

Factors influencing the responsible innovation process: an overview on Latin America and the 20 most innovative countries

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Abstract

The topic innovation has been discussed in the literature for several decades. It was only after the mid-20th century that innovation became a widely recognized concept in the field of economics and management. Nowadays, the topic has become an important one not for academicians, but also to company and governments, once its outcomes are drivers for competitive advantage. The Sustainable Development Goals has been a call from the United Nations, and they should be a guideline to all the innovation processes for responsible innovation. The purpose of this paper is to explore the concept of innovation and its importance in driving progress and economic development for countries, as well as its impacts on the SDG, analyzing the factors that influences its process. In order to reach this purpose, the paper explores the Global Innovation Index (GII), an annual report that assesses the innovation capabilities and performance of the countries around the world, making a comparison with the 20 top most innovative countries in the world. The analysis of its of influencer were built from other index, and factors like Human Freedom, Corruption, and Expenditure in Education, among others, were considered. The results show the process of innovation is quite more complex, and some general assumptions cannot be made. It is required a deeper approach, including aspects mentioned along the paper. Promoting a sustained and inclusive economic development is a great challenge for countries in Latin America, and it is necessary to address some challenges, and work towards building more diversified, innovative, and competitive economies.

Keywords: innovation; SDG; Latin America; innovative countries; technology transfer.

1. Introduction

Innovation is the process of creating something new or significantly improving an existing product, service, process, or idea, that creates value and meets a need in a unique and better way than what was previously available. These characteristics are able to provide competitive advantage for those organizations or countries who are able to innovate.

Due to its relevance to organizations and countries, assessing innovation has become strategic. Born with this purpose, the Global Innovation Index (GII) is an annual report published by the World Intellectual Property Organization (WIPO) that assesses the innovation capabilities and performance of countries worldwide.

Taking into consideration that the innovation process requires other capabilities and investments, the purpose of this paper is to provide a comparison of the innovation index from the top 20 most innovative countries and the ones from Latin America. Additionally, we will also infer the influences of the innovation index by other factors generally considered as driving forces or barriers to innovation, namely: income, government spending on R&D, human development, Government expenditure on education, total (% of GDP), Human Freedom Index, and corruption. In order to accomplish this objective, an exploratory review

on the theme was done, and the basis for the analysis was a documental analysis performed in different types of indexes, described along the text.

2. Innovation

Innovation is a term pursued by many companies, knowledge-based organizations, or countries, under the premise that it will somehow bring competitive advantage for their existence. The Oslo Manual (OECD, 2018) defines it as a new or improved product or process, or even a combination of both, that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process). Innovation can be defined as the process of creating something new or significantly improving an existing product, service, process, or idea that creates value and meets a need in a unique and better way than what was previously available (Kogabayev, & Maziliauskas, 2017; Granstrand, & Holgersson, 2020; Baregheh, Rowley, & Sambrook, 2009).

The term involves introducing new methods, approaches, or technologies that lead to better outcomes, increased efficiency, reduced costs, and improved customer experience. It can be a disruptive force that transforms industries and creates new markets, or it can be an incremental improvement that makes existing products or services more useful or user-friendly (OECD, 2018). It is often driven by a desire to solve problems, improve quality of life, or generate new opportunities for growth and development.

The term began to be used more frequently in literature in the late 19th and early 20th centuries. One of the earliest known uses of the term "innovation" in the modern sense can be traced back to the work of Schumpeter in his book *The Theory of Economic Development* (1911), where he introduced the concept of "creative destruction" to describe how innovation drives economic growth and development by destroying old ways of doing things and creating new opportunities for entrepreneurs and businesses (Schumpeter, 2017). Since then, the study of innovation has become a prominent topic in various fields, including business, economics, engineering, and technology.

