, and to avoid further shortages in all the country's commercial networks.

A clear reflection of the role of science, technology and innovation in Cuba during the pandemic is that it has become one of the few countries in the region to have its own vaccines against Covid-19 and to be one of the countries with the highest percentage of the population vaccinated. Two of the reasons for this achievement are the development of its biotechnology industry and the level of preparation of the country's professionals in the sector. According to ONEI (2021), in 2020 there were a total of 89391 physical workers in science, technology and innovation (STI) activities, of which 52646 with higher education, showing a decrease in this figure with respect to the previous year. At the same time, of the professionals with a higher level, 1120 were specialists in advanced technologies with the highest category and 15796 were FTE researchers.

Another fundamental reason has been the importance given by the government to the linkage with science, technology and innovation, involving the most important Cuban scientists in the decision-making process to face the crisis, as a result of a change of approach in the type of management to be implemented by the government. This new approach promoted by the President of the Republic establishes a model of innovation-oriented government management that encompasses all levels of management and society (Díaz-Canel Bermúdez & Delgado Fernández, 2021). Moreover, "the extension to other sectors of the economy of the Government Work System oriented to Science and Innovation has increased the visibility of other scientific fields such as agricultural sciences,

engineering and technology, social and humanistic sciences, and natural and exact sciences" (Rodríguez Batista & Núñez Jover, 2021, p. 10).

The Cuban government has implemented policies aimed at the development of science, technology and innovation with national scope since 1959. It was Fidel Castro Ruz in 1993, President of the Councils of State and Ministers at that time, who defined that the future of the Cuban nation was not in the production and export of *commodities*, but in the development of a society of men of science and based on knowledge. As part of the construction of this society, institutions were created which, following the evolution of science, technology and innovation activities, today make up the Science, Technology and Innovation System (SCIT), which implementation began in 1996 after the creation of the Ministry of Science, Technology and Environment in 1994.

Núñez Jover and Montalvo Arriete (2013, pp. 44-47) state that the main problems of both the policy and the SCIT in the period 1995-2010 were: "weak interaction between R&D and production, and insufficient demand from the business sector to the research sector; insufficient legal-methodological basis of the SCIT; insufficient financial resources in foreign currency; insufficient scientific-technical information and limitations in access to national information networks and the Internet".

The updating of the Cuban economic, political and social model is an example of continuity in government policy, reflecting the will to achieve economic and social development based precisely on science, technology and innovation. Since the VI Congress of the PCC, important challenges have been posed and great expectations were generated, approving guiding documents linked to each other, for the economic and social development of the country, which were updated during the VIII Congress held in 2021, and contain the innovation policy of the nation. This science, technology and innovation policy is aimed at eliminating the deficiencies inherited from previous stages and to boost the role of this activity at all organizational levels and sectors of the economy.

One of the most important transformations that took place as a result of the updating of the Cuban economic, political and social Model of socialist development (hereinafter the Model), was the need to submit the Constitution of the Republic of Cuba approved by a majority of citizens in 2019 to a referendum, in order to contextualize the magna carta in view of the needs of a change that would lead to the economic and social development of the Cuban nation.

The 2019 Constitution, in its Title II Economic Foundations, Article 21: "The State promotes the advancement of science, technology and innovation as essential elements for economic and social

development. In turn, it implements forms of organization, financing and management of scientific activity; it favors the systematic and accelerated introduction of its results in productive and service processes, through the corresponding institutional and regulatory framework" (National Assembly of People's Power, 2019, p. 75).

Therefore, since the Constitution is the supreme law of the country, the government is obliged or compelled to generate changes in the current policy and legal framework directly or indirectly related to science, technology and innovation activities that imply a brake on economic and social development, a limitation pointed out in Núñez Jover and Montalvo Arriete (2013). In the three guiding documents analyzed, specifically those approved after the VII Congress of the PCC, the importance of innovation for the economic and social development of the nation is established.

