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Sustaining the Path for Innovation Capability from a Developing Country Perspective: A Conceptual Framework

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Abstract: Innovation capability contributes to the competitiveness of a country. However, due to the multi-faceted nature of this dynamic capability, its development is considered a risky task. Thus, it is critical to concentrate the efforts on the determinants that might provide a higher impact on sustaining the development of this capability, particularly for a developing country with limited resources. This work presents a systematic literature review examining 14 innovation determinants to advance the understanding of their impact on countries' innovation capability. This research studied the literature by qualitative strategies to categorize and contextualize the findings. It also includes the contribution made by experts from a developing country through interviews. The selected publications and the interviews provided fundamental elements to identify the impact and linkages of the innovation determinants on the development of innovation capability. From here, a conceptual framework is outlined proposing an incremental loop that encompasses five stages: (1) government support, (2) implementation of innovation agencies, (3) R&D projects between U-I, (4) innovation clusters development, and (5) innovation output achievement. These stages systematize practical strategies regarding the 14 determinants posing a path to sustain the growth of this capability in the context of developing countries, contributing from theoretical and practical standpoints.

Keywords: innovation capability; innovation determinants; university-industry collaboration; innovation policy; systematic literature review; developing countries; conceptual framework

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1. Introduction

Innovation plays a significant role in countries' well-being, growth, and success, leading them to economic, intellectual, and social benefits [1,2]. Moreover, innovation is an essential factor in the competitiveness of a country [3], enhancing its capability to create and offer new-to-the-world products, services, and technologies over the long run [4]. Further, when properly managed, innovation is a dynamic capability that leads to achieving a competitive and sustainable advantage [5–8]. This capability comprises different standpoints, e.g., national capability [4,9,10], regional capability [11–13], public capability [13–16], and organizational capability [17–20], among others. Hence, developing countries have the potential to create value, prompt their economy, and improve international competitiveness by building and sustaining their capability to innovate [1,21,22]. In addition, innovation capability triggers the pursuit of sustainability from several perspectives [23,24]. For developing countries and low-income regions, the main interest in enhancing their innovation capability is the achievement of economic and social sustainability [25–27]. Moreover, this capability fosters knowledge creation [6] and disruptive technology as means to achieve sustainability in SMEs [27]. Furthermore, innovation capability promotes sustainable value creation by stimulating the design of sustainable products and services while adopting and implementing cleaner and eco-efficient production practices, promoting the use of sustainable and eco-friendly raw materials, and waste reduction and handling, among other sustainable actions [28–30].

In recent decades, the study of innovation capability and innovation determinants has reached the interest of researchers and practitioners. Various mechanisms evaluate the performance of this capability from different approaches [4,9,10,31]. They comprise several indicators which, in some cases, are redefined, adjusted, changed, or eliminated over the years. Therefore, the literature including every innovation determinant presented by different organizations might be overwhelming. It is difficult for a developing country to track the behavior of each innovation determinant, considering that some of the primary innovation indexes have changed during the last years [32,33]. Furthermore, public and private agents participating in national innovation systems should design an innovation and R&D policy framework concentrating their efforts on managing those innovation determinants that might represent the higher positive impact possible on building and sustaining their innovation capability to achieve a competitive advantage. All this is necessary for a developing country coping with significant limitations and a lack of resources for innovation and R&D activities.

Despite being a relatively new field of research, several studies have examined the impact of innovation determinants on innovation capability [19,34–39]. However, few studies explore a broad set of innovation determinants to understand their effect on innovation capability and the relationships between them due to the multi-faceted nature of this capability and its complexity [19,40–43].

With this in view, the primary purpose of this work is to deepen the understanding of the impact of 14 innovation determinants on national innovation capability, wearing in mind this research question: which is the path that developing countries might follow to grow their innovation capability in a sustained way? Thus, this work searches for ways to sustain this capability in those countries and provides two main contributions: (1) to explore and integrate findings from empirical studies on the impact of the selected innovation determinants and the relationships between them, integrating the analysis with the perspective of experts from a developing country, and (2) to present a conceptual framework to sustain the growth of innovation capability and further gain a competitive advantage.

The structure of this paper is as follows. Section 2 provides the background of the innovation assessing mechanism used to select the innovation determinants under study. Section 3 outlines the methodological considerations for examining the publications and interviews included in this work. Section 4 highlights the findings and discussion regarding the impact and relationships between the innovation determinants. Section 5 presents a conceptual framework to sustain the growth of innovation capability. Finally, Section 6 summarizes some general considerations and limitations of this study.

2. Theoretical Background

2.1. Innovation Capability

Schumpeter was the first to recognize innovation as a critical factor of economic change [44]. He identified market power, entrepreneurial activities, and innovation as triggers of economic changes. Furthermore, the author argued that technological innovation causes temporary monopolies necessary to prompt companies to generate new products and processes [24]. In more recent times, the relevance of this concept has increased due to the rapid changes in the socio-politic and economic global landscape. Damanpour [20] (p. 556) defined innovation as the "adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization". In addition, Lawson and Samson [45] defined this capability from a dynamics capability approach as a continuous ability to transform ideas and knowledge into new products, systems, and processes that benefits a firm and its stakeholders. Since the beginning of this century, a country's capability to innovate has gained increased attention from policymakers, practitioners, and scholars [9,10,16,19]. In 2002, Furman [4] (p. 900) defined the innovation capacity of a country as "the ability of a country—as both a political and economic entity—to produce and commercialize a flow of new-to-the-world technologies over the long term". Moreover, each country performs distinct degrees of innovativeness as the result of "cross-country innovation policy" and "economic geography" differences [4,46].

Numerous factors and agents frame the complex innovation system of a country where policymakers, practitioners, scholars, researchers, government agencies, universities, financing sources, investors, and industry decision-makers, among others, interact to generate innovative and creative products, services, methods, and technologies [2,47–49]. Furthermore, to manage the innovation capability of a country, it needs to be measured [2]. No single determinant captures the multi-dimensional nature of the ability of a nation to innovate [2]. For this research, an innovation determinant is defined as an important variable within the innovation system. It is also possible to recognize that some determinants are closely related to the implementation and development of innovation (innovation input), and others point to the results of this capability (innovation outputs) [2,4,48]. Likewise, the performance within an innovation system involves a comprehensive process, where every event and action that takes place between the participants of such a system causes an impact on the innovation determinants and, as a result, on the innovation capacity of the system [37,50–52]. Hence, measuring the performance of these complex innovation systems is an intricate process [2,4,19]. Performance measurement is a process used to determine the status of an attribute or attributes of the measurement objects [53]. The measures should be dynamic and support development and closure [54]. "Thus, measurement is not contradictory within the process of innovation, but can rather be used as a tool for developing innovation capability" [50] (p. 163).

2.2. Innovation Capability Assessing Mechanisms and Innovation Determinants

Various entities and scholars have undertaken the task of assessing the capability for innovation of a country by developing different instruments for that purpose [11,16,19], such as the European Innovation Scoreboard (EIS) [31], Global Innovation Index (GII) [9], national innovation capacity [4], or Global Competitive Index (GCI) [10]. Each one of these instruments poses its own set of methods, variables, and interpretations for evaluating innovation. The present work includes three main mechanisms as the theoretical background to identify the innovation determinants under study.

