www.revistageintec.net
ISSN: 2237-0722
revista GEINTEC Gestão, Inovação e Tecnologias

Evolution of Innovation Indicators in Peru

Jessica Acevedo-Flores[1]; John Morillo-Flores[2*]; Linda Shardin-Flores[3]
[1]Universidad Privada San Juan Bautista, Perú.
[1]https://orcid.org/0000-0002-0050-7886
[2*]Universidad Privada San Juan Bautista, Perú.
[2*]john.morillo@upsjb.edu.pe, https://orcid.org/0000-0002-2136-4458
[3]Universidad Privada San Juan Bautista, Perú.
[3]https://orcid.org/0000-0002-1279-8975

Abstract
A country's economy, in terms of productivity, poverty reduction and sustainable development, is related to its progress in innovation; therefore, it is of special interest to analyze and compare the indicators that measure innovation capacity. This study examines the evolution of innovation in Peru in recent years. A systematic search was conducted for data related to innovation indicators from the competitiveness rankings of the World Economic Forum, Ricyt, Indecopi, Sunedu, OECD, Concytec, Consejo Privado de Competitividad, among other organizations that evaluate global or regional performance. The results indicate that, during the last decade, Peru has shown some improvements in innovation; the number of patents granted has shown sustained growth, especially in universities; however, most of the indicators have not shown regular behavior, and some even showed drops. Likewise, Peruvian performance is still limited, especially when compared to other countries in the region such as Chile and Colombia, South American partners in the Pacific Alliance. In conclusion, despite Peru's remarkable macroeconomic growth in recent years, as well as the increased budget allocated to STI, the legal framework for intellectual property, the PCT system, university reform with research incentive policies, among other factors, Peru's performance in innovation has not reached the expected values, nor has it shown sustained and regular growth.

Key-words: Indicator, Innovation, Research, Patent, STI.

1. Methodology

A systematic search was carried out in order to compile all historical data on innovation indicators for Peru as well as for countries in the region with similar realities, especially taking into account Chile and Colombia, Peru's partners - in addition to Mexico - in the Pacific Alliance.

In the present study, indicators that measure knowledge transfer were considered as those that serve as a reference since they constitute the innovation pillars of the global competitiveness assessment, such as the GCI and GII. In particular, the information provided by government institutions in Peru, the National Institute for the Defense of Competition and Protection of Intellectual Property (Indecopi), the Private Competitiveness Council, the National Council for Science and Technology and Technological Innovation (Concytec), as well as taking into account the same instruments used by the National Superintendence of Higher Education (Sunedu) are taken into account. Additionally, the indicators compiled by the Ibero-American Network of Science and Technology Indicators (Ricyt) are considered to evaluate and report on research progress in Peruvian universities in terms of research products embodied in inventions and innovations that are formalized and measured by the number of patents.

2. Introduction

According to the Oslo Manual (2005), innovation is "the introduction of a new or significantly improved product (good or service), process, marketing method or organizational method in the company's internal practices, workplace organization or external relations". Innovation is based on learning insofar as it is linked to the transforming action of the world; it has a deep sense of change because it generates characteristics that do not occur spontaneously.

The triad of science, technology and innovation (STI) is a factor that affects a country's productivity levels (ECLAC, 2010). In fact, there is a positive and close relationship between innovation and productivity itself, as evidenced in the annual reports published by the World Economic Forum (WEF), which measures average productivity per worker through its Global Competitiveness Index (GCI) and the development of innovation through the Global Innovation Index (GII) reported annually by the group formed by Cornell University, the European Institute of Business Administration (INSEAD) and the World Intellectual Property Organization (WIPO). According to the Organization for Economic Cooperation and Development (OECD) (2005), the three elements, STI and its relationship are basically based on knowledge: generation (science), application (technology) and commercialization (innovation), indispensable aspects for the development and economic growth of a country (Private Competitiveness Council, 2020).

Progress in STI is generally measured by comparing a country's investment in research and technological development (R&D) (Concytec, 2016; OECD, 2015). There are studies where it is shown that promoting a favorable environment for STI development has a favorable impact on

economies at a global level, specifically, on poverty reduction and sustainable development (Coe and Helpman, 1995) with a positive impact on people's quality of life; since, as indicated by UNESCO, investing in STI is fundamental for economic development and social progress. On the contrary, according to figures from the Inter-American Development Bank (IDB), a low level of investment in R&D is one of the factors causing productivity gaps between developed and developing countries.

Among the main social actors involved in innovation processes are companies, academia and the State. Each of these actors must fulfill their role: companies must invest in scientific production in order to increase productivity; universities must increase their theoretical and empirical knowledge base in order to create new concepts and products and thus increase productive capacity, either directly or indirectly. And finally, the State must, through appropriate incentives, promote innovation activities by investing in the formation of human capital in universities, granting effective recognition to researchers, as well as through subsidies, direct government production, mechanisms for defining intellectual property rights and creating tax incentives to finance R&D and innovation in companies.

Talk of innovation is generally measured by patents, which include inventions, utility models and industrial designs. Patents derive from the evaluation to which research is subjected from two sources: resources and results. The first groups together all the necessary elements (financial, human and bibliographic resources) to generate quality research (Hackett et al., 2008). In the second instance, there are the results or products of research, patents and publications; the latter comprise all written scientific documents, such as articles, books, book chapters, among others, in which the terms of the research, the method used and the findings obtained are detailed; they are generally published in specialized journals. Patents correspond to the recognition of the intellectual property of an invention or innovation from which marketing and production rights are granted at national or international level. In Peru, patents are registered at Indecopi.

In Peru, the most recent University Reform process began in 2014, within the framework of University Law 30220, which establishes academic quality, research and innovation as principles and purposes of the university (Law 30220, 2014). According to the former director of Concytec, with the implementation of Law No. 30220, the State, in its different instances, such as ministries and executing units, has increased investment in STI with respect to other periods, between 0.15% and 0.2% of GDP, a figure below the OECD countries that on average are reaching 4.5% of GDP or even lower than that recorded in countries in the region such as Chile or Colombia (La Cámara, 2020).