Currently, innovation is widely recognized as a key driver of progress and a critical factor in shaping the future of society and the economy. There are many authors who have contributed significantly to the study of innovation, namely Joseph Schumpeter, who introduced the concept of "creative destruction" to explain how innovation drives economic growth and development (Silvino, Joaquim, Souza, Santos, & Balbino, 2020); Clayton Christensen, who coined the term "disruptive innovation" (Christensen, Baumann, Ruggles, & Sadtler, 2006); Nathan Rosenberg; known for his research on the economic history of technology and innovation, as well as the role of institutions in promoting innovation (Kline, & Rosenberg, 2010); Everett Rogers, who developed the diffusion of innovations theory (Rogers, Singhal, & Quinlan, 2014); Henry Chesbrough, who popularized the concept of "open innovation" (Chesbrough, 2004); Eric von Hippel, who pioneered the study of user innovation (von Hippel, & Euchner, 2013). These authors, among others, have made significant contributions to our understanding of innovation and its role in driving progress and growth in various fields.

The innovation process is not simple, and requires investments and structure from the entity dedicated to it. These conditions are not always present in most of the smaller organizations or developing countries. Due to high investments required, sometimes a good way to seek innovation is transferring technology (Pagani, Zammar, Kovaleski, & Resende, 2016).

To innovate is imperative. Nevertheless, a question that we pose is: Are all kinds of innovation positive for society and humankind in general? In this sense, the next section deal with responsible innovation.

2.1. Responsible Innovation

The theme Responsible Innovation has been on literature since 1978. The year 2018 reached the peak of its publications at Scopus database. The term refers to the practice of integrating ethical, societal, and environmental considerations into the process of innovation and technological development. It involves anticipating and addressing potential risks, considering the wider impacts of innovations, and ensuring that the benefits are distributed equitably (Stilgoe, Owen, & Macnaghten, 2013). Responsible innovation aims to align technological advancements with societal values, sustainability, and long-term well-being (European Commission, 2014; 2019).

Some concepts and definitions of responsible innovation have been posed on the literature, as synthesized as follow:

- **Responsible Research and Innovation (RRI):** RRI is an approach that promotes the integration of ethical, social, and environmental considerations in research and innovation processes. It emphasizes the involvement of stakeholders and the public in decision-making and aligning scientific and technological advancements with societal values and needs (Owen, Macnaghten, & Stilgoe, 2012).

- **Triple Helix Model:** this model proposes that innovation occurs through the interaction of academia, industry, and government. Responsible innovation within this model involves collaboration among these actors to address societal challenges and ensure the ethical and sustainable development of technologies (Etzkowitz, & Leydesdorff, 2000).

- **Anticipatory Governance:** the term refers to the practice of proactively assessing and managing the potential impacts, risks, and uncertainties associated with emerging technologies. It involves engaging diverse stakeholders in foresight exercises, policy development, and decision-making to shape the direction of innovation (Guston, 2014).

- **Open Innovation:** Open innovation emphasizes collaboration, knowledge sharing, and co-creation among different stakeholders, including individuals, organizations, and communities. Responsible open innovation seeks to ensure transparency, inclusivity, and equitable distribution of benefits while addressing potential risks and concerns (Chesbrough, 2003).

These concepts highlight the importance of considering ethical, social, and environmental aspects, involving stakeholders, and anticipating and managing potential impacts to foster responsible and sustainable innovation.

According to Stilgoe, Owen, & Macnaghten (2013), and the European Commission (2014; 2019), some practical examples of responsible innovation may include, but are not limited to: **Socially Inclusive Design:** Creating products and services that are accessible and usable by a wide range of individuals, including those with disabilities or special needs. This can involve designing user interfaces, architecture, or transportation systems that are inclusive and considerate of diverse user populations.

- **Biomedical Innovations:** Advancing healthcare technologies and treatments while ensuring the safety, efficacy, and ethical implications of medical interventions. This includes rigorous testing, adherence to ethical guidelines, and considering potential social, cultural, and economic impacts.

- **Technologies related to Sustainable Energy:** Developing renewable energy solutions such as solar power, wind power, and energy storage systems that reduce carbon emissions, combat climate change, and promote a transition to a sustainable energy future.

- **Ethical AI:** Ensuring that artificial intelligence (AI) systems are designed and implemented in a manner that respects human rights, privacy, and fairness. This includes addressing biases in algorithms,

promoting transparency, and involving diverse stakeholders in the development process. Besides these examples, others related to Sustainable Development Goals (UN, 2020) should also be considered.

Due to its relevance, measuring innovation has become strategic. The next section will present an index dedicated to this task.