First, the World Intellectual Property Organization (WIPO), in cooperation with INSEAD and Cornell University, issues the Global Innovation Index (GII) since 2007 [9,55]. GII identifies innovation capability as "the ability to exploit new technological combinations; it embraces the notion of incremental innovation and innovation without research" [2] (p. 176). The ultimate goal of GII is "to discover what works best in producing an ecosystem where people can achieve their highest potential, innovating and creating to improve lives everywhere" [2] (p. vii). Its last edition, published in 2021, comprises 81 indicators gathered from different sources such as the World Bank, direct surveys to representatives of the assessed country, international and global entities, among others. Regarding the nature of the indicators, they fall into three categories: (1) qualitative and subjective indicators resulting from soft data and surveys (3 indicators), (2) composite indicators resulting from qualitative and quantitative elements reflected in index data (15 indicators), and (3) quantitative objective data gathered from hard-data (63 indicators) [2]. These indicators are organized into two sub-indexes grouping a total of seven pillars: (1) Innovation Input Sub-Index, encompassing the pillars of infrastructure, human capital and research, institutions, business sophistication, and market sophistication; and (2) Innovation Output Sub-Index, comprising the pillars of creative outputs and knowledge and technology outputs. Various studies have considered GII to examine the innovation capability of several countries [56–60]. Sohn et al. [56] proposed a structural equation model to analyze the linkages between the seven pillars using GII data from 2013. The authors found strong direct and indirect effects of business sophistication and infrastructure on creative output. Later, Oturakci [59] examined GII data from 2013 to 2020 by applying canonical correction analysis. Pillars of business sophistication, human capital and research, and creative outputs were the most relevant and explanatory in developing innovation input sub-index. Nevertheless, there was a statistically significant difference in the results when comparing the income levels of the countries. Likewise, Crespo and Crespo [57] conducted a fuzzy-set qualitative analysis to compare high-income and low-income countries using GII data. Among its results, the study found that high-income countries could achieve a high innovation performance only due to their infrastructure. The study also showed that the pillar of human capital and research was sufficient to achieve high innovation outputs in these countries. In contrast, a single innovation pillar is not enough to lead developing or low-income countries to higher innovation performance. The authors suggested the design of multi-faceted policies for these countries considering various dimensions simultaneously.

Second, Furman et al. [4] outlined a mathematical model to evaluate the national innovation capacity (NIC). The framework for the national innovation capacity proposed by the authors was based on prior research on three different areas: the cluster-based theory of national industrial competitive advantage [61], ideas-driven endogenous growth theory [62], and research on national innovation systems [63]. Each of those approaches identified specific factors that determine the “flow of innovation” in a country. The three theories shared diverse common analytical factors but differed in the factors each emphasizes and their levels of abstraction. NIC is characterized as the result of three building blocks. This model assesses this capability by analyzing and integrating 20 variables selected from different sources (e.g., World Bank, International Institute for Management Development (IIMD), US Patent and Trademark Office (USPTO), and OECD-database). The variables are systematized into four categories. First, cluster-specific innovation environment reflects the firms’ efforts to create and commercialize innovation induced by their microeconomic environment. Diverse cluster-specific policies, investments, and circumstances determine the scope to which an industrial cluster of a country competes based on “technological innovation”. Second, the common-innovation infrastructure sets the broad context for innovation in an economy and encompasses some of the significant policy and investment choices toward innovative activities having an overall effect on it. Third, is the quality of linkages between the former two categories. The link between those two is reciprocal: a given common-innovation infrastructure might lead to increased innovation output when the cluster innovation environment is robust (and vice versa). Finally, the interplay between the three categories results in the overall innovation capability performance of a country reflected in the related and contributing outputs factors. Based on this work, Hu and Mathews [64] analyzed the innovation capability of 16 countries, including five “latecomer” countries from East Asia: Taiwan, Korea, Hong Kong, Singapore, and China. The authors found some differences for this group of countries with previous findings: the role of public R&D expenditure seems to be moderately important, and fewer national factors were relevant for successful catch-up strategies. Their results suggested that latecomer countries can close the gap with more developed economies by directing resources toward developing innovation capability. Later, Wu et al. [65] analyzed the innovation capability of 80 countries by including [4] framework among other prominent studies. The empirical results revealed that the levels of foreign direct investments and international trade have a positive and significant effect on innovation productivity in emerging innovator countries. With caution, while interpreting the results, the authors pointed to the importance of continuously attracting more foreign direct investments and sustaining and expanding the international high-tech export for these countries.

Third, the World Economic Forum introduced the Global Competitiveness Index (GCI) in 2004 [10]. The GCI concentrates its evaluation process on identifying and assessing “the factors that underpin the process of economic growth and human development” [48] (p. 8). The GCI was renamed GCI 4.0 in 2018 to capture the significance of factors related to the impact of the fourth industrial revolution on human capital, resilience, agility, and innovation [32]. This latest version includes 64 new indicators, given a total of 103 variables grouped in 12 pillars ranking the competitiveness of a country. Further, four categories organize the pillars as follows: (1) Enabling Environment encompassing macroeconomics stability, ICT adoption, infrastructure, and institutions pillars; (2) Human Capital which comprises pillars of health and skills; (3) Markets including financial systems, market size, labor market, and product market; and (4) Innovation systems that includes innovation capability and business dynamism pillars. The innovation capability pillar quantifies and qualifies the ability of a country to develop an environment promoting connectivity, collaboration, formal research, and creativity, and the capability to translate ideas into new products, services, and processes. Bucher [66] evaluated the contribution of each pillar to the GCI value of 41 European countries based on GCI data for the period 2014–2016 using diverse statistical methods. Among the results, the study showed that the innovation pillar supports macroeconomic and institutional stability, and human capital development. Moreover, it generates a more efficient infrastructure. Further, Olczyk et al. [67] provided a critique of the GCI 4.0. They identified the need to optimize weights (done on GCI 4.0) and reduce the set of variables (as on previous GCI) to produce a strongly correlated ranking and also will ease the comparison of regional competitiveness. The authors also recognized that sub-indices of human capital and innovation environment are relatively well balanced.

These three mechanisms are among the prominent ones used to assess the innovation capability of a nation due to the global approach they adopt by analyzing several countries and the numerous studies conducted using these innovation mechanisms as their framework. Although it might be argued that these carefully crafted assessing mechanisms are mainly suitable for developed countries, where data collection tends to be better carried out than in developing countries (particularly considering rural settings with small agricultural holdings), it is precisely the transparency of the information (freely and publicly available), the continuity of the publications of the indexes and the contrast with various sources that provide a common ground to evaluate and compare the innovation capability between countries with different settings [57,59,65,67,68].

A comparative analysis was performed to identify similar innovation determinants adopted between these three mechanisms for measuring innovation capability [69]: GII [2], NIC [4], and GCI 4.0 (primarily regarding the innovation capability pillar) [48]. Table 1 presents the list of the 14 variables identified from the comparison and included in this study.

The 14 innovation determinants are chosen based on their commonality among the three assessing mechanisms aforementioned. These innovation determinants are included in at least two of the three mechanisms. Thus, six innovation determinants are present in the three mechanisms: (1) gross expenditure on R&D (GERD_GEN), (2) scientific and technical patents and articles (SCIEN_PTNT), (3) university-industry R&D collaboration (UNI_IND_COL), (4) openness to international trade and investment (OPEN_INV), (5) private industry gross expenditure on R&D (GERD_IND), AND (6) state of cluster development and depth (CLUST_ST). Two of the innovation determinants are recognized from GII and NIC: (7) spending on education (SPEN_EDU), and (8) R&D full-time personnel (R&D_PERS). Three of the determinants are encompassed in GII and GCI 4.0: (9) university/research centers prominence (QS university ranking) (PROMIN_), (10) Co-inventions (co-creations) (CO_INV), and (11) trademark applications (TRADEMARK). In addition, NIC and GCI 4.0 encompass two determinants: (12) strength of protection for intellectual property & promotion (IP_PROTEC), and (13) R&D performed by universities (GERD_UNI). Finally, utility models (UTI_MDEL) is also included in this list as it is part of the GI and was part of the previous edition of GCI [70,71]. Further description and characterization of the 14 innovation determinants are provided in Section 4.

Table 1. List of innovation determinants identified in common from GII, NIC, and GCI 4.0.