In the case of the Model, Chapter III defines that: "In the planning of economic and social development, the training, qualification and integral management of human potential, as well as the role of science, technology and innovation at all levels are placed in the foreground, with a vision that ensures the short and medium term fulfillment of the strategic objectives" (PCC, 2021, p. 37).

For its part, the PNDES states that it is necessary to "perfect and enhance the institutional framework in which science, technology, innovation and rationalization are developed, as well as to generate an environment where innovation systems play a key role in raising the impact of knowledge and qualification on the country's economic and social development with better moral, social, material and scientific recognition of human potential" (PCC, 2017, p. 19).

Finally, in the case of the Guidelines, since the VI Congress of the PCC, guidelines have been approved for three periods: 2011-2016; 2016-2021; and 2021-2026. These constitute a guide in the search for short, medium and long term solutions to the problems affecting the country. From one period to another, guidelines have been modified, deleted or added. In the document corresponding to the 2021-2026 period, 15 guidelines related to the Science, Technology, Innovation and Environment Policy can be found in Chapter V.

As part of the updating of the model, a fundamental step was to broaden the typology of the forms of ownership and management, recognizing them as economic actors interacting with their environment under similar conditions. Another important step was to foster the emergence of "entrepreneurial or budgeted organizations in charge of scientific activities that guarantee the combination of research and technological innovation, the rapid, efficient and effective increase of

new products and services, with recognized quality standards and effective internal and external marketing management" (PCC, 2021, p. 25).

The objective, or rather the challenge, imposed by the policy is to promote the creation of organizations with a strong focus on innovation, making them sustainable, environmentally friendly and, at the same time, capable of generating a spillover effect to other sectors, helping their development, with their scientific and technological results, in line with the proposals of ECLAC (2021) and the SDGs. Thus, the PNDES recognizes within the third general objective of the strategic axis Human potential, science, technology and innovation, the need to generate our own technologies to achieve technological sovereignty, an indispensable element to advance as a country in search of development according to Amin (1978).

The updating of the policy seeks greater cohesion of the SCIT, based on the application of regulations that promote the fulfillment of these objectives, establish the limits, those responsible, and do not hinder the execution of each of them, as well as an entity to guide and control their implementation. This situation differs from the scenario existing in most countries in the LAC region according to (ECLAC, 2021).

For Díaz Fernández (2019), despite the policies outlined, there is no development strategy based on innovation and the National Economic and Social Development Plan until 2030 falls short of meeting this need because it groups it with human potential, science and technology. Innovation must be addressed with an integrative, systemic and transversal approach, principles that have been taken into account in the conception of the new government management model (Díaz-Canel Bermúdez & Delgado Fernández, 2021).

Since the celebration of the VI Congress of the PCC, a group of legal provisions was put into effect that respond to the provisions of guideline 130, and, after the updating of the guidelines in the VII Congress of the PCC, in 99, as well as in article 21 of the aforementioned Constitution. Most of these provisions are aimed at the organization, definition and control of the entities and research personnel that make up the Science, Technology and Innovation System, updating the existing ones and/or approving new ones.

The legal norm with the greatest conceptual weight approved is Decree-Law 7/2020 of the Science, Technology and Innovation System (Rodríguez Batista & Núñez Jover, 2021, p. 8) with its corresponding regulation contained in Decree 40/2021. Article 2, subsection a, defines that the SCIT

is aimed at "increasing the contribution of science, technology and innovation, to economic, social and environmental development, through the integration between its components and the requirements of society" (p. 2604). For Rodríguez Batista and Núñez Jover (2021, p. 10) the main contribution of the norm is "to include for the first time the definition of SCTI in Cuban conditions, recognizing the social actors that are related to STI activity, their interactions, the corresponding legal-methodological basis, as well as its expression at the national, sectoral and territorial levels".