2.2. Global Innovation Index

The Global Innovation Index (GII), in collaboration with other partners, is an annual report published by the World Intellectual Property Organization (WIPO) (Dutta, Lanvin, Wunsch Vincent, & León, 2022). The report evaluates global innovation capabilities using diverse indicators, considering R&D investment, education, infrastructure, and intellectual property. It is a trusted benchmark for innovation used globally by governments, organizations, and businesses to shape policies and investments, offering valuable insights for policymakers, business leaders, and stakeholders to enhance innovation capabilities and competitiveness (WIPO, 2022; Dutta, Lanvin, Wunsch-Vincent, & León, 2022).

The index does not explicitly categorize examples of responsible innovation, however provides insights into the innovative practices and performances of countries worldwide. Here are some examples of responsible innovation (RI), that can be found in the GII:

- **Renewable Energy Solutions:** Many countries have demonstrated (RI) in the field of renewable energy. For instance, Denmark has been a leader in wind energy innovation, driving the development of efficient wind turbines and integrating wind power into their energy systems. This contributes to reducing carbon emissions and promoting sustainable energy sources.
- **Healthcare Technologies:** RI in healthcare involves developing innovative medical technologies and treatments while considering ethical and social implications. For example, Israel has been at the forefront of medical innovation, with advancements in areas such as telemedicine, personalized medicine, and medical devices, improving healthcare access and patient outcomes.
- **Sustainable Agriculture Practices:** RI in agriculture focuses on developing sustainable farming practices that minimize environmental impact and ensure food security. The Netherlands has implemented innovative techniques such as vertical farming, precision agriculture, and efficient water management systems, aiming to increase productivity while reducing resource consumption.
- **Social Entrepreneurship:** Social entrepreneurship combines innovation and business models to address social and environmental challenges. Many countries foster RI through supportive ecosystems for social enterprises. India, for instance, has seen the rise of social enterprises leveraging technology to address issues like access to education, healthcare, and financial services for marginalized communities.

These examples highlight how different countries have implemented RI practices to tackle societal challenges, promote sustainability, and create positive impacts. The Global Innovation Index provides a broader perspective on innovative practices and their potential for responsible and sustainable outcomes.

2.3. The context of economic development in Latin America

Latin America is characterized by a number of economic challenges, including high levels of inequality, political instability, corruption, and dependence on commodity exports. Many countries in the region also face significant infrastructure gaps, particularly in areas such as transportation, energy, and telecommunications, which can limit their ability to attract investment and promote economic growth (Pagani, Kovalesski, & Resende, 2016).

In recent years, some countries in Latin America have taken steps to address these challenges and promote economic development (Jardon, & Pagani, 2016). For instance, some countries have pursued diverse strategies, such as economic reforms, education investment, and skill development, to attract investment and enhance productivity. Nevertheless, progress remains uneven, with persistent economic and social challenges for many nations. (Azam, 2022). The region needs to address pathways to RI, driven by strategies such as Triple Helix.

3. Methodology

In an attempt to find connections between developed and developing countries and innovation level, we selected the top 20 most innovative countries from the GII to compare with Latin America, which is a group composed by developing countries. This work is an exploratory research combined with a documental analysis. We used the GII to select the top 20 most innovative countries to compare with the countries from Latin America regarding the innovation factors. We selected the following factors to compare the innovation index among the two groups of countries: Income Group Rank, Human Development Index, Government expenditure on education, total (% of GDP), Human Freedom Index, and Transparency Level Perception Index. All of the sources for the data are properly referred in the next section. The results of crossing and comparing these indexes are shown in the sequence.

4. Results

According to the GII, the top 20 innovative countries have a much higher score than Latin American countries. The average GII score of the top 20 innovative countries is 56.9, while the average score for Latin American countries is only 26.2. The innovation index scores for these countries range from 34 for Chile to 17.3 for Honduras. The highest scoring country in Latin America, Chile, has a GII score of 34, which is still significantly lower than the lowest scoring country in the top 20, Iceland, with a score of 49.5. This indicates a significant gap in innovation performance between these two regions.

Subsequently, other indexes will be compared with the GII.