VAR_COD	Variable Name	Type	Reference	Notes
GERD_GEN	Gross expenditure on R&D	Innovation input	[2,4,48]	GII: 2.3.2. Gross expenditure on R&D (GERD), % GDP NIC: Aggregate R&D expenditures GCI 4.0: 12.07 R&D expenditures
SCIEN_PTNT	Scientific and technical patents/articles	Innovation output	[2,4,48]	GII: 6.1.1. Patents by origin/bn PPP$ GDP 6.1.4. Scientific and technical articles/bn PPP$ GDP NIC: International Patents Publications in Academic journals GCI 4.0: 12.06 Patent applications
UNI_IND_COL	University-industry R&D collaboration	Innovation input	[2,4,48]	GII: 5.2.1. University–industry R&D collaboration NIC: Implied as part of the variable percentage of R&D performed by universities GCI 4.0: 12.04 Multi-stakeholder collaboration
OPEN_INV	Openness to international trade and investment	Innovation input	[2,4,48]	GII: As part of market sophistication pillar (4.2. Investment & 4.3. Trade, diversification, and market scale) NIC: Openness to international trade and investment GCI 4.0: As part of pillar 7: product market, and 10.02 Imports of goods and services
GERD_IND	Private industry gross expenditure on R&D (GERD)	Innovation input	[2,4,48]	GII: 5.1.3. GERD performed by business, % GDP 5.1.4. GERD financed by business, % NIC: Percentage of R&D funded by industry divided by total R&D expenditures GCI 4.0: As part of 12.07 R&D expenditure
CLUST_ST	State of cluster development and depth	Innovation input	[2,4,48]	GII: 5.2.2. State of cluster development and depth NIC: Implicit at cluster-specific innovation environment category GCI 4.0: 12.02 State of cluster development
SPEN_EDU	Spending on education	Innovation input	[2,4,48]	GII: 2.1.1. Expenditure on education, % GDP NIC: Share of GDP spend on higher education GCI 4.0: No stated directly
R&D_PERS	R&D Full-time personnel	Innovation input	[2,4,48]	GII: 2.3.1. Researchers, full-time equivalent (FTE) (per million population) NIC: Aggregate employed scientists & engineers GCI 4.0: No stated directly
PROMIN_	University/Research Centers prominence (QS university ranking)	Innovation input	[2,4,48]	GII: 2.3.4. QS university ranking, top 3 NIC: No stated directly GCI 4.0: 12.08 Research institutions prominence
CO_INV	Co-inventions (co-creations)	Innovation output	[2,4,48]	GII: 6.1.2. Patent Cooperation Treaty applications by origin/bn PPP$ GDP NIC: No stated directly GCI 4.0: 12.03 International co-inventions
TRADEMARK	Trademark applications	Innovation output	[2,4,48]	GII: 7.1.1. Trademarks by origin/bn PPP$ GDP NIC: No stated directly GCI 4.0: 12.10 Trademark applications
IP_PROTEC	Strength of protection for intellectual property & promotion	Innovation input	[2,4,48]	GII: No stated directly NIC: Strength of protection for Intellectual Property GCI 4.0: 1.15 Intellectual property protection
GERD_UNI	R&D performed by universities	Innovation input	[2,4,48]	GII: No stated directly NIC: Percentage of R&D performed by universities GCI 4.0: As part of 12.07 R&D expenditure
UTI_MDEL	Utility models	Innovation output	[2,4,48]	GII: 6.1.3. Utility models by origin/bn PPP$ GDP NIC: No stated directly GCI 4.0: No stated directly

3. Methodology

A systematic literature review and expert interviews were conducted as the main methodologies used in this research. The systematic literature review is a research methodology defined as “a specific methodology that locates existing studies, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in such a way that allows reasonably clear conclusions to be reached about what is and is not known” [72] (p. 671). This methodology, primarily developed within the field of medicine, is gaining attention in business research [73,74] and managerial studies [19,75–77]. To further this research, the systematic literature review methodology was applied to characterize the role played by the variables under study to enhance innovation capability, particularly in developing countries. Tranfield et al. [78] proposed three key steps for conducting a systematic review: planning, executing, and reporting the results. Hence, the systematic review was conducted between 21 April and 14 November 2021.

Figure 1 presents the complete methodological process applied to this research.

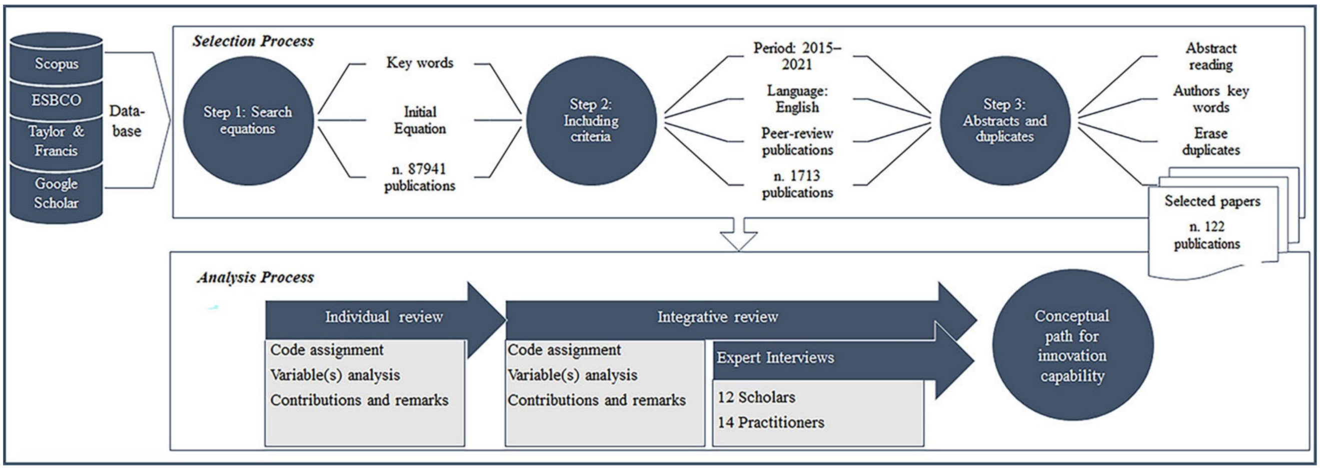

Figure 1. Methodological process applied to the research. Note: authors elaboration.

Two main processes took place. First, the selection process was conducted to determine which publications would be comprised in the systematic literature review. Secondly, the analysis process integrated the findings from the selection process with the expert interviews to outline the conceptual approach for sustaining the development. The remaining section provides a more comprehensive description of this process.

3.1. Selection Process

This research encompasses the three steps for a systematic review to build the dataset comprising the selected papers according to the criteria set for this work. The articulation of the steps for the selection process allows identifying and characterizing relevant literature related to the variables under study and their influence on innovation capability. The review was conducted using Scopus-Elsevier, EBSCO, Taylor & Francis, and Google Scholar databases (see dataset Novillo et al. [79]). The review examined studies published from 2015 to 2021 due to the growing relevance of innovation capability in the literature during the past decade [13,14,19] but limited to these five years as the variables included in GII and GCI 4.0 were modified during that period. The design of the search equations contained the key terms of the variable under study in the context of innovation capability/capacity. Table 2 summarizes the results of Step 1 and Step 2.

At first, Step 1 resulted in a total of 87,941 articles by combining the search of the keywords of the fourteen innovation determinants analyzed in this study.

Next, for Step 2, only articles in English were included, and various filters were applied to each database, depending on its features, to limit the results to the topic under research. A paper to be considered should be related to the areas of business, management, innovation, social sciences, and economics. They also should be published in an international journal, excluding conference proceedings, book chapters, and monographs. Thus, Step 2 resulted in 1713 publications.

When applying Step 3, duplicated papers were eliminated. Finally, every title, set of keywords, and abstracts were read to determine if the publication referred to the variables under study and the relation with innovation capability or innovation capacity and conducted in a developing country or compared with developing countries. This is to apply the "fit for the purpose" method [19,76]. At this stage, the research was limited to international journals classified as Q1/Q2 according to the SCImago ranking [19,80]. However, it was decided to keep 22 contributions between conference proceedings (10), books (6), and reports (3) to avoid missing potential inputs for this research [75]. This resulted in 122 publications for analysis.

Table 2. Innovation determinants analysis: summary of results from Step 1 and Step 2.

VAR_COD	Key Words	Step 1	Step 2	Including Criteria
OPEN_INV	openness-investment	2677	383	• Publications between 2015 and 2021 • Language of articles: English • Reading titles and their relationship with the analyzed variable • Keyword reading • Innovation Capacity/Capability • Developing economies • Developed economies (comparison with the previous ones) • Peer-reviewed publication
GERD_IND	expenditure/investment-R&D-business/enterprises/industry	27,377	1028	
R&D_PERS	human capital-R&D personnel	2251	26	
IP_PROTEC	Intellectual Protection-Intellectual Property	701	31	
GERD_UNI	university-R&D-expenditure/investment	2774	17	
UTI_MDEL	utility models-patent	25	21	
GERD_GEN	gross-expenditure- R&D	29,820	19	
UNI_IND_COL	university/academy-industry/enterprise-research-collaboration	832	57	
SPEN_EDU	expenditure/investment-university/academy	2374	26	
PROMIN_	QS-ranking/score-university/academy-innovation	17,955	30	
CLUST_ST	Cluster development-economy-innovation linkages	997	30	
CO_INV SCIEN_PTNT	patents-collaboration-university/academia-industry-innovation	100	22	
TRADEMARK	trademark-application*-industry	58	23	
	TOTAL	87,941	1713	

* Asterisk (*) was used as a Boolean modifier in the search equation.