By stipulating, in the new University Law, that research is an essential and mandatory function of universities, it was established that they must be established as academic communities oriented to the generation of knowledge. Consequently, national policies for the improvement of

education and national development include the promotion of university research as part of their strategy. Likewise, the instruments that make up such policies agree that universities must comply with the following: develop research institutes and innovation centers, train competent professionals and researchers, and respond to the needs of the national reality (CEPLAN, 2010; Concytec, 2013; Minedu, 2015).

Before the University Reform, between 1973 and 2014, patents processed, according to the type of national applicant, were distributed as 24% companies, 3% universities and 1% research centers. However, it is important to indicate that in countries with a higher degree of scientific, technological and industrial development, it is the companies that represent the great mass of economic agents that turn to the patent system. This is due to the fact that the initiative to innovate really arises from economic studies, the advance of globalization, the opening of markets and commercial integration between countries, which make innovation a survival necessity for social actors (professionals, companies, universities and other institutions). Those who do not innovate or do not update their knowledge will probably be displaced or expelled from the market by their peers who bet on innovation; these are the rules of competition and sustainability that dominate markets today (Cabrales, 2008 and Villarán de la Puente, 2015).

In addition, it is important to take into account what happened in 2020, the year in which the health crisis caused by covid-19, the disease produced by the new coronavirus (SARS-CoV-2), reached pandemic status and became the most important global public health emergency of the last century (WHO, 2020). This situation has been negatively affecting global development in all important aspects of the social spectrum, health, economy, education. The GCI rankings, produced annually by the WEF, have been suspended in 2020 and its analysis has focused on outlining a set of priorities related to recovery and revival, assessing the elements that helped countries to manage the pandemic more effectively, concluding that "countries with advanced digital economies, consolidated social safety nets and robust health systems are those that have managed the impact of the pandemic most effectively" (WEF, 2020).

3. Innovation Indicators

Due to the need to measure and compare developed and developing countries, the development of different types of innovation indicators has been encouraged to accurately assess the performance of each country or region. Indicators provide information that simplifies reality by extracting data and revealing trends. They are derived from statistical data and provide warning

signals for decision-making and early action, as well as periodic comparisons, sorted in orderly order (Lizuka and Hollanders, 2017).

There are several types of innovation indicators: the first made up of existing data and statistics especially to measure the creation, diffusion and flow of knowledge (R&D, publications, citations, patents, human resources in STI, among others); second the innovation survey (product, process, organization, business model and sources of innovation) as defined in the Oslo Manual and, third, composite indicators (Global Competitiveness Index, Global Innovation Index).

The patent is the document that certifies the exclusive right granted by the State to the creator, author or owner of an invention, a utility model or a design that is considered unique and novel in a given geographical area. Likewise, the patent corresponds to the legal system established to protect inventions; the granting of a patent is the official recognition of the innovation, which grants exclusive intellectual property rights allowing only the author of an invention to exploit it and prevent a third party from using it for commercial purposes without his authorization for a certain time according to the laws and agreements governing the territory where the patent application is registered (WIPO, 2015; Sunedu, 2018). Additionally, the time granted to patent protection also varies according to the type; for the case of Peru, the duration of an invention patent is 20 years and that of a utility model patent, 10 years. In both cases, the period is counted from the filing date of the application.

The number of patents applied for and granted in a country constitutes an innovation indicator that makes it possible to approximate the level of development and technological progress achieved by a country. In addition, according to the Paris Convention, two types of protection are considered: invention patents and utility model patents (Villarán de la Puente, 2015). The requirement of the first type is that the products or processes meet three conditions of novelty (being new), inventive level (not being obvious or evident) and industrial application (being useful). On the other hand, the conditions for utility model patents are that the products only meet the criteria of novelty (being new) and technical advantage (functioning or utility different from what already exists).

The composite indicators considered in this study are the GII and the GCI. Both indices are taken from their respective reports, which are considered an important reference by the economies participating in the evaluation, as they allow them to identify weaknesses and -probably- adjust their comprehensive policies with the aim of improving them.

The total GCI index comprises twelve pillars, one of them being innovation, which, in turn, consists of sub-pillars that measure spending on patent applications, R&D, scientific publications,

among others. Peru has shown excellent results in macroeconomic terms in recent decades; however, these results have not been equally reflected in its innovation indicators.

The total GII index "reflects a deeper and more elaborate understanding of the innovation process and new trends in innovation in different countries around the world" (WIPO, 2011), it is based on two sub-indices: resources and results; each one comprises pillars or elements of the economy that make innovative activity possible, totaling seven innovation pillars, five related to resources for innovation and two related to results.

In addition to the aforementioned GII and GCI, there is a set of basic innovation indicators provided by Ricyt. A relevant indicator taken into account when evaluating the number of patents, since it can give an idea of the extent to which a country depends on inventions developed outside it, is the Dependency Ratio, i.e. the number of patent applications made by foreigners divided by the number of applications made by nationals. The higher this rate is, the greater the degree of dependence of the country in terms of technological innovation; consequently, in a model of a politically, economically and scientifically independent country, rates lower than 1 would indicate a preponderance of the use of technology produced within the country (Edsberg et al., 2001).

In contrast, the Self-Sufficiency Rate is a complementary index to the previous one and corresponds to the number of patents applied for by residents divided by the total number of patents applied for. It is important to consider that this value does not necessarily decrease due to a lower capacity of technology generation by the residents of a country; it has been the case that the values of this rate are diluted by a significant increase in the number of patent applications filed by foreigners or non-residents (Edsberg et al., 2001).

On the other hand, the Invention Coefficient refers to patents applied for by residents per 100,000 inhabitants, which is probably the index that best reflects technological innovation activity (Edsberg et al., 2001).

Finally, within the framework of the Patent Cooperation Treaty (PCT), Peru has adhered to this system of filing - not granting - patents, under the World Intellectual Property Organization (WIPO), which allows the streamlining of the application process in 153 countries (Edsberg et al., 2001 and Castro, 2020).