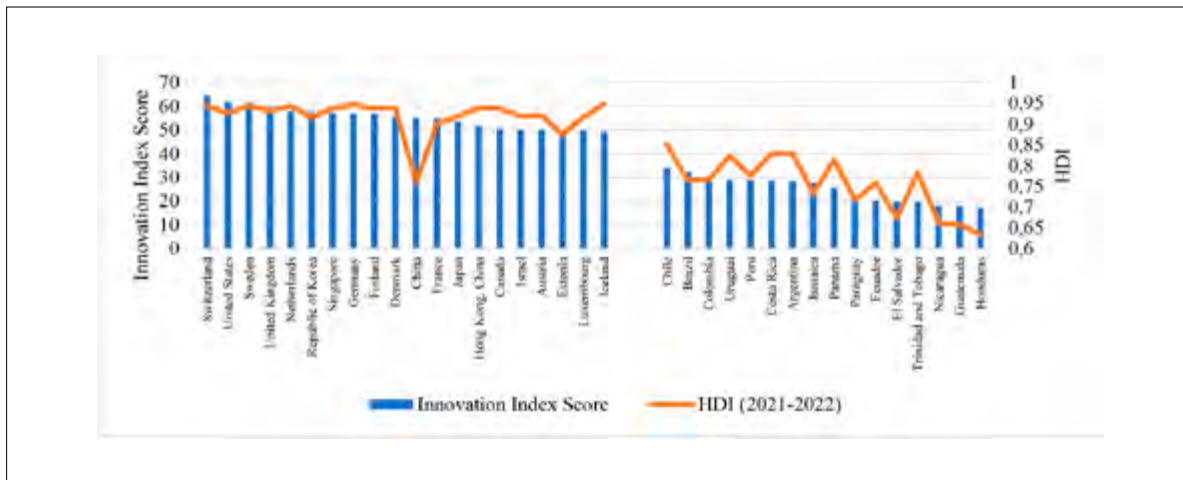
4.1. Innovation Index Score X Income Group Rank

The top 20 innovative countries average a score of 55.4, while Latin American countries average 25. Income and innovation show a correlation, except for China. However, this correlation does not apply to Latin American countries, indicating that income level is not the sole determinant of innovation, once some upper middle-income Latin American countries perform better than high income countries in terms of innovation.

4.2. Innovation Index Score X Human Development Index

When comparing the top 20 innovative countries with Latin American ones, there are significant differences in terms of innovation and human development, as observed in Figure 1. Top innovative countries like Switzerland, the US, and Sweden excel in GII and HDI, with strong innovation capabilities and high human development. They invest in R&D, protect intellectual property, and foster supportive innovation environments.

FIGURE 1. Innovation Index Score X Human Development Index



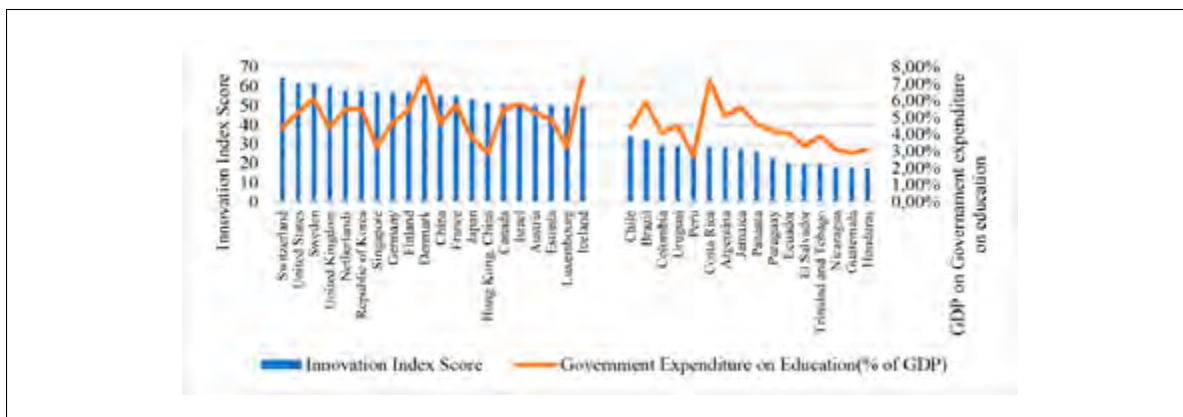
Source: Elaborated by the authors with data from WIPO (2022) and HDR (2022).