3.2. Analysis Process

These studies were gathered and processed on Mendeley-Reference Management Software to ease the reading and processing of valuable information. In addition, an Excel datasheet was created to collect, filter, and analyze the scientific features of the selected papers, providing a better understanding of each publication.

The dataset comprises information such as the name of the journal, country, type of paper (empirical or conceptual), related innovation determinant(s), applied methodology (survey, case study, statistical models, etc.,); unit of analysis (firm level, country level); type of country (developing country or developed country). This dataset allowed the classification of the selected publications, examined the relation of each studied variable to the development of innovation capability, particularly in developing countries, and identified, if possible, effective policies to enhance and prompt that capability.

Further, the results of the review are integrated with a series of interviews with 14 practitioners and 12 academics related to areas of transference, innovation, and research (see Section 4.2) [81]. These interviews contributed an expert and practical viewpoint on the innovation determinants for innovation capability and the significance of this capability in developing countries, such as Ecuador. Hence, the interviewees represent countries from Latin America, mainly Ecuador, providing a developing country perspective. Finally, the findings are summarized in a conceptual framework for innovation capability.

4. Results and Discussion

This section presents the systematic approach developed to examine and combine the selected publications and the results of the interviews with experts. First, the characterization of the publications under study, including the methodological aspects, is analyzed. Next, results, contributions, and conclusions were studied. Finally, the findings from the literature review are compared and integrated with the analysis of the responses provided by the experts to identify the relevance of the innovation determinants in generating innovation capability in a developing country.

4.1. Characterization of Selected Publications

The dataset comprises publications related to one or more innovation determinants sharing the context of innovation capability. Table 3 presents the code, description, and frequency on which they relate to the publications included in this research.

Table 3. Innovation determinants based on GII, NIC, and GCI 4.0.

VAR_COD	Variable	Definition	Frequency %	Relevant References
CLUST_ST	State of cluster development and depth	Refer to the spread of innovation clusters and their reach. It comprises clusters' level of depth and development (i.e., geographic concentration of partnerships in a specific sector, such as suppliers, goods makers, service providers, and institutes). It includes the linkages among the universities, industry, and government agencies established to develop innovation and creativity.	17.5%	[12,14,15,17,21,34,35,38,42,47,82–99]
UNI_IND_COL	University-industry R&D collaboration	Include the extent to which various entities such as businesses, universities, and research centers engage mutually in collaborative R&D and innovation activities. It also encompasses sharing the efforts to design new concepts, theories, models, and methods.	12.9%	[12,38,82,84,88,89,96,97,100–109]
GERD_IND	Private industry GERD	Correspond to R&D spending performed and funded by private businesses and industry.	11.8%	[8,17,21,34,37,47,82,90,110–123]
SCIEN_PTNT	Scientific and technical patents/articles	Include patents registered by universities, industries, or research centers or in partnership between them. In addition, it comprises citations of patents in scientific articles as well.	10.6%	[34,36,42,84,88,97,98,100,101,104,109,124–130]
GERD_GEN	Gross expenditure on R&D	Include private and public current spending as well as capital directed to R&D activities. This funding is systematically performed to gain knowledge to be applied to new developments. Thus, GERD_GEN encompasses the "total domestic intramural expenditure on R&D during a given period as a percentage of GDP. . . . without considering the source of funding" [2] (p. 186).	8.9%	[13,14,34,38,42,98,104,115,116,121,122,125,131–134]
OPEN_INV	Openness to international trade and investment	It refers to the effects of direct and indirect investment (e.g., market capitalization, venture capital, FDI) and international trade (e.g., ICT imports, applied tariff rate, exports' diversification) on the capacity to innovate of a country. It also comprises the extent to which policy, tariffs, and regulations prompt, leverage, stimulate, or prevent investment and international trade from impacting R&D and innovation.	7.0%	[8,12,38,39,41,111,112,116,120,122,131,132,134–139]
R&D_PERS	R&D Full-time personnel	Comprise the group of full-time personnel, such as scientists, professionals, and engineers, engaged in conceptualizing and creating new knowledge in all fields. This group of professionals, research, theorize, develop, and improve models, concepts, techniques, methodologies, instrumentation, or software.	7.0%	[15,21,37,38,83,93,100,102,109,117,127,136,140–143]
IP_PROTEC	Strength of protection for Intellectual Property & Promotion	Refer to the extent and strength to which intellectual property (IP) and innovation are protected and promoted by a nation, including the policymaking protecting and promoting IP rights.	5.0%	[36,82,95,100,111,114,118,126,130,132,143–145]
UTI_MDEL	Utility models	Encompasses a distinct formulation of the patent right, where a utility model is granted under slightly different terms and requirements than the ones applied for standard patents. These requirements comprise less strict patentability conditions and a shorter period for protection.	4.6%	[124,127,133,146–149]
CO_INV	Co-inventions (co-creations)	Include the applications to a patent family with co-inventors located abroad.	4.6%	[34,40,150,151]
SPEN_EDU	Spending on education	Encompass the sharing of GDP spent on higher education (i.e., tertiary and secondary education). It includes funding sponsored by external sources to the government.	3.8%	[103,125,131,135,152–154]
GERD_UNI	R&D performed by universities	Encompass all R&D spending performed by universities regardless of its sourcing.	3.6%	[34,35,82,93,104,105,108]
PROMIN_	University/Research centers prominence (QS university ranking)	Comprise the prominence and standing of private and public universities, research centers, government agencies, and corporative entities engaged in R&D activities and generating innovation.	1.4%	[84,155–158]
TRADEMARK	Trademark applications	Refers to distinctive signs, marks, and features that an owner designs for a particular product and/or service to distinguish it (them) from those of the competence. A trademark can comprise names, logos, numbers, figures, slogans, images, sounds, and moving images, presented by themselves or in combination.	1.4%	[39,117,126,129,159]
		TOTAL	100%	

Most of the studies relate to the CLUST_ST variable (17.5%). It refers to the spread of innovation clusters, which reveals the state of innovation systems within a productive sector of a city, country, or region, shaped by innovation policies put in place by the government, industry, market, and other innovation stakeholders [15,35,38,90,92]. Moreover, CLUST_ST is tight to the collaborative linkages between industry, university, and research centers

(UNI_IND_COL), reflected in a 12.9% frequency, as CLUST_ST depends largely on the strength of those linkages [4,34,42,101].

Enterprises need to allocate enough resources to pave their path to innovation. Thus, 11.8% of the examined publications point to the relevance of GERD_IND for enhancing innovation capability [34,112,122]. Further, GERD_GEN (8.9% frequency) and OPEN_INV (7.0% frequency) have a significant impact on engaging in innovation undertakings, as they trigger or restrain investing in innovation activities [38,131,134,160]. However, the study of IP_PROTEC's impact on stimulating the innovation capability in a country has received lesser attention (5.0% frequency) as a direct object of research, regardless of its importance in providing the proper environment for developing and enhancing innovation capability [36,95,126,161].

Finally, innovation efforts and collaboration are mirrored in the scientific performance of the innovation participants [34,84,98]. Hence, SCIEN_PTNT is among the widespread measurements for innovation capability performance [102,108], linked to 10.6% of the studied publications, in contrast with the remaining innovation outputs under examination (UTI_MDEL 4.6%, CO_INV 4.6%, and TRADEMARK 1.4%).

From the previous analysis, it is interesting to identify the link between the innovation determinants and the classification of the country where the study was conducted. Hence, Figure 2 shows the distribution of the 14 variables regarding the segmentation of the country as developed, developing, and both.