4. Innovation Indicators for Peru

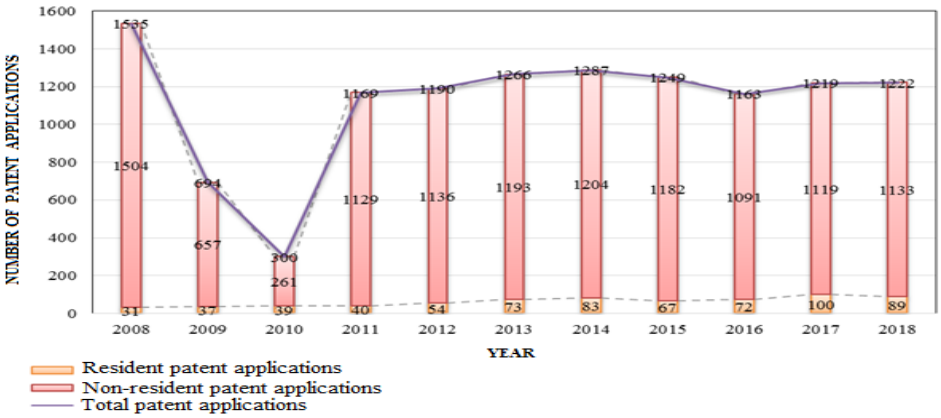
The following is an analysis of Peru's innovation indicators in recent years; first, the indicators compiled by Ricyt for the period 2008-2018 are taken. Graph 1 illustrates the evolution of

patent applications processed annually in the government office in charge, Indecopi. As shown, the year with the highest number of non-resident applications (1,535) was 2008, followed by a significant drop - to one-fifth - for two consecutive years, followed by a growth of approximately 290% in 2011, since then remaining above 1,100 applications per year. In contrast, patent applications by resident citizens were initially unaffected, presenting a sustained growth from 2008 to 2014, followed by an irregular behavior and reaching the maximum value of 100 domestic applications filed in 2017. It should be specified that the patent applications considered in this first analysis correspond only to invention patents.

Graph 2 shows the annual Dependency Rate comprised in the period 2008-2018, which when evaluated it is important to remember that it represents the degree of dependence of the country with respect to technological innovation and that, in the case of Peru, it has been decreasing since 2011 although not regularly in the last five years. As mentioned, this rate is positive as long as it is decreasing. In 2008, it reached its highest value; while in 2010, its lowest value; however, these results were mainly due to the fall in the number of non-resident applications and not due to a significant growth in the number of resident applications.

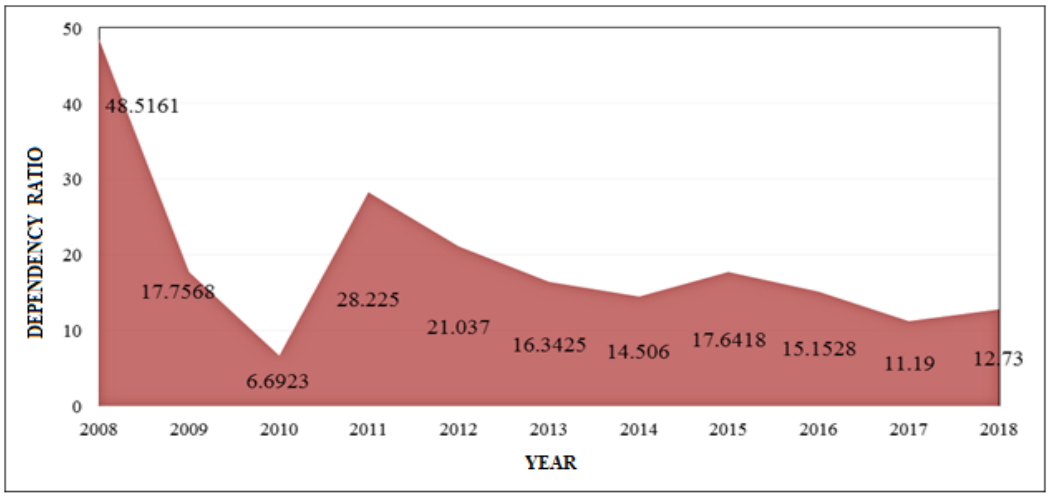
Peru's Self-Sufficiency Rate from 2008-2018 is shown in Figure 3 and is evaluated similarly to the Dependency Rate; however, contrary to the Dependency Rate, it is desirable that this indicator increases annually to indicate greater technology generation capacity. The highest self-sufficiency rate occurred in 2010 due to the large drop in the number of patent applications filed by non-residents, which is why the indicator can be evaluated more accurately in the last five-year period in which the ratio between the number of patent applications of non-residents and residents does not present variations as significant as those of 2009-2010, as shown in Graph 1.