In contrast, Latin American countries like Chile, Brazil, and Colombia lag in both GII and HDI, facing challenges in R&D investment, IP protection, and supportive innovation environments. Investing in innovation and creating supportive ecosystems is crucial, requiring collaboration between governments, private sector, and academia to promote research, entrepreneurship, and technological growth.

4.3. Innovation Index Score X Government expenditure on education

In terms of government expenditure on education, the top 20 innovative countries have an average of 5.1% of GDP spent on education, while Latin American countries have an average of 4.3% (Fig. 2). This suggests that, while education investment varies between regions, the disparity in innovation performance is more pronounced. Some Latin American countries invest heavily in education and perform well in innovation, like Costa Rica. However, countries like El Salvador and Trinidad and Tobago have low scores in both areas, indicating a need for increased investment in education and innovation. Education investment alone does not solely determine innovation performance; factors like financing access, regulatory environment, and entrepreneurial culture also contribute.

FIGURE 2. Innovation Index Score X Government Expenditure on education

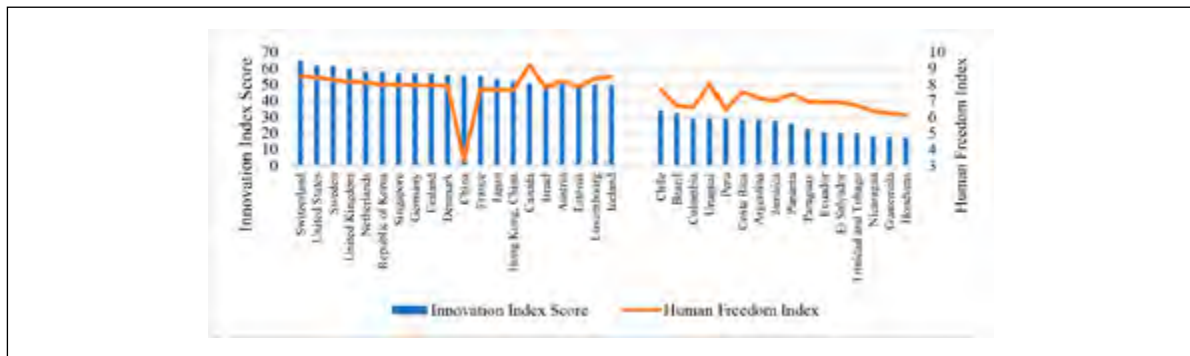


Source: Elaborated by the authors with data from WIPO (2022) and The World Bank (2022).

4.4. Innovation Index Score X Human Freedom Index

In terms of the innovation score and the Human Freedom Index, we can observe that the top 20 innovative countries have a higher score than Latin American countries on average. Nevertheless, the difference is not as significant (Fig. 3).

FIGURE 3. Innovation Index Score X Human Freedom Index



Source: Elaborated by the authors with data from WIPO (2022) and World Population Review (2023).

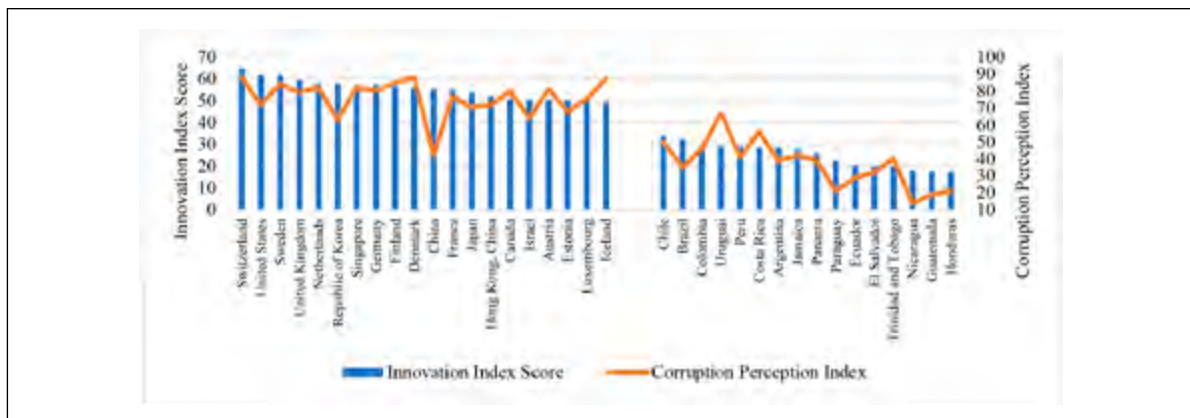
The average Human Freedom Index score for the top 20 innovative countries is 8.04, while the average score for Latin American countries is 6.9. Overall, the top 20 innovative countries outperform Latin American countries in terms of innovation, despite they also tend to have higher scores on the Human Freedom Index.

