

Área: Inovação | **Tema:** Temas Emergentes em Inovação

EVOLUÇÃO DAS HÉLICES DE INOVAÇÃO: ABORDAGENS DO MODELO DA QUÍNTUPLA HÉLICE

INNOVATION HELIXES EVOLUTION: THE QUINTUPLE HELIX MODEL APPROACHES

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RESUMO

Inovação é a meta mais importantes pela qual uma firma deve objetivar, porém de modo mais amplo, a Academia e o Governo estão muito envolvidos nesse processo, seja em fomentar conhecimentos científicos, capital intelectual, políticas e fomento para alta tecnologia, incentivos fiscais ou outros impulsionadores para isso. A literatura dispõe de diversos estudos sobre o modelo de Tríplex Hélice, no qual nos apresenta mecanismos de colaboração e interação entre essas instituições, porém há uma lacuna de estudos afim de organizarem estes dados, a pontuar a evolução do estado da arte das hélices da inovação. Para tal, o presente estudo, a partir de uma análise bibliográfica, organizou a literatura sobre o que tem sido estudado em termos do modelo da Quíntupla Hélice de Inovação.

Palavras-Chave: Quíntupla Hélice, Modelo de Hélices da Inovação; Sustentabilidade

ABSTRACT

Innovation is the most important goal that a firm must thrive, meanwhile by a widest view, Universities and Government are too much involved in this process, being it on offering scientific knowledges, qualified workforce, high technology politics and scholarships, tax incentives or others promotion programs. The literature has a relatively large number of studies approaching the Triple Helix model, which present us collaboration and relationship mechanisms between those institutions; however, there are a lack of studies seeking to organize this literature in order to point out this knowledge's state of art evolution of Innovation Helixes. Perceiving this gap, the present work aims to make a bibliographic analysis aiming to organize the literature of what has been researched in terms of Quintuple Innovation Helix.

Keywords: Quintuple Helix; Innovation Helixes Model; Sustainability.

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Key-words: Quintuple Helix; Innovation Helixes Model; Sustainability.

1. INTRODUCTION

Innovation must take place in a region that needs to be stimulated through the adoption of certain public policies that to regional development as a means of integrated, rather than fragmented and reductionist. In this way, the adoption of a new methodology is necessary as a strategy to cover all regional actors responsible for leveraging development.

As a way of highlighting the importance of innovation in the process of developing a region is that it highlights the concept that evidence of a joint action by the as Etzkowitz (2009) points out. The Triple Helix paradigm comes to the to the social aspirations of the adoption of policies of the governmental transversality, where it is necessary and fundamental for the participation of industry (private companies) with the contribution of capital, universities giving support and conceptual framework, together with the government acting through policies of tax incentives, with a view to the regional."

The Triple Helix describes this new model innovation and helps students, researchers and legislators in addressing issues such as: how we broaden the role of universities in social and regional development? How governments at all levels can encourage citizens to play a key role in active role in promotion and innovation and, conversely, how citizens can encourage their

governments to do this? As the companies can collaborate with one another and with universities and governments to become innovative? What are the key elements and challenges to achieve such goals?

As you can see, innovation becomes an instrument of power, generating a competitive advantage, which emphasizes the adoption of this partnership methodology government - university - company with purpose of developing public policies of science and technology based on the interaction of triple helix. Thus, within the contribution of innovation, the Triple Helix dynamics, the government is the main protagonist and partner-supporter innovation and development together with the companies that bring together the productive country, based on universities, where the knowledge is the raw material.

Therefore, how the innovation helixes literature has been developed? What are the main trends in the topic? To answer these questions the present study aims to develop a bibliographic analysis on quintuple innovation helix, considering studies published between 2010 and 2018, that is, during the last 8 years. The period under analysis comprises the absence of updated analyzes and, consequently, the unknown of what have been studied, possible new approaches, gaps and conceptual trends that have been developed within the period. By achieving the paper goal, the review will contribute to the development of innovation management studies, providing a knowledge roadmap for researchers and managers guiding them in the area.

2. INNOVATION HELIXES

Etzkowitz (2009) presents the Triple Helix as the key for innovation everywhere, being societies based on knowledge. Since the creation, dissemination and use of knowledge move from the periphery to the center of governance and production industry, the concept of innovation in products and processes, is itself being transformed into (Etzkowitz & Leidesdorff, 1995).