Graph 1 - Number of Patent Applications in Peru, 2008-2018



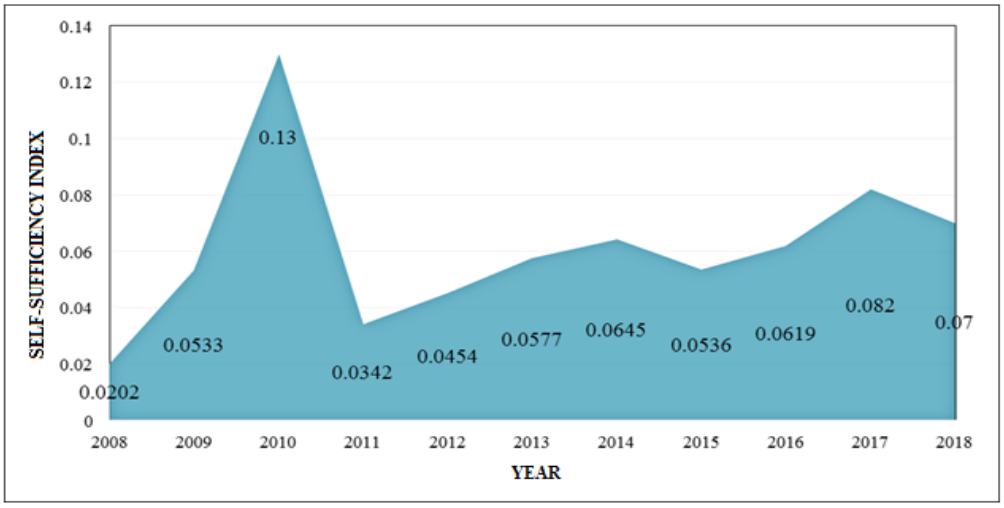
Source: Ricyt. Own elaboration

Graph 2 - Dependency Rate in Peru, 2008-2018



Source: Ricyt. Own elaboration

Graph 3 - Self-sufficiency Rate in Peru, 2008-2018

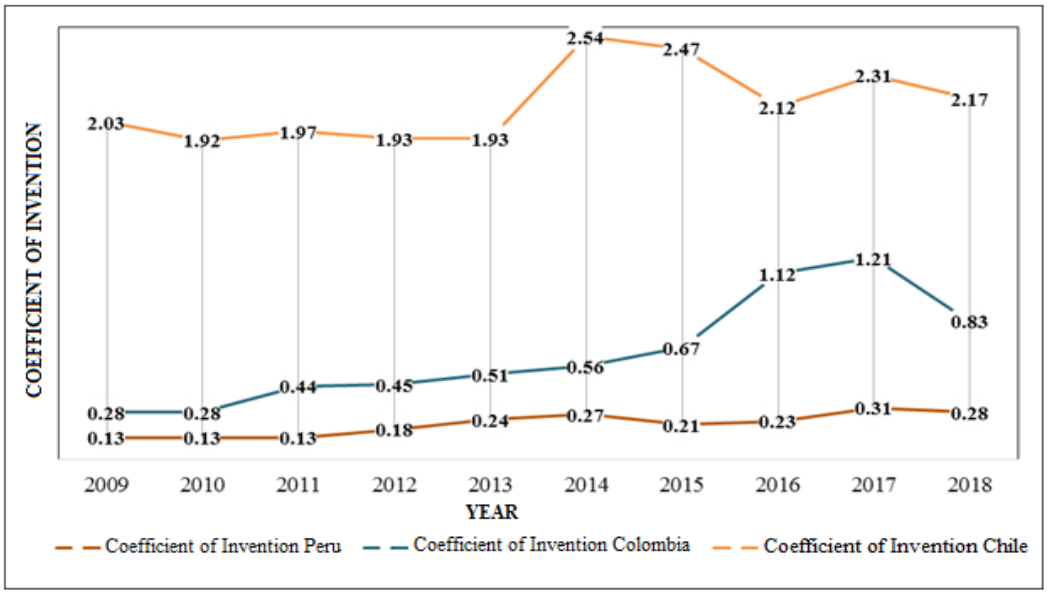


Source: Ricyt. Own elaboration

The Coefficient of Invention effectively reflects a country's technological innovation activity. Figure 4 shows the behavior of this indicator in the South American countries that are members of the Pacific Alliance, i.e. Chile, Colombia and Peru. As can be seen in the graph, Chile is the country with the highest innovation activity, well above Colombia and Peru. With respect to 2011, Peru has doubled its invention coefficient in 2018; however, its invention coefficient is approximately eight times lower than that of Chile and one third of the coefficient achieved by Colombia. The highest performance achieved by Peru in this indicator was in 2017 and was 0.31, while in the last five-year period reported (2014-2018) the average of this coefficient was 0.26.

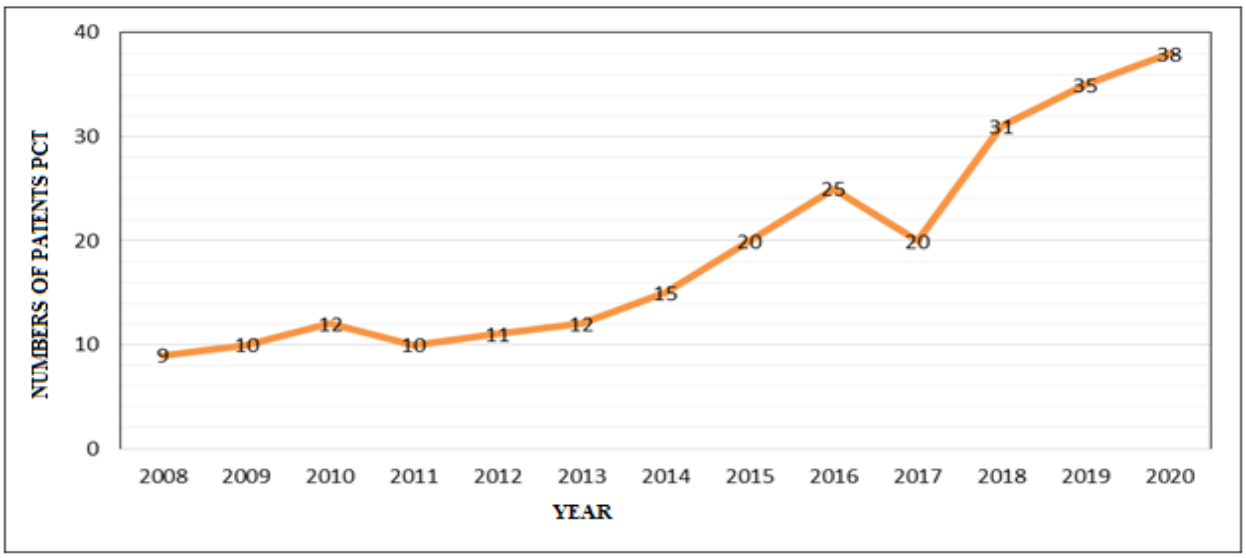
Regarding the number of PCT Patents (Figure 5), Peru maintained a sustained growth in the last decade, 2011-2020, despite a single 25% decrease occurred in 2017, followed by a 35.5% recovery in 2018, having quadrupled said indicator in the thirteen-year period between 2008 and 2020.

Graph 4 - Invention Coefficient of South American Countries of the Pacific Alliance, 2008-2018.