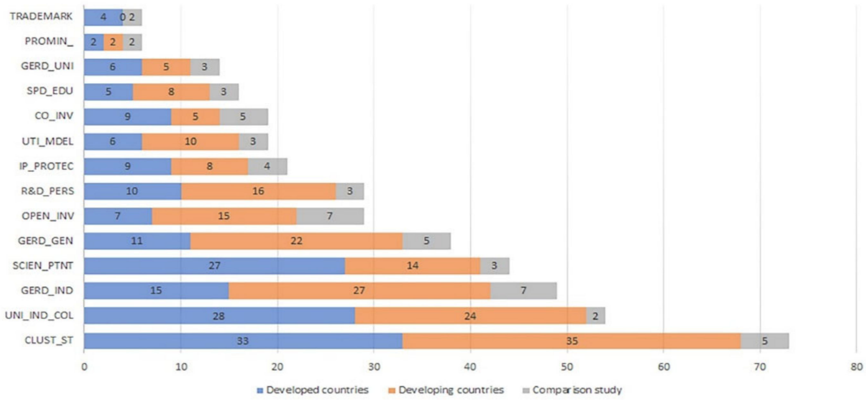

Figure 2. Frequency distribution according to innovation determinant and countries' classification.

The prevalence of addressing any of the innovation determinants under study seems to issue factors identified as relevant to improve the innovation capacity in the innovation system of developing countries more than responding to a trend. It is worth noting that the publications included in this work conducted in developing countries mainly focus on CLUST_ST, GERD_IND, UNI_IND_COL, and GERD_GEN [21,98,102,109,121,162]. It might be argued that this is due to the recognition of the positive impact of collaborative efforts between university and industry to improve innovation capability, previously reported by developed countries [34,35,97,107], and as a result of this cooperative linkage, innovation funding from public and private sources, as well as the spread of the cluster gain pace [42,106,125,131,162]. In contrast, the study of a trendy topic, for example, the role played by IP_PROTEC in developing innovation capability, is relatively low in this group of countries. Similarly, the analysis of innovation outputs has received less attention in comparison with developed countries, except for UTI_MDEL [133,149,163]. Lastly, there are few comparative studies between the two classifications of countries analyzing the performance of the innovation determinants under research.

Regarding country representation, Figure 3 shows the percentage of participation in the publications by region.

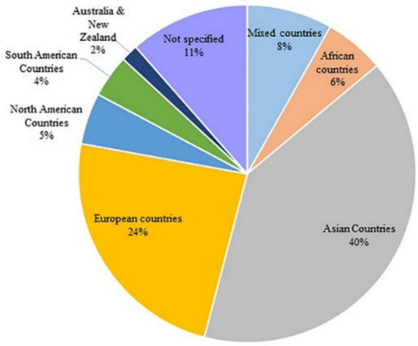

Figure 3. Percentage of participation in the publications by region.

The configuration of Figure 3 presents the participation of continental regions in the publications considering if the study was handled in a single developing country, a comparison between a developing country and a developed country, or if it was a comparative study among several countries. At first sight, Asian countries have paid significant attention to investigating the variables included in this study, particularly China with 29 studies, whether analyzing the country itself or comparing it with others. These results reflect the recent innovation policy reform adopted in 2013 by this developing country oriented toward improving and enforcing IP_PROTEC, increasing GERD_GER, GERD_IND, and enhancing CLUST_ST and UNI_IND_COL to consolidate this country as a technological potency [164]. Further, European countries participated in 24% of publications, including six conducted in a set of countries from the region, where the studies focused on CLUST_ST and UNI_IND_COL. Although the European Union has extensive research- and innovation-policy framework, the frequency of participation of a particular developing country is lower than in developed countries. In contrast, African countries participated in 6% of the studies (also oriented to CLUST_ST and UNI_IND_COL), where South Africa stands out in five studies. This continent developed the Science, Technology, and Innovation Strategy for Africa 2024 (STISA-2024) to respond to the demand for technology, innovation, and science to improve common welfare [165]. These findings show the current efforts of the region to generate national innovation capacity as South Africa was the only country with a national innovation policy in 2010. American countries have a low representation: 5% for North America and 4% for South America, where Canada (2) and Brazil (3) are the countries with more participations in the respective region. Brazil has recently implemented a national innovation policy to strengthen the environmental sustainability of the country and social development [166]. In addition, 8% of the studies comprise various countries from different regions, where the United States (6) stands out. Finally, 11% of the publications do not specify the country or countries under study.

It is pertinent to consider the research methods applied in the studied publications. This analysis provides insight into how the study of the innovation determinants included in this work has been approached. The analysis initiates by identifying the foundational approach adopted, allowing the classification of the contributions between mainly conceptual- and empirical-based. The 122 publications included two systematic literature reviews and one purely conceptual, a total of 3 conceptual-based works, while 119 adopted an empirical approach. Hence, it might be interpreted as the interest in researching the practical implications of innovation determinants on developing innovation capability.

Figure 4 shows the distribution of the publications regarding the empirical approach classified primarily as quantitative, qualitative, and both simultaneously.

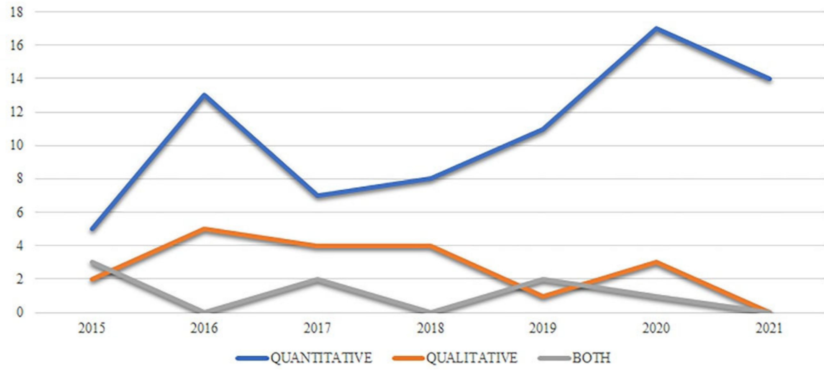

Figure 4. Temporal distribution of publications by methodological approach.

Looking closely at empirical publications, the application of quantitative methods has had positive growth, especially during the last three years. Among the main quantitative approaches implemented by the authors are regression models (17.21% or 21 publications), statistical analysis (13.93% or 17 publications), and econometric models (8.20% or ten publications). In contrast, authors have decreased the adoption of the qualitative approach during the same period, where the primary method adopted is the case study methodology (7.38% or nine publications). Finally, studies adopting both quantitative and qualitative approaches are published in an average of two studies every second year, in total of eight publications included in this work (6.56%). These results show the relevance of quantitative research, particularly regression models, statistical analysis, and econometric models, to provide empirical elements for understanding the impact of innovation determinants on national innovation capability and further outline innovation policies.

4.2. Characterization of Interviews

Parallel to the systematic literature review, various experts (12 academics and 14 practitioners) from Ecuador (a developing country) participated in an interview. The results of the interviews were published as a dataset by Novillo et al. [81]. Figure 5 presents the percentage of participants by the position occupied at their organizations.

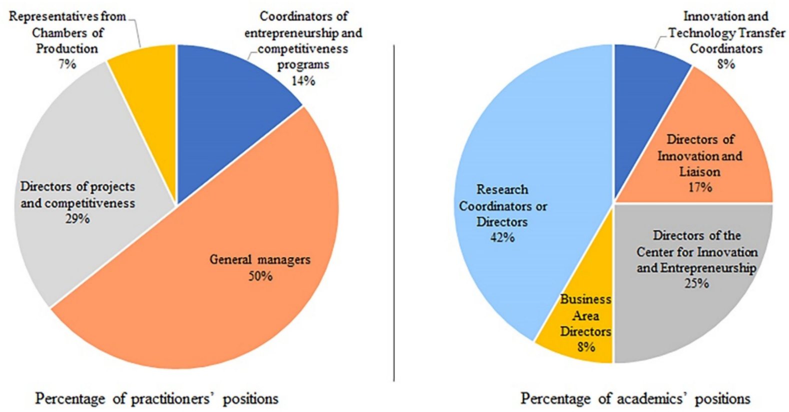

Figure 5. Percentage of participants' positions.

Regarding the distribution of practitioners, half of them occupy the CEO position of the company, while 43% are related to planning, entrepreneurship, and competitiveness. Further, academic participants correspond to experts related to innovation and R&D areas from different universities with their main headquarters in Ecuador.

Among the first questions asked to the experts was how is innovation perceived in the organizations where they belong (Q6 for practitioners: In the industrial sector to which your organization belongs, how innovation is perceived? Close question with more than one option possible; and Q5 academics: In the university to which you belong, how innovation is perceived? Closed question with more than one option possible). Figure 6 presents the comparison of their answers.