The authors Carayannis and Campapbell (2010), propose an interdisciplinary and transdisciplinary framework of analysis relating three important concepts, knowledge, innovation and the environment. Concepts that in themselves have a high complexity. The model title quintuple helix includes in its model the natural environments. These natural environments

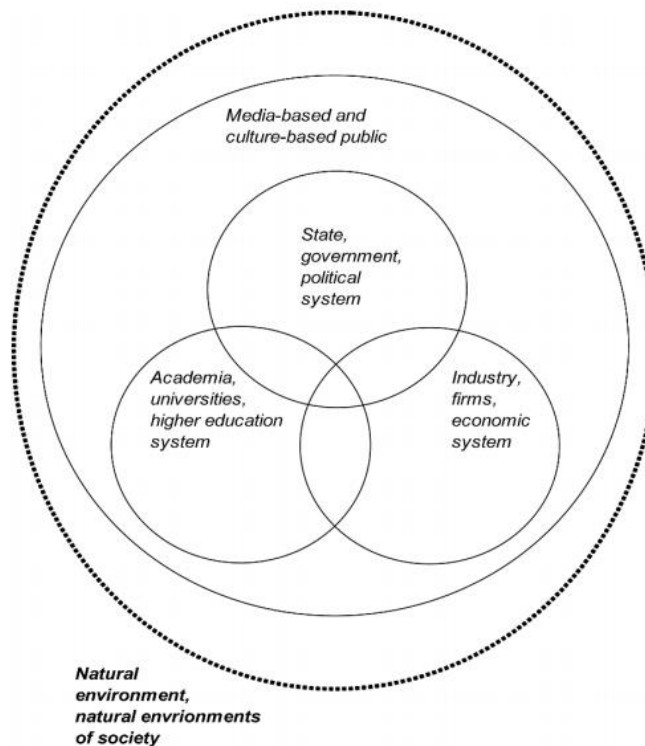
describe the complex relationship between different political, economic, and social systems that involve society.

Although the term natural environment gives an idea of the concept of nature, linked to ecology, the authors' proposal treats society as a "natural environment". Society with its multiple levels of aggregation: local - regional - supranational - global, formed by diverse actors. The natural environment includes the process of knowledge and innovation as intrinsic characteristics of society.

According to the Oslo Manual OECD (2018), the natural environment can be an important external factor that influences the decisions of firms, including changes in environmental amenities, flooding and other natural disasters, pandemics and epidemics, climate change, and water, soil and air pollution.

Figure 1 presently visible the model proposed by Carayannis and Campapbell (2010).

Figura 1: The four and five-helix model of the Quintuple Helix



Source: CARAYANNIS AND CAMPAPBELL (2010)

The quintuple helix covers, first, the triple helix - university, industry and government relation, and the quadruple helix with the media-based and culture-based public.

In this conception, the knowledge and innovation achieved in the previous phases would extend the capacity of non-linear models of innovation, where the application of development practices would overflow. According to the authors, Carayannis and Campbell (2010), the Quintuple Helix has the potential to serve as an analytical framework for sustainable development and social ecology, by conceptually relating knowledge and innovation to the environment, besides enabling the description of what sustainable development, as well as issues such as eco-innovation and eco-entrepreneurship.

To Carayannis, Barth and Campbell (2012, p. 1), “The Quintuple Helix supports here the formation of a win-win situation between ecology, knowledge and innovation, creating synergies between economy, society, and democracy”. Opportunity use for global sustainability issues.

3. METHOD

The present work consists of a bibliographic analysis on quintuple helices. This is a method that fits well when the objective is mapping and evaluation a knowledge area, besides it enables to specify a research question in order to develop and advance the scientific background that requires an investigation (Tranfield, Denyer & Smart, 2003). To achieve the goal of mapping and evaluating the intellectual territory of the given area, the method focuses on establishing a research question that uses an explicit and systematic method to identify, select and evaluate relevant papers in order to collect and analyze data from them (De-La-Torre-Ugarte, Takahashi & Bertolozzi, 2010). In sum, this method allow the researcher to identify the evidences and synthesize them, aiming to present the state of art and future trends of a determined topic (De-La-Torre-Ugarte, Takahashi & Bertolozzi, 2010).