Source: Ricyt. Own elaboration

Graph 5 - Patents PCT, 2008-2020



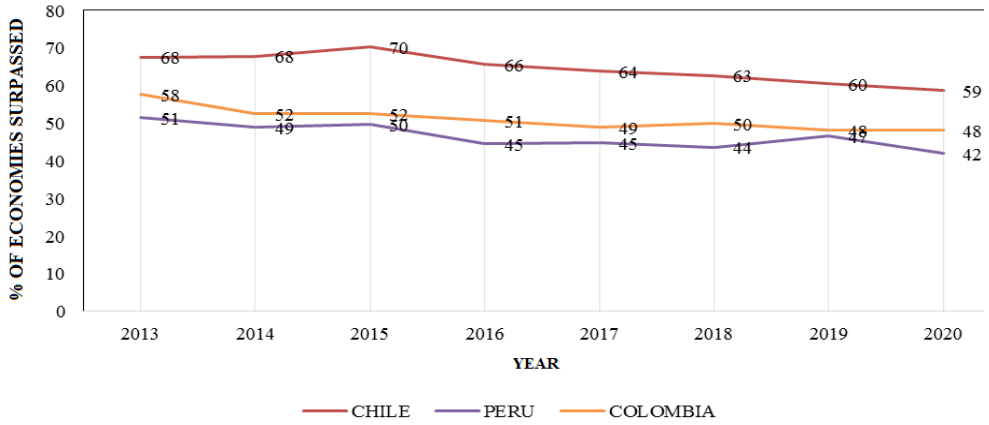
Source: Ricyt, Direction of Inventions and News Technologys (DIN) of Indecopi. Own elaboration

Regarding the GII composite innovation index, Figure 6 shows the overall performance of the South American countries that are members of the Pacific Alliance for the period 2013-2020. In this comparison, the results of Peru, Chile and Colombia are shown, taking as a reference their position in the global ranking and the percentage of countries they outperform. In the GII 2020, Peru is ranked 76th, dropping seven positions with respect to 2019, being above 42% of the countries evaluated; meanwhile, Chile, which ranked 54th, is above 59% of countries; and Colombia, ranked 68th, exceeds 45% of the 131 economies evaluated that year. Chile's superior performance in technological innovation over the last eight years is evident, placing it in the top half of the ranking; however, it is worth noting that since its best evaluation in 2015, when it outperformed more than a third of the countries evaluated, its results have been declining steadily, and it has no longer been in the top third in innovation since the last five years. Colombia and Peru have performed almost constantly and without abrupt variations in their positions; however, both obtained their best results in 2013, when they outperformed more than half of the economies evaluated, followed by a decline in their respective results.

With respect to the GCI composite index, Peru dropped two positions in the last published report, ranking 65th. Figure 7 shows the evolution in the period 2006-2019 of the innovation capacity pillar, in addition to two sub-indices or sub-pillars related to innovation: university-industry collaboration in R&D and business spending on R&D; similar to the GII analysis, the performance in a given index or sub-index refers to the percentage of economies evaluated and that are surpassed by Peru. Regarding the capacity to innovate, Peru does not manage to place itself in the upper average of the ranking and its performance even declined in the 2008-2017 decade, showing a recovery in recent years in which it has surpassed 36% of the countries in evaluation and occupies the 90th position in this pillar. Regarding the university-business collaboration in R&D sub-index, the performance is below two-thirds of the countries evaluated, a decade having passed since the best performance shown (rank 95th); in the Latin American region, this performance places Peru in 13th place out of 16. The sub-index of business expenditure on R&D is another Peruvian weakness in the innovation pillar, since, according to the ranking, Peru is among the 15 countries with the worst performance; that is, it is surpassed by 90% of the 137 economies evaluated, reaching its best performance in 2007 when it surpassed 44% of countries and ranked 74th out of 131 (16th out of 20 countries in the Latin American region). It is important to add that this sub-index, as of 2018, is evaluated differently, being now simply R&D Expenditure as a percentage of GDP; in this sub-index, Peru ranked 106th out of 141 economies under evaluation in 2019.

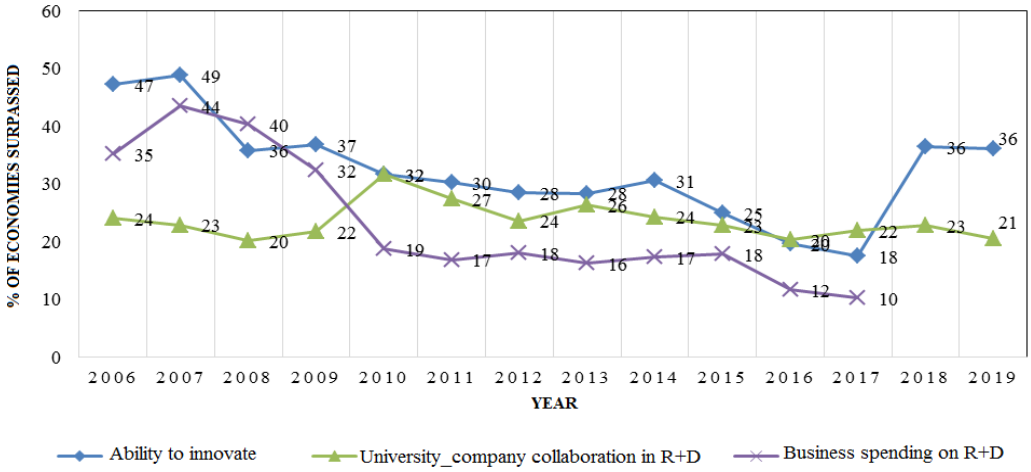
In the five-year period 2015-2019, there were a total of 2,605 invention patents (Figure 8) and 698 utility models granted in Peru (Figure 9); that is, a total of 3,303. In that period, patents granted to national applications for invention patents represented 5% (131) of the total granted, with an annual average of applications granted of 26.2. Regarding utility model patents granted in total in the last five-year period, they accounted for 88.25% (616) of the total, with an annual average of national patents granted of 123.2. In both types of patents, a sustained growth is seen both in domestic and foreign applications served and granted, except for the year 2019 in which the number of resident patent applications granted to utility models had a slight decrease (-6%) with respect to the previous year.