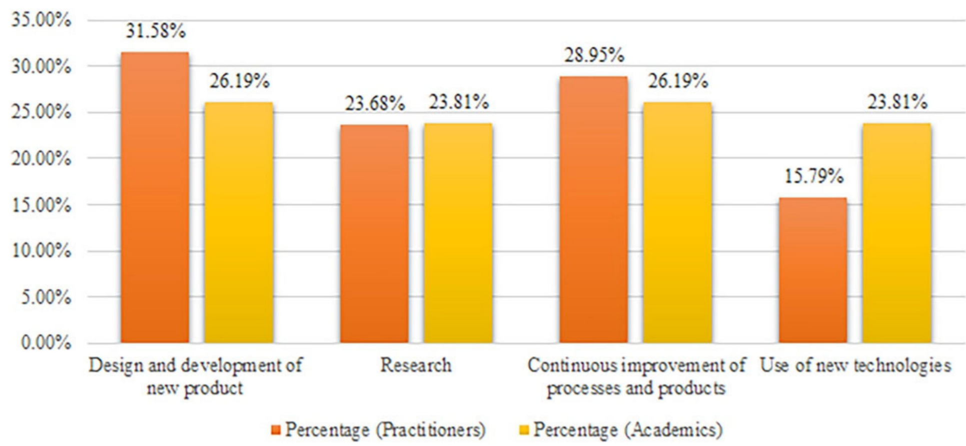

Figure 6. Perception of the innovation concept.

On this question related to the perception of innovation by universities and business entities, the responses leading the chart are the design and development of new products (31.58% practitioners and 26.19% academics), followed by the continuous improvement of processes and products (23.68% practitioners and 23.81% academics). These answers show a similar perception across business and academic environments. This is also in line with the literature definition of innovation capability [4,19]. The following section will discuss findings from the interviews related to the innovation determinants under study.

4.3. Discussing Findings from Systematic Literature Review and Interviews on Innovation Determinants

Developing innovation as a dynamic capability is a complex undertaking [47]. Numerous variables need to be considered for its growth [64]. Moreover, various indexes posed to measure the performance of innovation capability [2,4,16,31,48,167]. However, this task might be overwhelming for a developing country required to keep up with several variables at once. The 14 innovation determinants were systematically modeled by ISM to identify the structural correlation between them to understand their impact on the innovation capability [43], providing an initial ground for a path to develop this capability, particularly in developing countries. This present work presents a comprehensive analysis of these determinants from the literature review and the interviews with experts to propose a conceptual framework to enrich theory building in the area of innovation capability development.

4.3.1. The Prominence of State of Cluster Development and Depth (CLUST_ST) for Developing Innovation Systems

Innovation capability development depends on the interactions between various agents such as government, industry, university, and customers, among others, leading to innovation outputs. Further, these interactions are fashioned by a policy framework, openness to investment and trade for R&D, and “economic geography” [11,13,17,55]. Studies from developed and developing countries show the positive impact of CLUST_ST on establishing a sustainable framework (including financial sourcing, investment, and policies) that prompts R&D and innovation undertakings by public and private sectors in a geographic region [34,35,90,109]. The firms born directly in high-tech industries in university spin-offs are more likely to effectively leverage government support and take advantage of able resources and spillover externalities generated by innovation systems and specialized clusters [21,86,92,109,168]. In addition, the interviews showed comparable findings, where the participants held a similar perspective, where practitioners and academics agreed on the relevance of developing innovation clusters to enhance the innovation performance of a productive sector. Hence, CLUST_ST, as the level of development and widespread innovation clusters, contributes to leveraging the innovation performance of each agent and implementing a proper policy framework. Public and private innovation agents need to participate in generating such a framework. Further, as they exchange efforts and resources, CLUST_ST becomes robust. The integration among the actors related to an innovation system is prompted by developing a sustainable environment for innovation [21].

4.3.2. The Role of University-Industry R&D Collaboration (UNI_IND_COL) on CLUST_ST

CLUST_ST is closely related to UNI_IND_COL, as one of the determining factors of CLUST_ST is the strength of the linkage and collaboration between industry, university, and research centers [4,55,88,169]. The engagement in innovative undertakings is closely related to the relations and cooperation established through indirect, mediated, formal, or informal ties among these innovation agents, where the universities are viewed as the originators and disseminators of valuable knowledge [84,97,99]. The strength of those ties depends on diverse factors such as specialization, funding sources, in-house research capabilities, knowledge-based sector, and entrepreneurship orientation of both industry and universities [38,98,109]. Moreover, special linkages originate through innovation support programs conducted by research centers that provide an initial stage to develop innovation capabilities, in particular, oriented toward small and medium-sized enterprises (SMEs). For example, Kurdve et al. [170] identified the positive impact on SMEs' collaboration skills and absorptive innovation capability when research centers, integrated by academia and industry, coached these firms. By taking note of the benefits gained by the productive sectors in developed countries when collaborating with the universities to enhance their innovation capability, several efforts have been made to strengthen the same linkage in developing countries [109]. In this regard, although practitioners and academics acknowledged the necessity of collaborative links between industry and academy to enhance their research and innovation capabilities, they also recognized the lack of engagement in mutual innovation undertakings in the Ecuadorian context, where academics perceived far distant the relationship with the industry while practitioners perceived an indifferent distance to the university. Thus, it might be argued that in many developing countries, the university is mainly perceived as a training center to prepare professionals to work in a plant. Now the university is working to enhance its role as an active R&D agent, but the industry is skeptical about joining efforts in this direction with the university. The collaboration of these two innovation agents is critical to enhancing innovation performance, as it frames the state of cluster development. Thus, to promote their integration in R&D initiatives, a mediator agent might serve as a bridge between them and the available resources for R&D.

4.3.3. The Impact of Gross R&D Expenditure and Performance on Implementing Innovation Capability

Another relevant variable for developing innovation capability is GERD_IND, which determines the funding and performance of resources allocated for R&D by the industry and private sectors. The selected studies showed a positive impact of GERD_IND on firm competitiveness [37,89,107,119,122]. Private sectors make a significant contribution by financing resources for disruptive innovation [111]. Thus, accessing financial resources stimulates engagement with innovation and R&D activities and undertakings. However, it is necessary to distinguish the reality between large firms and SMEs, where the former are more flexible in their capability to allocate resources for R&D, whereas the latter are restricted in doing so [21,37,95,170,171]. In addition, interviewees remarked on the need to channel private investment into R&D activities and projects within a business-model framed to integrate industry and university for developing new products and services that generate benefits and financial returns for both counterparts. In addition, Choi et al. [110] found a positive and long-term effect on firms' revenue when adopting an intensive investment strategy directed at product innovation. An intensive investment strategy toward process innovation showed a positive impact also but was not as effective as the former strategy. Hence, firms should develop and offer market-oriented innovative products to gain a competitive advantage.

Similar results are found when considering GERD_GEN. There is a positive impact of sourcing R&D on the innovation capability of a country [95,103,113,125], as "expenditure on R&D reflects the nation's absorptive capacity and represents innovation efforts" [131] (p. 6). However, it also appears that public R&D funding is less effective than private funding concerning the expected results [42,113,114]. In addition, there is a distinction between how universities and enterprises benefit from public funding, as universities seem to benefit more from public R&D funding [34,38,98]. When comparing developed countries to developing countries, the former are more capable of directing financial resources to R&D undertakings than the latter. In contrast, developing countries have restricted budgets where investing in R&D is not perceived as a priority, although necessary to compete in dynamic and uncertain environments [21,95,116]. Many interviewees pointed out the need for direct and indirect public incentives, for example, reducing taxes and enhancing funding, anti-corruption strategies, and information transparency, for innovation and R&D projects to foster innovation capability, which is in line with [4,11,26,103,135,172,173]. Moreover, GERD_UNI is supported by both public and private sources due to the role of universities in generating and spreading knowledge as part of their core mission, which shows the entrusted position that universities have gained as R&D agents [89,170,174]. Through GERD_UNI, these institutions prompt research and innovation capabilities in the environment where they interact, leading to improve innovativeness at a country level [104,108,168]. In this regard, interviewed academics and practitioners remarked on the need for a leading program to direct public and private investments to achieve public and private R&D goals where the industry contributes to its market knowledge, labor force and the university provides the expertise on research and innovative mechanisms to solve the needs of productive and public sectors. Regarding the context of developing countries, it is necessary to transparent and decentralized R&D investments and expenditures to gain the trust and commitment of all the stakeholders.