This paper will follow the three stages proposed by Tranfield et al. (2003): planning, executing and reporting the results. The planning stage consists in the identification of the need to do the revision, in the proposal preparation and in a review protocol development. Moreover, the execution phase is the stage that needs the studies identification that will be considered in the paper

and, consequently, extracted, evaluated, monitored and synthesized. Lastly, in the reporting phase, it is necessary, besides reporting, to recommend and to suggest the evidences collected.

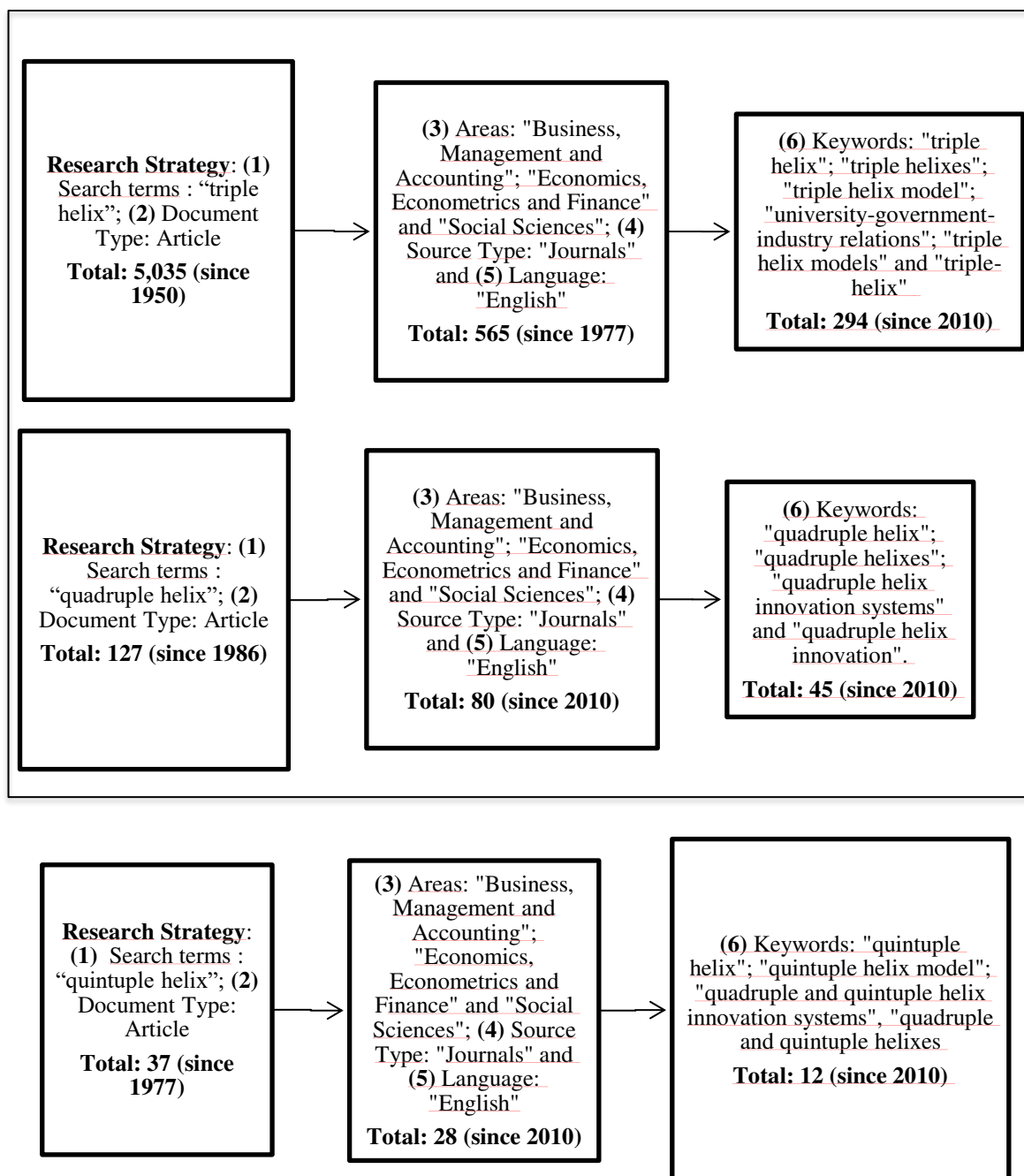
3.1. Planning Stage

During the planning phase, it was defined that the research objective consists in develop a review of the literature on innovation helixes considering studies comprised between the years 2010 and 2018. The period under analysis was chosen due the fact that, when a preliminary research was done in order to identify the strategy possibilities, the first studies about the topic using the defined strategy was dated in 2010. Besides, this scenario repeated when the proper research was effectively done. As the aiming of this study is map the knowledge arena, we decided to cover all the period in order to organize the existing knowledge and point out it possible trends. To doing it was necessary a broad and consolidated data source, with a high publication coverage, besides containing high impact and peer reviewed publications (Podsakoff et al., 2005). Therefore, the Scopus database was defined as the basis for the research due to the fact that it fulfilled those requirements.

The search term was defined based on an extensive bibliographic review that allowed the authors to create a list with the most relevant search terms for the article purpose. By doing so, it was defined “quintuple helix” as search terms and then applied it in the Scopus database aiming to verify how the results would behavior. In this sense, this search term generated 36 papers to be analyzed and, as consequence, this scenario implied a need for new filters to refine this scope.

The new filters included then consists in “Business, Management and Accounting”, “Economics, Econometrics and Finance” and “Social Sciences” as the areas of coverage, “Article” as document type and, lastly, “Journals” as source. Besides, we select papers that use the English as a written language and specific keywords generated by the search terms applied in Scopus. These filters refined the results and provided more specificity, generating 12 papers. So, as it can be seen in the figure 1, our research protocol followed in defining the research strategies in the first step, then the first and second inclusion/exclusion criteria and, finally, the articles’ quality assessment. All these steps proposed in figure 1 will be totally explained along the methodology session.