Graph 6 - GII of the South American Countries of the Pacific Alliance, 2013-2020



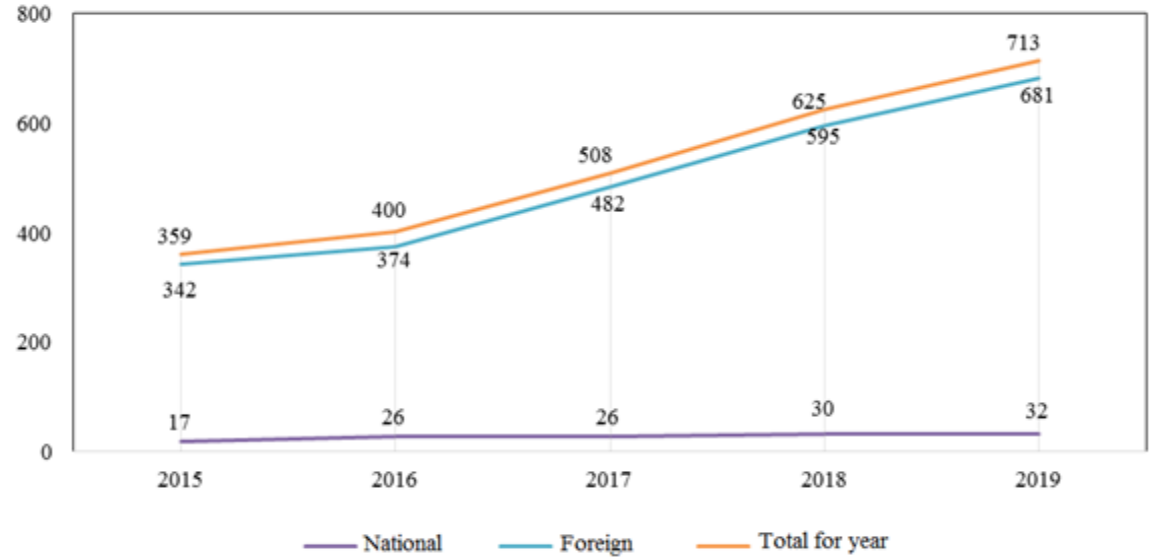
Source: GII Report. Own elaboration

Graph 7 - Peru's Performance in the Innovation Pillar of the GCI, 2006-2019.



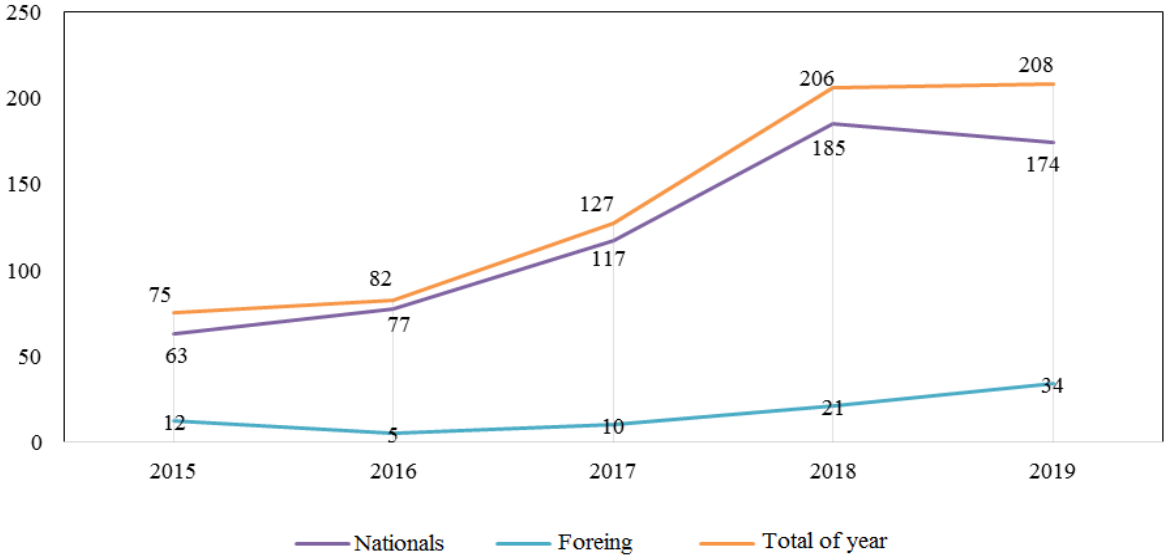
Source: GCI-WEF (report until 2019, as due to the Covid-19 pandemic no assessment was performed in 2020). Own elaboration

Graph 8 - Number of Invention Patents Granted in Peru, 2015-2019.



Source: Directorate of Inventions and New Technologies (DIN) of Indecopi. Own elaboration

Graph 9 - Number of utility model patents granted in Peru, 2015-2019.



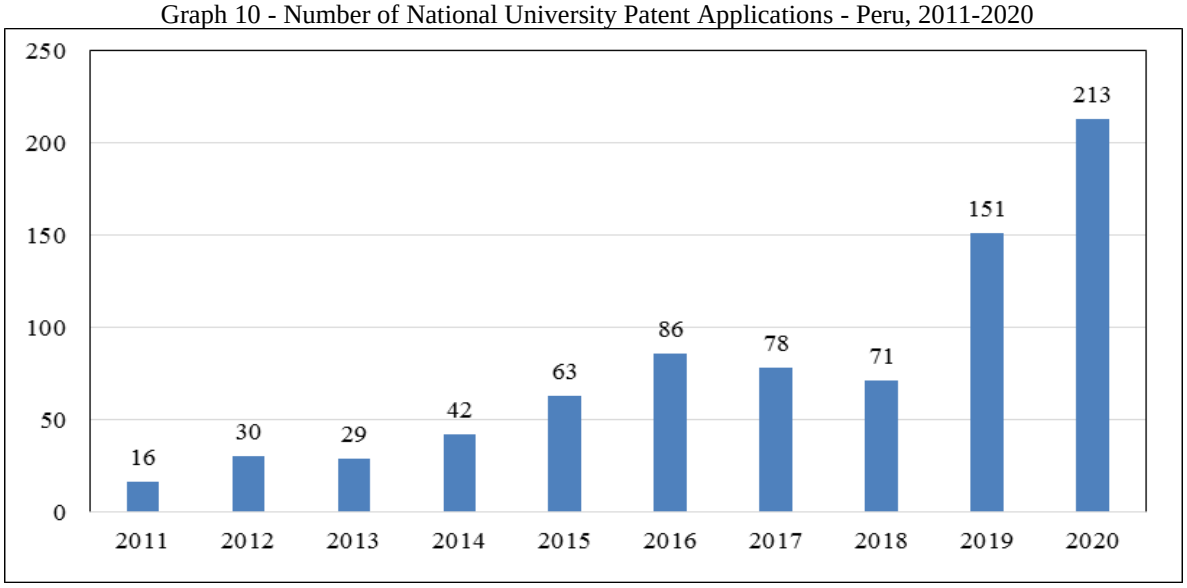
Source: Directorate of Inventions and New Technologies (DIN) of Indecopi. Own elaboration