However, it is important to note that there are exceptions in both cases, and some Latin American countries have relatively high scores on both indices.

4.5. Innovation Index Score X Corruption Perception Index

The Global Innovation Index (GII) and the Corruption Perception Index (Transparency, 2022) are two different indicators that provide insights into the overall development and progress of a country. As for the latter, it means that, the more transparent, the lower is the level of corruption. Thus, the lower is % in Figure 4, the less corruption is perceived in the country.

FIGURE 4. Innovation Index Score X Corruption Perception Index



Source: Elaborated by the authors with data from WIPO (2022) and Transparency (2022).

As for innovation score and level of transparency, we can observe that the top 20 innovative countries have significantly higher scores than Latin American countries. The top 20 innovative countries tend to be wealthier, more developed, and more stable than Latin American countries. This suggests that innovation is closely linked to broader economic and social factors that can influence a country's overall development. However, there are some exceptions, such as China, which ranks 42nd in transparency but still ranks 11th in innovation.

Thus, despite transparency may be more conducive to innovation, as transparency can help foster a more open and accountable environment for research and development, we can observe that innovation and transparency are not necessarily related. It is worth noting that innovation is a complex and multi-dimensional concept that is influenced by a wide range of factors, including education and human capital development, research and development investment, regulatory environment, and entrepreneurial culture, among others.

While the GII does not explicitly define RI, it does highlight several aspects related to responsible and sustainable innovation. In the context of the Global Innovation Index, RI is closely tied to sustainable development goals and the impact of innovation on society and the environment. It emphasizes the need to align innovation strategies with sustainable development objectives, such as reducing inequality, protecting the environment, and improving social well-being.

5. Conclusion

Innovation is a critical factor in shaping the future of society and the economy, and it can transform industries and create new markets. RI involves engaging diverse stakeholders, including governments, businesses, academia, and civil society, in decision-making processes to ensure transparency, inclusivity, and accountability.

Based on the GII, RI is an approach to innovation that goes beyond technological advancements and economic growth, encompassing the integration of ethical, social, and environmental considerations into the innovation process. RI entails considering the broader impact of innovations on society, including their potential to create positive social change, improve access to essential services, and foster sustainable practices, encouraging the development of innovative solutions that are not only technologically advanced but also socially and environmentally responsible. In summary, RI, as highlighted by the Global Innovation Index, is an inclusive and sustainable approach that seeks to maximize the positive impacts of innovation while minimizing negative consequences. It involves integrating ethical, social, and environmental considerations throughout the innovation process to create a better future for all.

This paper compared the top 20 innovative countries with the countries in Latin America. The top 20 innovative countries are, most of them, developed countries, whereas Latin America figures among the developing ones.

The comparison of Latin American countries with the top 20 most innovative countries in the world has highlighted significant differences in terms of innovation capabilities and human development. While investment in education is important, it is not the only factor determining innovation performance, as access to financing, a supportive regulatory environment, and a strong culture of entrepreneurship also play a significant role.

The analysis of income, government expenditure on education, human freedom index, and corruption perception index has revealed that investing in R&D and creating a supportive environment for innovation

is crucial for fostering innovation and economic development. This major limitation of this work was the difficulty to condense such huge analysis in only a few pages, what makes it quite superficial. Therefore, for futures works, it is suggested to deepen the analysis and include a temporal approach, that could more accurately infer the results.

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