Figure 2: Triple and Quadruple Helixes Search for Data Comparison



Source: The Authors (2019).

3.2. Executing Stage

The execution stage proposed by Tranfield et al. (2003) comprises five steps: (1) grouping publications; (2) compiling the considerations; (3) classifying and defining result typologies and, lastly, (4) result synthesis. In the first one, we will collect all the papers generated by the strategies applied in the Scopus and download them into the software Mendeley 1.18 version aiming to better manage all the articles. Then we will create an Excel spreadsheet containing cells to allocate and organize all the collected information from the articles, both included and excluded.

So, all the articles based on Mendeley 1.18 will be read at least the title and the abstract. If title and abstract matched with the inclusion criteria (innovation capability as dependent variable) we went further and read the article at all and extracted all the essential information, such as title, authors name, journal that was published, method and results, then we put into the Excel spreadsheet all this information.

The second inclusion criteria will consist in assessing the quality of the studies included to verify if there were articles with unclear structure, objectives, methods and results, that is, articles unable to match with high quality standards of doing science. This step will allow us to better refine our paper by including only studies with the best scientific structure found by the research strategy applied in Scopus database.

After this grouping activity and all the articles organized inside the same topic, the results inside each topic were read again and categorized according to the common topic. Each topic generated by the classification will be organized in a common structure and the results will be written based on the common structure.

3.3. Reporting Stage

Lastly, to approach the reporting stage it is important to observe that, after reading all the articles, we will organize them in constructs that are correlated to the variables found about the perspectives of quintuple helix.

In the results session final, we will build a table in order to present the results conclusion of this study in a synthesized way: In this way, the first column introduces the constructs; while the second will describe by the authors together that used the construct to approach innovation

capability and, lastly; the third column which contain the highlights summarized by construct as a whole.

4. RESULTS AND ANALYSIS

In this section, it will be possible to organize the found studies, according to its mainly subjects citation. Hence, in the next subsections we will discuss detailed these groups in order to specify the main findings.

Figure 3: Papers analysed.