Other regulations to be highlighted are Agreement 156/2021 which approved the creation of the National Innovation Council, which consists of a regulation issued through Presidential Decree 262/2021 published in the Official Gazette No. 44 Extraordinary of May 28, 2021 and Decree-Law 28/2021 On the Technical Advisory Councils. Issued by the Council of State published in Official Gazette No. 24 Ordinary of March 5, 2021. These are spaces for concertation on science, technology and innovation policies that cover all management and organizational levels, contributing from their level of action to the development of this activity. These are another step towards strengthening and consolidating the SCIT, which also contributes to the conception of innovation policy at the national level in the not too distant future.

The involvement of the country's top management in all decisions related to science, technology and innovation activities facilitates the path to achieve the economic and social development so necessary for the Cuban nation.

As part of the process of strengthening the SCIT, other legal norms are approved that break with "the deep paradigm that limited -without explicit norm that prevented it- the participation of a Budgeted Unit, in particular a University, as a shareholder in a Commercial Company, which creates better conditions for a more effective progress in the University-Company interaction" (Rodríguez Batista & Núñez Jover, 2021, p. 11).

Examples are Decree No. 363/2019 On Science and Technology Parks and Science and Technology Enterprises that function as an interface between universities and science, technology and innovation entities with productive and service entities approved by the Council of Ministers published in Official Gazette No. 86 Ordinary of November 8, 2019 and Decree 2/2020 On High Technology Enterprises published in Official Gazette No. 16 Ordinary of February 26, 2020.

These regulations are based on Decree-Law 323 On Science, Technology and Innovation Entities, published in the Official Gazette No. 37 Extraordinary of August 29, 2014 issued by the Council of

State. Thus, two resolutions issued by CITMA were published in the same gazette that modify those in force, resulting from the approval of Decree 363/2019. These are: Resolution 286/2019 "Regulations for the organization and operation of the national registry of science, technology and innovation entities" which repeals Resolution 164/2014; and Resolution 287/2019 "Regulations for the system of programs and projects of Science, technology and innovation" which repeals Resolution 15/2010 and Resolution 44/2012.

Decree 363/2019 is an important step in updating the Science, Technology and Innovation System and its structures, because it allows the incorporation of organizations whose main function is to enhance science, technology and innovation, such as Science and Technology Parks (PCTs in Spanish) and business enterprises, which had not been recognized before in any regulation. This document defines the basic functional areas of the parks, defining two: innovation areas; and enterprises incubators.

However, throughout the document, reference is only made to incubators on one occasion and incubation on two, always linked to the PCTs, and they are not identified or conceptualized as an actor that can function independently of the PCTs, an aspect that may hinder the development of projects in those universities that do not have the conditions to create one. Another figure within the norm are the interface enterprises, which by their concept come to replace the Research Results Transfer Offices, an entity that was part of the structure of some Cuban universities such as the University of Havana, finally providing them with a legal personality and entrepreneurial functions.

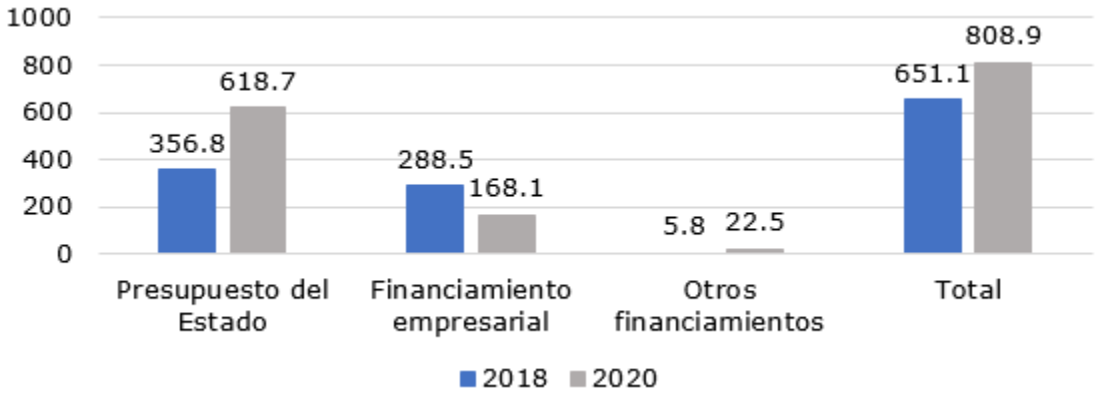
Direct results of the implementation of Decree 363/2019 include the approval of: two PCTs (Havana Science and Technology Park and the Matanzas Science and Technology Park S.A.); four interface companies linked to universities; and the University Foundation for Innovation and Development of the University of Havana. In contrast, the country has more than 50 universities, which means that there is potential to create new entities that promote innovation and university-industry linkages. An important aspect of the regulation is that it opens the door to the creation of technology-based enterprises or university spin-offs as another mechanism for technology transfer from universities, leaving legal and methodological gaps to be solved that require their own regulations given the complexities involved in this type of organizations, particularly financing funds.

