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THE BIBLIOMETRIC ANALYSIS OF REGIONAL INNOVATIONS OF KAZAKHSTAN IN THE CONTEXT OF TRIPLE HELIX MODEL

Abstract

This research aims to conduct an analysis of scientific literature on issues related to regional innovation in the context of Triple Helix model, including Kazakhstan. In order to accomplish the objective, the bibliometric analysis was carried out using four primary search strings: "Triple Helix and Kazakhstan," "Kazakhstan regional innovation," "Regional Innovation and Triple Helix," and "Regional Innovation." The bibliometric analysis was conducted using the computer softwares VOSviewer, the computerized databases Scopus and Web of Science. Establishing links and relationships was achieved through the use of the computer software VOSViewer, which automatically applied methods of co-occurrence and keyword analysis. The results obtained from the areas mentioned earlier, particularly in the context of Kazakhstan and the publication output and connections within Triple Helix, are limited. It was revealed that in Kazakhstan there is a small amount of scientific research on regional innovation in the context of the Triple Helix model, which reflects the economic situation when the Triple Helix model is not sufficiently integrated into the state policy of regional development to study it. Kazakhstani policymakers and scholars focus on regional economic growth development as a strategy rather than integrating innovation models or the Triple Helix model in regional development. The primary contribution of this paper is to highlight the limited availability of literature and research on the topic at hand. Additionally, it emphasizes the need for further investigation and serves as a potential agenda for policymakers and scholars interested in regional development and innovation in Kazakhstan and other countries.

Key words: regional development, triple helix, bibliometric analysis, research articles, regional innovation, regional innovation system, innovation public policy.

Introduction

Regional innovation is a part of the concept of regional development, which is a complex and multifaceted concept encompassing various socioeconomic factors. These factors include but are not restricted to, natural resource endowments, the quality and quantity of labor, the availability and accessibility of capital, investments in productive and overhead infrastructure, the presence of an entrepreneurial culture and attitude, the development of physical infrastructure, the sectoral structure of the region, the state of technological infrastructure and progress, the presence of an open mind, and the existence of public support systems [1].

Innovation management within a particular region does not occur spontaneously or independently. The socio-economic progress of a particular region is significantly shaped by the governmental entities operating within that region. Specifically, the entities involved include governmental bodies at both the municipal and national levels, higher education institutions, and commercial enterprises. Every institution contributes to the development of the region in many ways. Universities aim to produce graduates who can contribute to the development of their respective regions. Ideally, the government provides financial support to universities and enterprises by allocating grants, subsidies, and project finance. Firms, in turn, generate employment opportunities, foster circumstances for economic growth, and facilitate the creation of essential commodities and services for the betterment of society. Any discourse about innovation fundamentally revolves around the concept of alteration [2].

According to the OECD, regional innovation catalyzes economic expansion. It serves as a strategic instrument for tackling pressing global concerns, including but not limited to climate change and socio-economic disparities. Many regions are increasingly focusing on promoting economic development by supporting innovation. The individuals in question establish and execute strategies and policy instruments to capitalize on their existing advantages and make necessary adjustments. Moreover, the OECD urges the establishment of a collective regional perspective that is firmly based on an examination of the strengths and limitations within the region. The primary objective of regional innovation policy lies in establishing a conducive ecosystem that fosters entrepreneurship and facilitates corporate expansion, ultimately leading to employment creation [3]. Here, supporting innovation and ecosystem fostering entrepreneurship is crucial to point out. So, a regional innovation system is a widely used framework for explaining how various innovation activities and processes drive a particular region's growth and competitive dynamics [4]. During its formation and development, the Triple Helix model of innovation [5] is essential, as the tripartite relationship between universities, industries, and governments is widely recognized as a fundamental framework for fostering the growth of a knowledge-based society, primarily through the promotion of innovation and entrepreneurship [6].

Effective interaction between these stakeholders and the development of measures for the development of regional innovation will be facilitated by the analysis of scientific literature in this area, since then socio-economic policy will be built on the basis of scientific research results, i.e. based on the "evidence based policy-making" approach, which in turn will improve the quality of public administration and achieve target indicators for the regional innovations development, in particular based on the Triple Helix model. Due to this, the research aims to conduct an analysis of scientific literature on issues related to regional innovation in the context of Triple Helix model, including Kazakhstan.

Establishing a knowledge-based economy that relies on knowledge is contingent upon the collaborative efforts of three key entities: academics, business, and government. Each actor within the economic system can be associated with a distinct element: universities are tasked with the generation of innovation, corporations are responsible for the accumulation of money, and the government assumes the role of governing interactions among these actors while upholding societal regulations [8]. The Triple Helix (TH) model has the potential to be an effective strategy for regional innovation development. While the TH model presents specific management issues it is crucial to emphasize the significance of implementing trilateral collaboration in the region to foster regional innovation development.