Year	Journal (H Index)	Title	Authors
2017	Scientometrics (95)	Quintuple helix structure of Sino-Korean research collaboration in science	Yoon, J., Yang, J.S.W., Park, H.W.
2017	Journal of the Knowledge Economy (20)	Sustainable Development of the Russian Arctic zone energy shelf: the Role of the Quintuple Innovation Helix Model	Carayannis, E.G., Cherepovitsyn, A.E., Ilinova, A.A.
2017	Journal of the Knowledge Economy (20)	The Balanced Development of the Spatial Innovation and Entrepreneurial Ecosystem Based on Principles of the Systems Compromise: A Conceptual Framework	Dubina, I.N., Campbell, D.F.J., Carayannis, E.G., Chub, A.A.e Grigoroudis, E.f; Kozhevina, O.V.
2016	Journal of the Knowledge Economy (20)	A Quadruple and Quintuple Helix Approach to Regional Innovation Systems in the Transformation to a Forestry-Based Bioeconomy	Grundel, I., Dahlström, M.
2016	Journal of Teacher Education for Sustainability (9)	The transformation of traditional universities into entrepreneurial universities to ensure sustainable higher education	Bikse, V., Lusena-Ezera, I., Rivza, B., Volkova, T.
2015	Journal of Innovation and Entrepreneurship	Mode 3 knowledge production: systems and systems theory, clusters and networks	Carayannis, E.G., Campbell, D.F.J.
2014	Journal of Innovation and Entrepreneurship	Developed democracies versus emerging autocracies: arts, democracy, and innovation in Quadruple Helix innovation systems	Carayannis, E.G., Campbell, D.F.J.
2013	International Journal of Social Ecology and Sustainable Development (7)	The quality of democracy-concept vs. the quintuple helix: On the virtues of minimalist vs. maximalist approaches in assessing the quality of democracy and the quality of society	Schlattl, G.
2013	International Journal of Social Ecology and Sustainable Development (7)	Freedom, equality and the quality of democracy: Democratic Life in the United States, Australia, Sweden and Germany	Barth, T.D.
2011	International Journal of Social Ecology and Sustainable Development (7)	The idea of a green new deal in a Quintuple Helix Model of knowledge, know-how and innovation	Barth, T.D.

2011	International Journal of Social Ecology and Sustainable Development (7)	The semi-aquatic theory: Semi-aquatic evolutionary phase and environment, language development of modern humans. with a short epilog on conceptualized evolution, social ecology and the Quintuple Helix	Carayannis, E.G., Campbell, D.F.J.
2010	International Journal of Social Ecology and Sustainable Development (7)	Triple helix, Quadruple helix and Quintuple helix and how do Knowledge, Innovation and the Environment relate to Each other? a proposed framework for a trans-disciplinary analysis of sustainable development and social ecology	Carayannis, E.G., Campbell, D.F.J.

Source: Scopus (2019).

Then, according to figure 3 is possible to analyse the 12 papers found after the search guided by the method. The main authors with the majority of the published articles about quintuple helix and their area center and affiliations are Carayannis – from the European Union Research Center, Department of Information Systems & Technology Management, School of Business of The George Washington University/USA – and Campbell – from the Unit for Quality Enhancement, University of Applied Arts Vienna and Faculty for Interdisciplinary Studies, Institute of Science Communication and Higher Education Research (WIHO)/Austria –, who started publishing the first study in 2010. The third author with more publications is Barth from University of Vienna/Austria, beign co-author on his first publication with Campbell, according to his description.

The journal with more publications about this thematic is the International Journal of Social Ecology and Sustainable Development, in which Carayannis is the chief-editor, presenting 5 from the 12 studies.

According to the issue of the studies, it is possible to analyze according to figure 4.

Figure 4: Papers' issues.

Title	Study Issue
Quintuple helix structure of Sino-Korean research collaboration in science	The present study employs the N-tuple Helix Model as a suitable alternative to analyze the structure of scientific collaboration networks beyond university–industry–government (UIG) relations.
Sustainable Development of the Russian Arctic zone energy shelf: the Role of the Quintuple Innovation Helix Model	The objective of this paper is to develop the concept of sustainable development of the Russian Arctic zone energy shelf within the framework of the Quintuple Innovation Helix Model which focuses on university-industry-government relations, public and civil society, and the natural environment
The Balanced Development of the Spatial Innovation and Entrepreneurial Ecosystem	The purpose and interest of the article is to provide information for other discussion of these and other issues related to the organization