Taking into account that the regulations offer more advantages than disadvantages, it is essential that the universities, together with CITMA and the sponsors, before defining the type of organization

to be used for the promotion of innovation, define their real capacities, their human and material resources, real and potential, in order to know the type of innovation to be promoted. It should be taken into account that an organization can be strong innovating processes or services, and not necessarily in disruptive, radical technology (Guerrero & Urbano, 2016).

This regulation has only been in force for two years, and no research has been found that addresses its effectiveness in practice, nor the performance of these new organizations. Despite this, it is expected that they will have an impact on the purchasing power of researchers and that one of their effects will be to reduce the exodus of professionals, mainly from higher education, to other sectors of the economy or other countries. This should lead to an increase in the participation of the business sector in the financing of innovation; and reduce the weight that the state currently has as the main investor in science, technology and innovation activities. At the same time, other sources of funding for research are defined as foreign organizations (governmental, business, academic, non-governmental organizations, among others).

Graph 2 shows the behavior of spending on science and technology activities by funding source for the years 2018 and 2020.



Graph 2 - Current expenditures on science and technology activities by source of financing (millions of Cuban pesos)

Source: Adapted from Anuario Estadístico de Cuba 2020. Science and Technology (ONEI, 2021, p. 9)

Graph 2 shows that, instead of decreasing, there was a significant increase in the state budget aimed at financing science and technology activity, and a contraction in the participation of the business system, which is in line with the behavior of this indicator in the LAC region. For its part, the item

Other sources grew more than twice in 2020 compared to 2018 and this is where foreign organizations are encompassed. The yearbook does not break down this item by type of source, so it is not possible to define the real share of foreign investment within current spending on science, technology and innovation activities. One of the possible reasons for the increase in the state's share of the budget is the country's strategy for confronting Covid-19. This strategy has yielded numerous scientific results, including the creation of five vaccine candidates in record time, two of which are already vaccines, and the national production of artificial respirators, among others.

Total expenditures on science and technology reached 969 million of Cuban pesos in 2020, showing an increase of 269.9 million over the previous year. According to ONEI (2021) this money is distributed in: Research and development (556.5 million of Cuban pesos); Innovation (38 million of Cuban pesos); and Other scientific and technological activities (374.5 million of Cuban pesos). The distribution of spending by type of research follows the same pattern as in LAC, with basic research having the greatest weight. The Statistical Yearbook of Cuba in its 2021 edition, for the first time, has disaggregated innovation activity from the heading Other scientific and technological activities in response to the "new Subsystem of Complementary Statistical Information, approved in Resolution No. 366/2020" (ONEI, 2021).

It should be noted that in the introductory section of Chapter 16 Science and Technology, where the definitions of concepts and indicators are presented, this report does not include the concept of innovation, an important element for identifying what this new item would contain.