4.3.4. The Need for R&D Full-Time Personnel (R&D_PERS) to Develop Innovation Capability

The accurate performance of GERD_IND, GERD_GEN, and GERD_UNI demands hiring skilled staff capable of designing and executing R&D and innovation projects targeting practical and effective innovation outputs, e.g., patents, new products, processes, etc. [4,37,122,175]. Thus, universities are considered the primary training center for R&D_PERS, due to their role in knowledge transference [170,174]. R&D_PERS needs to develop the competence to concentrate its efforts on permanently generating new ideas and implementing innovation goals and key measures to track innovation performance on a daily-based operation [81]. Therefore, the allocation and instruction for R&D_PERS are necessary to develop and sustain R&D and innovation operations [21,122,136]. Furthermore, R&D_PERS is responsible for managing R&D collaboration in-house and with external counterparts such as research centers, universities, and government agencies to improve their innovation system by providing cost-advantage and benchmarking opportunities [21,37,176]. With this in view, organizations and, more broadly, countries should invest in human capital to enhance innovation performance [122,177]. Proper SPEN_EDU directs the development of contextual competencies and skilled staff to perform diverse technical, specialized, R&D, and creative tasks [81,82,131,154]. Thus, SPEN_EDU and the allocation of that spending are critical drivers for developing human capital, where human capital constitutes a crucial factor in innovation and economic growth [21,95,103,152]. Some developing countries have implemented R&D_PERS strategies to enrich their labor force as part of their broader innovation policy framework. Nevertheless, the innovation system of those countries is not attractive enough to retain this group of skilled personnel. Therefore, developing countries should generate an approach to allocate SPEN_EDU properly, and R&D_PERS is instructed but also effectively integrated into the national innovation system.

4.3.5. Openness (OPEN_INV) to Promote Innovativeness

The openness to foreign investments and trade is among the critical policies stimulating or limiting innovation capability. OPEN_INV is particularly relevant to generating an innovative environment for developing countries [103,116,131], as its scope reaches the design of international programs and policies to achieve local and regional benefits from export trade, spillovers, and integration [38,95,131,135]. In a study conducted in Sri Lanka, Adikari et al. [131] determined that while firms should concentrate their efforts locally on R&D undertakings to generate innovation capabilities, their primary incentive should be accessing advanced technology when going after foreign direct investment. In addition to these findings, from an exploratory study with a sample of 49 African countries [135], the authors concluded that countries with relatively high incomes had a better performance in their innovation capability by adopting a domestic orientation (control of corruption, financial inclusion, and education), whereas, countries with relatively low incomes enhanced their innovation capability by adopting an international orientation (inward migration, trade agreements, and export specialization). Responses from practitioners and academics pointed to the need for access to state-of-art technology through public policies and government incentives directed toward ease of R&D trade and investments. From the literature and interviews, it might be argued that OPEN_INV strategies and policies outlined by governments set the stage on which innovation agents interact with external actors in other countries to access resources that might be limited locally. Moreover, openness has a positive impact on generating new ideas, as exposure to new products, technologies, processes, and services triggers creativity. Thus, OPEN_INV policies should focus on stimulating FDI on R&D and developing a trade frame to reduce the technology gap and enhance CLUST_ST.

4.3.6. Strength of Protection for Intellectual Property & Promotion (IP_PROTEC)

Innovation is a proactive and risky undertaking, and developing this capability provides a competitive advantage. Nevertheless, it requires financial funding, human capital, and technology [81]. Hence, public policies protecting and promoting intellectual property (IP_PROTEC) have a positive impact on investing in innovation and R&D undertakings [108,123,130,161]. For example, Nhemachena et al. [95] found a robust relationship between strengthening IP_PROTEC systems and releasing new varieties and wheat productivity in South Africa. However, the study also showed that boosting IP_PROTEC is not enough incentive for all scenarios to prompt innovation investment. Further, Holmes et al. [161] identified the positive effect of IP_PROTEC and high industry growth on attracting foreign R&D investment, where higher degrees of IP_PROTEC had a positive impact on foreign R&D investment, while lower degrees of IP_PROTEC had a contrary effect. In this regard, academics and experts pointed to the need for IP_PROTEC policies that stimulate R&D initiatives. During the initial stages of the configuration of a national innovation system, developing countries require to start by implementing flexible strategies for IP_PROTEC that allow some degree of imitation and stimulate informal innovation processes. As the innovation system becomes robust, these countries should improve IP_PROTEC policies showing their commitment to enhancing innovation performance and developing this capability.

4.3.7. The Relation of R&D Institutional Prominence with Innovation Capability

When engaging in an innovation undertaking, selecting the proper partner might determine the impact and success of such a task [84,92,107]. PROMIN_ gains relevance as it is linked to the scientific performance of universities and research centers [2,48,178,179]. Hence, studies have shown a positive effect when firms engage with specialized research centers to achieve innovation outputs and scientific absorptive capacity [84,89,99,104,116,155]. In addition, among the observations made by the experts during the interviews emerged the need to develop the capability to transfer the expertise, knowledge, and technologies from universities and research centers to the production sectors in the context of a developing country [81].

4.3.8. Innovation Outputs to Trace the Steps for Developing National Innovation Capability

Innovation capability performance results in innovation outputs [92,104]. Among them, SCIEN_PTNT is largely used to measure innovation capacity [4,12,19,133,180]. Patents comprise novelty, invention, and non-obviousness, and the process to register a patent might result exhaustive and expensive. Further, SCIEN_PTNT quality depends on well-organized UNI_IND_COL [34,42,98,127] and on access to R&D funding to support innovation and R&D processes necessary to achieve innovation outputs [81,89,102,108]. Further, UTI_MDELs are a particular form of invention patent that is more affordable and flexible than granting a regular patent [169]. Thus, UTI_MDELs are regarded as an accessible path for achieving innovation, particularly in developing countries, as they improve companies' innovation performance by encouraging technical learning while reaching a patentable invention [81,124,133,163,180]. Finally, a TRADEMARK constitutes a noteworthy intellectual property for an institution that dedicates resources as well as creative and innovative capabilities to develop a brand communicating a precise market identity to differentiate from its competitors [117,126,159]. All this points to the necessity of innovation systems prompting the generation of innovation outputs and protecting the commercialization of new inventions and investments in mark creation [39,81,117,126].

As previously pointed out, UNI_IND_COL is closely related to CLUST_ST, thus, this latter variable also has a positive effect on developing the necessary structural knowledge to enhance innovation outputs portfolios and landscape [38,82,134]. CO_INV also results from joined efforts between industry, universities, and other institutions sharing innovation goals [34,81,84,89,99]. CLUST_ST and PROMIN_ lingkages have a significant impact on the process of co-creating value to reach innovation outputs [89]. Hence, it is necessary to design proper strategies for selecting adequate partners to gain mutual benefits and lucrative rates while attaining the desired innovation output [97,100,110]. This consideration is particularly relevant for developing countries to cope with limited resources [81,133,180]. Moreover, value creation depends on the capability to manage and market innovation outputs [39,110,117,126] for generating innovation capability to achieve a sustainable competitive advantage [5,8,19,181].

5. Sustaining the Development of Innovation Capability

From the previous discussion analyzing the impact of 14 innovation determinants on developing innovation capability and the relationships between them, a conceptual framework is presented for sustaining the development of this dynamic capability to achieve a further competitive advantage. Figure 7 shows a systematic path including public policies, government incentives, business-university linkages enablers, innovation clusters development, and achievement of innovation outputs.

This path proposes an incremental loop where innovation as a dynamic capability provides temporal advantages for organizations to be ahead of competitive forces while enhancing and sustaining the growth of such capabilities, making them challenging to imitate [5,8,182,183].