Based on Principles of the Systems Compromise: A Conceptual Framework	and management of stakeholder interaction in the process of sustainable development in space innovation and entrepreneurship ecosystem. In addition to presenting formal game theory modeling and business simulation games
A Quadruple and Quintuple Helix Approach to Regional Innovation Systems in the Transformation to a Forestry-Based Bioeconomy	This article aims to understand the possible preconditions for the transformation of a regional innovation system (RIS) into a quadruple and quintuple helix system applied to the development of a sustainable forestry-based bioeconomy in Värmland, Sweden.
The transformation of traditional universities into entrepreneurial universities to ensure sustainable higher education	This paper aims to investigate the experience and to identify the drivers of transforming traditional universities into Entrepreneurial Universities for ensuring sustainable higher education in Latvia.
Mode 3 knowledge production: systems and systems theory, clusters and networks	The purpose of the article is to establish a conceptual link between systems and systems theory and with knowledge application. They use concepts such as Systems theory, clusters and innovation networks.
Developed democracies versus emerging autocracies: arts, democracy, and innovation in Quadruple Helix innovation systems	The authors seek to investigate artistic research connections. innovation and innovation systems, based on and applying the concepts of the Quadruple and Quintuple Helix innovation systems. How does artistic research relate to research in the sciences, and how does artistic research relate to innovation and innovation systems?
The quality of democracy-concept vs. the quintuple helix: On the virtues of minimalist vs. maximalist approaches in assessing the quality of democracy and the quality of society	The aim of this paper is to highlight the need to avoid the fallacy of excessive conceptual effort in evaluating the quality of democracy.
Freedom, equality and the quality of democracy: Democratic Life in the United States, Australia, Sweden and Germany	By investigating the quality of democracy this article develops two theses:1.) Democracy with their quality rises or falls with the expression of freedom and/or equality; 2.) Democracy generates its stability from a balanced interaction between freedom and equality. With the concept of Democratic Life this article examines these two theses: Democratic Life as newly developed concept measures the quality of democracy with providing information about the type of a democracy and an approach to measure a democracy's democratic development for the top 20 of the Democracy Ranking (2009).
The idea of a green new deal in a Quintuple Helix Model of knowledge, know-how and innovation	This article is about the discussion of a correlation between a potential Green New Deal project and the scientific innovation model of a Quintuple Helix in advanced democracies to demonstrate that the sought for knowledge, sustainability, and green development can imply an excess in quality of democracies.
The semi-aquatic theory: Semi-aquatic evolutionary phase and environment, language development of modern humans. with a short epilog on conceptualized evolution, social ecology and the Quintuple Helix	This article presents the semi-aquatic theory motivated to provide an explanation for why or how did language of the modern humans develop?
Triple helix, Quadruple helix and Quintuple helix and how do Knowledge, Innovation and the Environment relate to Each other? a proposed framework for a trans-disciplinary analysis of sustainable development and social ecology	This article develops an inter-disciplinary and trans-disciplinary framework of analysis that relates knowledge, innovation and the environment (natural environments) to each other.

Source: All the studies found.

In this issues, we can observe the main related subjects as geopolitics, democracy, innovation and sustainability, approaching the European context of innovation development. About the method, most of the studies was descriptive, approaching case study, bibliographic data, survey and interviews.

5. FINAL REMARKS

The objective of this study was achieved by implementing a bibliographic analysis aiming to organize the literature of what has been researched in terms of Quintuple Innovation Helix. From the triple and quadruple helixes, their evolution – the quintuple helix – can show us that approaching variables as the environment and the community, we can have a better understanding of how we should improve innovation development processes, giving the importance that these helixes have on changing development standards.

It is possible to analyze that 12 published studies is still a small number towards to the triple and quadruple helixes, but the new world demands ask more about its contributions, trying to amplify the voice of local people and the nature situation and historic.

About the limitations of the study, it was used just one database and a basic bibliographic analysis for organizing this area of study.

For future studies, it is possible to highlight the relations between the three concepts of helixes and to identify the main cases in the world, classifying them according to their related thematic and datas as GDP and build the maps of relationships and shares between universities, governments, companies, the environment and the local community.

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