Finally, it is important to analyze the innovation capacity of Peruvian universities, for which we consider the official data on patent applications in the country for the period 2005-2020. Figure 10 illustrates the evolution of patent applications filed with Indecopi by universities. Before 2011, the total number of patent applications was less than 10, producing a sustained growth between the years 2011 and 2016 of the same that increased from 16 to 86, passing through another irregular period (2017-2018) in which they decreased to then increase again in 2019-2020. The annual average of

national patent applications filed by universities in the last decade was 78, totaling 779; that is, 8.6% of the total number of patent applications filed by residents and non-residents, including invention patents and utility models.

It is worth mentioning that the capital Metropolitan Lima and the constitutional province of Callao have concentrated the vast majority of patent applications. Between the years 2011 and 2015, more than 90% of applications came from houses of studies based in Metropolitan Lima and Callao (Sunedu, 2020). According to Sunedu, since 2016, the percentage of patent applications from Lima and Callao has been decreasing and, on the contrary, applications from universities based in other regions of Peru have increased.

Graph 10 - Number of National University Patent Applications - Peru, 2011-2020



Source: Directorate of Inventions and New Technologies (DIN) of Indecopi, Sunedu Own elaboration

5. Discussion

The number of invention patent applications filed by residents in Peru still presents many limitations; although it has doubled in a decade, the total number of patent applications - including those of non-residents - has not presented a significant increase, presenting irregular behavior. However, according to Indecopi, the growth rate of patent applications including invention patents and utility models has been 4.9% in 2018-2019 and 6.8% in 2019-2020, which represents an encouraging statistic if this positive growth rate is maintained.

Regarding the Dependency Rate and the Self-Sufficiency Rate, being complementary indicators, they refer to the ratio between national or foreign patent applications to the total number of processed applications. For both indicators, Peru presents statistics below the average for the Latin American region (Ricyt); in other words, patent applications in Peru depend to a large extent on the contribution of foreign inventors.

One of the most important indicators to evaluate the development of the economy achieved by a country is the invention coefficient. Peru had in the 2009-2018 period an average invention coefficient of 0.21, well below the Latin American average (8.84), being one of the lowest in the region. It is evident that, despite the improvements in Peruvian results in the last decade, this coefficient continues to be one of the poorest performing indicators offered, especially when compared to the development of innovation in other countries such as the Pacific Alliance partners.

The number of PCT patent applications in Peru shows a regular growth that places it above the average of the Latin American region; however, Chile and Colombia exceed one hundred PCT patents, even Chile reached five times the last figure registered by Peru.

The development of STI is one of the fundamental factors that affect the increase in a country's productivity levels, which ultimately have an impact on its sustainable development. As established by Cornell University, INSEAD and WIPO, in The Conference Board, 2020 "the positive relationship between productivity and innovation is proven by analyzing the relationship between average productivity per worker and the development of innovation. Thus, the most productive countries are those with the highest development in innovation" (WIPO, 2021). Peru reduced its GII in 2020 by dropping 7 positions (-7) compared to 2019, showing -again- the gaps with Chile and Colombia, which despite dropping in the global ranking (Chile -3, Colombia -1), maintain advantageous positions in innovation performance. These results indicate that Peru still needs to boost STI development, especially when analyzing the results for each sub-index, the main weaknesses are identified: PISA test results in reading, mathematics and science, R&D expenditures as a percentage of GDP, university-industry collaboration, scientific articles in relation to the number of inhabitants, application of patents per million inhabitants, availability of scientists and engineers, among others.

In addition, the GCI competitiveness reports of the last 13 years show the sustained decrease in business spending on R&D and the reduced number of alliances between academia and the business sector for R&D projects, essential components for the development of innovation in an emerging economy such as Peru.

In the face of the covid-19 pandemic, public health expenses and the economic problems caused by the long quarantines established in most countries, the WEF, in its 2020 report, instead of an evaluation and ranking, has designed a report with considerations for recovery and transformation in four areas: the enabling environment, human capital, markets and innovation. Focusing on the latter, WEF recommends that countries expand public investment in R&D and promote it in the private sector; as well as promote incentives for tomorrow's markets: incentivizing and expanding patient investments in research, innovation and invention can create new "tomorrow's markets" and boost growth. (WEF, 2020).

Regarding patents granted by Indecopi, the last five years have reflected an increase in the number of invention patents and utility models; however, as for applications, the enormous dependence on foreign inventors-applicants is visible.

The positive aspect was reflected in the sustained increase of national patent applications from universities, even more so considering the gradual increase in the percentage of participation of universities from other regions of Peru different from Lima and Callao, reflecting the orientation towards the decentralization of knowledge (Sunedu, 2020). It is especially relevant to note that the remarkable interest of Peruvian universities in innovation has occurred since the implementation of the University Reform, within the framework of the new University Law 30220 of 2014, which establishes research and innovation as essential activities in the Peruvian university. Likewise, national policies aimed at promoting research and innovation activities in universities through national competitions for public funds granted by Concytec and Fondecyt, seem to be yielding results.

However, it is also important to note that, according to information from Indecopi, national applications filed by Peruvian companies and research centers are still far below the percentage of applications from legal entities. This would reflect that Peruvian companies have not yet generated an appropriate culture of protection of inventions and innovations or that business investment in innovation is very low, which represents a weakness in the face of globalization, market opening and global trade integration. This economic reality forces companies that wish to be sustainable and competitive to be actively and permanently involved in the development of innovation, which has become a necessity for survival in order not to be relegated and/or expelled from the market (Cabrales, 2008 and Villarán de la Puente, 2015).

According to what has been analyzed, we can reaffirm what was expressed by the National Competitiveness Council in 2015, "the poor development of innovation drivers in Peru is a critical

condition that is affecting its ability to grow in a sustained manner in the medium term" (Chang-Chang et al., 2015).