First, it is necessary to establish solid ground where to develop innovation capability. Hence, local and national government support plays a role in accomplishing this task by designing policies to promote institutional collaboration, mainly UNI_IND_COL, to engage with innovation and R&D activities. The proposed policies should consider local innovation agents and cope with the particular needs and priorities of developing countries. Innovation agents are willing to collaborate between them when compelling benefits are perceived while investing in R&D undertakings. Thus, an innovation policy framework includes economic incentives such as tax reduction, subsidies, and openness to R&D foreign investment and trade to ease access to state-of-art technology, among others (OPEN_INV and SPEN_EDU). In addition, implementing and improving intellectual property protection mechanisms (IP_PROTEC) are perceived as a public commitment to enhancing the national innovation system. In the initial stage, one of the limitations for governments from developing countries is their lack of transparency and anti-corruption strategies that permeate innovation systems. Thus, in addition to supporting OPEN_INV, IP_PROTEC, and SPEN_EDU initiatives, it is necessary to increase transparency and promote an environment of trust in this process to stimulate the participation of innovation agents in R&D undertakings.

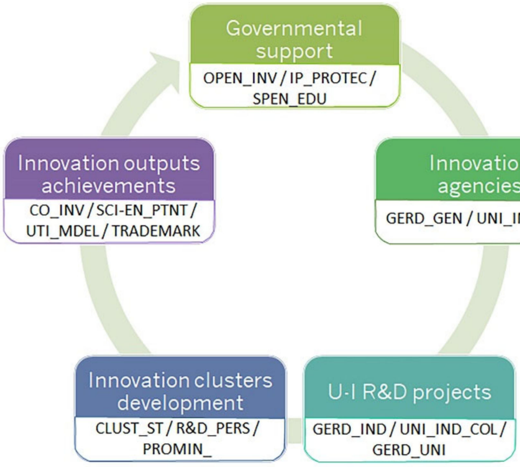

Figure 7. A conceptual framework for sustaining the development innovation capability.

Second, from the systematic review and interviews was identified the need for an impartial innovation agent to connect productive sectors, universities, and research centers. Innovation agencies play an intermediary role in implementing innovation policy frameworks and promoting mechanisms to generate a collaborative environment between innovation agents participating in an innovation system, especially industry and university linkages (UNI_IND_COL). As intermediaries, these agencies promote the organic development of an innovative ecosystem to foster scenarios where firms and universities interact and share ideas and resources to participate in R&D activities for mutual benefit. Additionally, they pool sources of financial and scientific resources for industry and university innovation (GERD_GEN). They also provide training programs to facilitate knowledge transference and the management of R&D projects between firms and universities. Here it is necessary to establish mechanisms to guarantee the transparency and decentralization of these agencies. To be an effective intermediary, these innovation agencies need to be part of the innovation system where they operate to rapidly identify relevant market trends and the impact on the supply to provide informed advice, to companies and universities, on when and where to locate their R&D resources and efforts. In addition, they should generate unbiased spaces to establish collaborative networks between potential partners that could join in a particular innovation undertaking. This is particularly important to support SMEs with limited resources in developing countries. Innovation requires proactive behavior and a willingness to take risks. Therefore, SMEs need guidance to effectively focus their innovative efforts to optimize their limited resources and establish a position in a business network.

Third, as the innovative ecosystem matures by taking advantage of the stages aforementioned, firms and universities partake actively in R&D + innovation programs and projects (course projects, internships, thesis, curriculum development, etc.) to generate practical solutions for the stakeholders involved. From these interactions, firms and universities channel and perform resources (GERD_IND, and GERD_UNI) for innovation undertakings. This engagement promotes the growth of innovation capability and competencies to further develop research areas of interest for the local innovation system (R&D_PERS).

As a result of this organic integration, it is possible to generate innovative business-model frameworks (PROMIN_).

Fourth, the configuration of technology, innovation, and science clusters is the next natural stage where there is a strong commitment between innovation agents. Firms are willing to invest in R&D as the tradeoffs are clear, and universities efficiently use R&D resources and capabilities. All this leads to establishing geographic spaces to develop technology and science parks to stimulate even deeper and spread scopes toward innovation (CLUST_ST). Thus, this requires revising the innovation policy framework to integrate policies promoting R&D investments to equip and sustain these parks.

Fifth, the innovation outputs result from effective play-out innovation capability, competencies, resources, and efforts. Due to the limitations and complexity of developing countries, the innovation policy framework requires including diverse innovation outputs to accommodate open and close innovation approaches. To further stimulate innovation outputs, these governments need to ease and promote IP rights for registering utility models and patents and creating local and regional trademarks (CO_INV, SCIEN_PTNT, UTI_MDEL, and TRADEMARK). Finally, these stages need to inform each other to adapt, intensify, or modify the strategies and policies to consolidate a robust national innovation system in the long run.

6. Conclusions

The capability of a country to innovate is a crucial factor in its competitiveness. Developing countries recognize the need to generate adequate actions to enhance innovation capacity for the welfare and sustainability of their countries. Various indexes seek to measure the performance and development of this capability. Nevertheless, keeping up with every assessing mechanism and indicator might be overwhelming for a developing country with limited resources. This research presents a conceptual framework aiming to ease this task of developing innovation capacity for this group of countries from a theory-building approach.

From the comparison of three innovation-assessing mechanisms (GII, NIC, and GCI), fourteen innovation capabilities were identified as relevant to developing national innovation capability [43,81]. These three mechanisms were selected due to their global reach and transparency. Further, a systematic literature review [79] and interviews with experts were conducted to identify the role and impact of the 14 innovation determinants on the innovation capability of a country. The discussion integrated the findings with interviews conducted with practitioners and academics related to innovation and R&D activities in the context of a developing country. The analysis presented the significance of these innovation determinants to the development of innovation capability and the relationship between them and complemented the findings from previous work [43]. For a theoretical contribution, all this allowed the construction of a conceptual framework for sustaining the growth of this dynamic capability by presenting an incremental path with five stages for stimulating innovation systems in developing countries. The five stages systematize practical strategies to enhance the impact of the 14 innovation determinants included in this framework, outlining the general conditions required in a developing country to stimulate local innovation agents to participate in R&D + I initiatives.

Furthermore, this work highlights some relevant aspects surrounding the research related to innovation capability. First, most of the empirical studies regarding the innovation determinants under examination were conducted in Asian countries, where China is the largest contributor and is still classified as a developing country by the World Trade Organization [184], followed by studies made in groups of European countries, mainly Spain, Russia, and the United Kingdom. In contrast, limited research was found from Latin American or African countries (with most countries classified as developing), where enhancing innovation capability might boost their competitiveness. Therefore, this study contributes from the perspective of one of these Latin American countries [185]. Second, the methodology in most of the studies used objective data collected from local, national, or regional institutions allowing the reduction of the bias drawn in their results while assessing innovation variables. Third, this study offers a general view of national innovation capability. However, the potential and contribution to enhancing this capability differ depending on the firms' size and ownership. Hence, it is of interest to better understand the impact of different types of companies on national innovation capacity, particularly in developing countries. Fourth, various studies analyzed more than one innovation determinant at the time, and innovation outcomes have received little attention in general, except SCIEN_PTNT. Thus, future research should evaluate different innovation outcomes such as UTI_MDEL, TRADEMARKS, and invention profit rates, among others, especially relevant for developing countries. In addition, this study examines the complex interactions between 14 determinants of innovation at different levels, advancing the body of knowledge on national innovation capability from a relational approach [19].

This paper also provides practical contributions by integrating academic inputs with the perspective of practitioners. This research has led to the proposed sustainable path to innovation capability development, where a series of incremental stages pave the way to enhance this dynamic capability and further achieve a competitive advantage. The initial commitment of local and national governments is necessary to generate strategies (OPEN_INV, IP_PROTEC, and SPEN_EDU) that stimulate innovation agents to undertake innovation initiatives. However, the design of innovation policies should include public and private innovation agents participating in the national innovation system. In addition, a critical element of this proposal is the implementation of innovation agencies (as impartial participants) to guide and support the generation of an innovation environment. Each innovation agent will develop this capability depending on their interest and willingness to integrate innovation systems.

Finally, this work encompasses some constraints. The systematic review encompassed the analysis of 122 articles in English related to the studied determinants published mainly in prominent journals on innovation, public policy, and management; nevertheless, this does not mean that the publications are a complete sample of peer-review journals. The period and databases selected may not comprise some articles related to the scope of this research. Finally, the conceptual framework does not explicitly include political, social, or proper cultural conditions for developing countries. However, these aspects can be related to, for example, IP_PROTEC, OPEN_INV, or CLUST_ST [11,186,187]. Thus, a suggestion for future research relays the analysis of the relationship between the 14 innovation determinants and social attributes.

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