Finally, some important performance indicators should be addressed when measuring the innovation capacity of a country or region related to the generation of patents and publications. Cuba, like the LAC region, shows a predominance of non-resident applications, reaching 69.7% of total applications in 2020 (ONEI, 2021). However, the dependency ratio has shown a continuous decrease in the last five years, from 5.09 in 2016 to 2.30 in 2020. It should be noted that the yearbook does not make a disaggregation of the sectors, nor of the national organizations that apply for and are granted patents, nor does it contemplate Cuba's grant and applications in other countries and regions.

Some factors that may limit this activity are: lack of financing; insufficient training of specialists in innovation management, particularly in the enterprise sector; insufficient use of the figure of the science, technology and innovation manager (Rodríguez Batista & Núñez Jover, 2021); decrease in the number of researchers linked to science, technology and innovation activity; among others.

Another regulation approved during the period analyzed and aimed at improving the situation of the results of science, technology and innovation activity is Resolution 287/2019. This is a regulation that seeks to improve the system of science, technology and innovation programs and projects, the remuneration and incentives for participation in science, technology and innovation projects, and to make viable the access to different sources of financing for the execution of these. However, the results obtained will depend on the efficient management of the participants in the projects, their capacity to establish links with different national and foreign organizations, among others.

Taking into account the above analysis, it can be stated that innovation is an indispensable element for the economic and social development of a country or region, but it is not enough. The Latin American and Caribbean region, especially countries like Cuba with structural deformations in its economy and lack of natural and financial resources, is called to generate policies that promote innovation and strengthen the institutional framework created at all levels and sectors, and to establish alliances between the actors of the innovation ecosystem, whether national, intra-regional or inter-regional.

In the case of Cuba, the evolution of the Science, Technology and Innovation Policy can be seen, being formal, coherent and continuous, where the strengthening of the institutional framework has been the focus of attention of most of the regulations issued in the last decade. The path of updating the science, technology and innovation policy initiated in 2011 still presents pending tasks, but there have been important advances that allow us to think about the approval in the not too distant future of a policy and specific rules to consolidate a national innovation ecosystem, and to identify within this the existence of various ecosystems such as the university entrepreneurship ecosystem.

The behavior of the indicators related to innovation, specifically the distribution of total expenditure by source of financing for science, technology and innovation activity and patents applied for, is similar for Cuba and the rest of LAC. Most of the region's investment in R&D was concentrated in Mexico, Chile, Brazil and Argentina, and the establishment of the institutional framework in charge of science, technology and innovation activity has not had the same development and importance for the countries of the region.

In the particular case of Cuba, due to the crisis situation generated by Covid-19, the tightening of the economic, commercial and financial blockade, and the implementation of the economic reorganization, the successful implementation of the Science, Technology and Innovation Policy

becomes more urgent. Cuban policy and legal norms on innovation recognize the link between innovation and economic and social development, a fundamental factor being the government's willingness to foster the adoption of strategies and mechanisms to promote and generate science, technology and innovation activities at all levels and in all sectors of the economy.

In the last two years, the largest number of measures have been approved to strengthen the Cuban SCIT, incorporating and recognizing actors such as the PCTs, structures used worldwide by governments, universities and companies for several decades to promote and manage innovation. It is important to make public the results of these spaces and evaluate their performance, because making Cuba's potentialities visible is another way to attract potential commercial partners.

In each of the guiding documents analyzed, the importance of human potential is highlighted as a fundamental figure in achieving the objectives set. Regulations have been approved aimed at increasing the income received from science, technology and innovation activities carried out by researchers, as well as promoting training within and outside the national territory, among others.

However, the exodus of professionals to other sectors and the emigration of professionals, including young recent graduates, are problems that can negatively affect the functioning of the SCIT and the success of the policy. Therefore, it is necessary to have an evaluation and control system for the policies implemented, and at the same time to conduct research to identify the needs, aspirations and proposals of young people and professionals linked to science, technology and innovation activities.

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Authors' contribution:

Susana Reyes Díaz wrote the manuscript and approve the version finally submitted.