Consequently, it is important for Peru to take into account the proposals of the National Competitiveness Council, the OECD, the WEF, and other national and international organizations to promote innovation as a productivity tool. Among the most important and feasible proposals are to promote the creation of innovation laboratories in public entities, to incorporate incentives to all the actors of the STI ecosystem - companies, universities, researchers, government - which can be materialized in tax benefits, a larger budget for competitive funds and STI programs, to increase the number of doctorate programs specifically in areas prioritized by the OECD, develop a national R&D and innovation database and portal, set feasible but ambitious goals in a government-driven National Innovation Plan with the interaction of all STI stakeholders, and finally, strengthen the academy-business partnership with the participation of highly qualified workers, researchers, and research institutes.

6. Conclusions

Patent-related statistics are an important indicator for measuring a country's degree of innovation. Consequently, many STI indicators use such statistics to measure, evaluate and contrast the performance of countries in the field of technological innovation and knowledge transfer. Innovation indicators provide an important basis for international comparisons, showing trends over time that also facilitate analysis to - ideally - make decisions in the formulation of policies to improve the results obtained in evaluations and comparisons.

The innovation indicators in Peru show the results obtained in the last decade; although most of them have increased regularly, albeit slightly, this growth has not placed Peru in an outstanding position in the global rankings that measure performance. Peru lags behind comparable countries in the Latin American region with respect to its innovation capabilities and component indexes, specifically, if compared to other Latin American countries, OECD members or its South American partners in the Pacific Alliance.

In conclusion, if Peru intends to improve its competitiveness and productivity in the global economy, it should emphasize its innovation policies, investing more in knowledge and intellectual capital, strengthening the quality of its higher education institutions, promoting entrepreneurship and involving companies in innovation activities.

References

Cabrales Muñoz, F. (2008). University Innovation. I'll engineer. *Chilean Journal of Engineering, 16*(2), 280–281. https://doi.org/10.4067/s0718-33052008000200001

Castro Calderón, M. (2020). *The PCT in Peru.* Webinar on the Patent Cooperation Treaty (PCT) for companies. Indecopi – WIPO.

National Strategic PlanningCenter. (2011). *Bicentennial Plan: Peru by 2021*. Lima: CEPLAN. <https://www.ceplan.gob.pe/documentos_/plan-bicentenario-el-peru-hacia-el-2021/>.

Chang-Chang, L., Franco, A., & Soplín, P. (2015). *Twenty years of Peru at the World Economic Forum.* National Competitiveness Council.

Coe, D. y Helpman, E. (1995). *International R&D Spillovers*. *European Economic Review, 39*(5), 859-887.

Economic Commission for Latin America and the Caribbean (ECLAC) (2010). *Innovate to grow Challenges and Opportunities for Sustainable and Inclusive Development in Ibero-America.* United Nations, Santiago, Chile.

National Council of Science, Technology and Technological Innovation. (2013). *PhDs: guarantee for the sustainable development of Peru.* Lima: CONCYTEC.

National Council for Science, Technology and Technological Innovation – Concytec (2016). *National Policy for the Development of Science, Technology and Technological Innovation.* Lima.

Private Competitiveness Council. (2020). *Competitiveness Report 2020.* Lima.

Edsberg, R., Truffer, I., & Raimondo, E. (2001). *Patent Indicators in Ibero-America* (1990-2000), 8.

Hackett, E., Amsterdamska, O., Lynch, M. y Wajcman, J. (2008). *The handbook of Science and Technology studies.* The MIT Press. 3th. Edition. Hong Kong: Massachusetts Institute of Technology.

National Institute for the Defense of Competition and the Protection of Intellectual Property - Indecopi. (2018). *Annual report on the situation of public and private universities in Peru on intellectual property.* Lima

The House | The CCL Magazine. (n.d.). https://lacamara.pe/concytec-peru-apuesta-por-mas-ciencia-y-tecnologia/.

Law 30220, University Law. (2014). Lima: Official Newspaper El Peruano. <https://www.sunedu.gob.pe/nueva-ley-universitaria-30220-2014/>.

Lizuka, M., & Hollanders, H. (2017). *Innovation Indicators*. DEIP Peru. http://www.cies.org.pe/sites/default/files/files/actividades/presentacion_michiko_lizuka.pdf.

Ministry of Education of Peru. (2015). *University Higher Education Quality Assurance Policy.* Lima: MINEDU, Directorate General of University Higher Education-DIGESU.
http://www. minedu.gob.pe/reforma-universitaria/pdf/politica.pdf.

Organisation for Economic Co-oron (OECD) (2005). *Oslo Manual. Guide to the collection and interpretation of innovation data.* OECD Publishing, 3rd ed. Editorial, Tragasa.

Organisation for Economic Co-oron (OECD) (2015). *Frascati Manual. Guide to the collection and presentation of information on experimental research and development.* OECD Publishing, Paris/FEYCT, Madrid, https://doi.org/10.1787/9789264310681-es.

World Intellectual Property Organization - WIPO. (2011). *The Global Innovation Index: Perspectives and Trends*. https://www.wipo.int/wipo_magazine/es/2011/04/article_0005.html

World Intellectual Property Organization - WIPO. (2015). *Frequently Asked Questions: Patents. WIPO Basics*. https://www.wipo.int/patents/es/faq_patents.html.

World Health Organization - WHO | *Updated WHO tips for international transport in relation to the 2019-nCoV new coronavirus outbreak.* (2020). WHO. http://www.who.int/ith/2019-nCoV_advice_for_international_traffic/es/.

National Superintendency of University Higher Education [SUNEDU] (2018). *Biennial report on Peruvian university reality.* Lima: SUNEDU.

Villarán De La Puente, F. (2015). *History of Patents and Inventions in* Peru. Indecopi, Lima.

World Economic Forum – WEF. (2020). *The Global Competitiveness Report*. *Global Competitiveness Index*. In World Economic Forum, *21*(3).

World Intellectual Property Organization - WIPO. (2021). *Global Innovation Index (GII)*. Wipo.int: https://www.wipo.int/global_innovation_index/en/