Developing countries that want to use a knowledge-based approach to development also work to improve their research infrastructure, train their workers to be highly skilled, and help their businesses be more innovative, which makes them more competitive. Many developing countries are transitioning from an exogenous regional development approach, which focuses on attracting firms from external sources, often subsidiaries or research and development centers of large multinational corporations, to an endogenous regional development approach. This new approach is centered around local factors such as a robust knowledge base, the availability of skilled labor services, proximity to knowledge sources, and the implementation of regional technology strategies and plans. The objective of this shift is to enhance the innovation potential of these countries. Novel approaches to attaining these goals can be identified by adopting a Triple Helix systems framework, which involves integrating and aligning knowledge, innovation, and consensus [9].

The triple helix model is often overlooked in innovation models, particularly concerning its potential applicability in fostering inventive development within regions. However, the trilateral cooperation model of innovation is one of the most effective tools for innovation creation in regions [10, 11, 12, 13]. Numerous instances exist of innovative development in various regions [14, 15, 16, 17, 18], one notable illustration being Silicon Valley [19, 20]. The innovative development model of this region has been examined within the framework of the interplay among three key institutions: universities, business enterprises, and the government. One sort of engagement is the cooperative relationship between businesses and universities. The mode mentioned earlier of collaboration has gained popularity in fostering regional development within the context of this particular interaction.

It should be noted that no bibliometric analysis on regional development in the context of the Triple Helix model has been carried out specifically. Some research papers have bibliometric approaches as bibliometric couplings dedicated to the Triple Helix, but not in the context of regional innovation development [21, 22]. However, some studies employ bibliometric analysis in regional innovation systems [23, 24] and regional development [25, 26, 27, 28]. However, in Kazakhstan and on the example of the republic, such studies have not been carried out. This research aims to fill this research gap.

Materials and methods

The study utilized two primary databases, namely Scopus and Web of Science in years 2018–2024. The study period was determined by the database itself, based on the selected keywords, i.e. starting from the first occurrence of a scientific publication on the specified keyword and tracking the development (evolution) of the topic to the present. The four main search strings:

- Triple Helix and Kazakhstan regions;
- Kazakhstan Regional Innovation;
- Regional Innovation and Triple Helix;
- Regional Innovation.

These keywords were employed for analysis to first identify the “Regional Development and Triple Helix” bibliometric data as overall general data for these topics. Then the keywords were narrowed down to the country (Kazakhstan).

In the computerized database Web of Science, the results for bibliometric data are as follows:

“Triple Helix and Kazakhstan regions”: 1 document.

“Kazakhstan Regional Innovation”: 52 documents and those articles are about regional innovation development in the context of innovation infrastructure, testing innovation development in the regions, innovative clusters, knowledge-based economy, innovation diffusions, innovation management, ICT development, green economy in regions, financing investment processes in the regions of the country, localization and concentration of innovative activity, regional cooperation, regional competitiveness , entrepreneurial ecosystems, innovation management. 6 articles were excluded since they were not related to the topic at all.

“Regional Innovation and Triple Helix”: 416 documents, filters used: area categories: management, economic, business, regional urban planning, education and educational research, social sciences interdisciplinary, urban studies, multidisciplinary studies, education scientific disciplines.

"Regional Innovation": 19079 documents, filters used: area categories: education scientific disciplines, business finance, area studies, social sciences disciplines, multidisciplinary sciences, education educational research, development studies, regional urban planning, business, management, economics. At the end, the refined result showed 4982 documents.

The next data for analysis is retrieved from the Scopus database. The main results performed were:

"Triple Helix and Kazakhstan regions": 5 documents.

"Kazakhstan Regional Innovation": 100 documents. The main focus of those articles lies on: education and innovation, regional diversification, regional digital policy, university innovation management, regional growth, regional modernization transformation, regional economic integration, sustainable development and innovation, development of public-private partnerships (PPP) in the conditions of innovative development, economic sustainability of regional development, innovation activity, the level of innovation development, knowledge spillovers, open innovation paradigm, and regional innovation policy.

"Regional Innovation and Triple Helix": 347 documents, filters used: areas: business, management accounting, social sciences, economics and econometrics – finance.

"Regional Innovation": 25027 documents total results, filters used: areas: social sciences, business, management and accounting, economics, econometrics and finance, multidisciplinary 16328 documents resulted.

Then data was exported for bibliometric analysis via VOSviewer. Each keyword document result was separately analyzed. The main focus of maps was on keywords co-occurrences analysis techniques [7]. The additional analysis was performed using the R/R-studio software tool and the Biblioshiny browser. The Web of Science database was utilized to analyze the relationship between the Triple Helix concept and education, as well as the Triple Helix concept and regions. This study was conducted using Biblioshiny bibliometric techniques, including longitudinal theme map analysis and examination of countries' scientific productivity. The software has demonstrated the visual implications of each keyword string in the network, overlay, and density map visualization layers.

Results and discussion

The research was conducted on the following basic provisions:

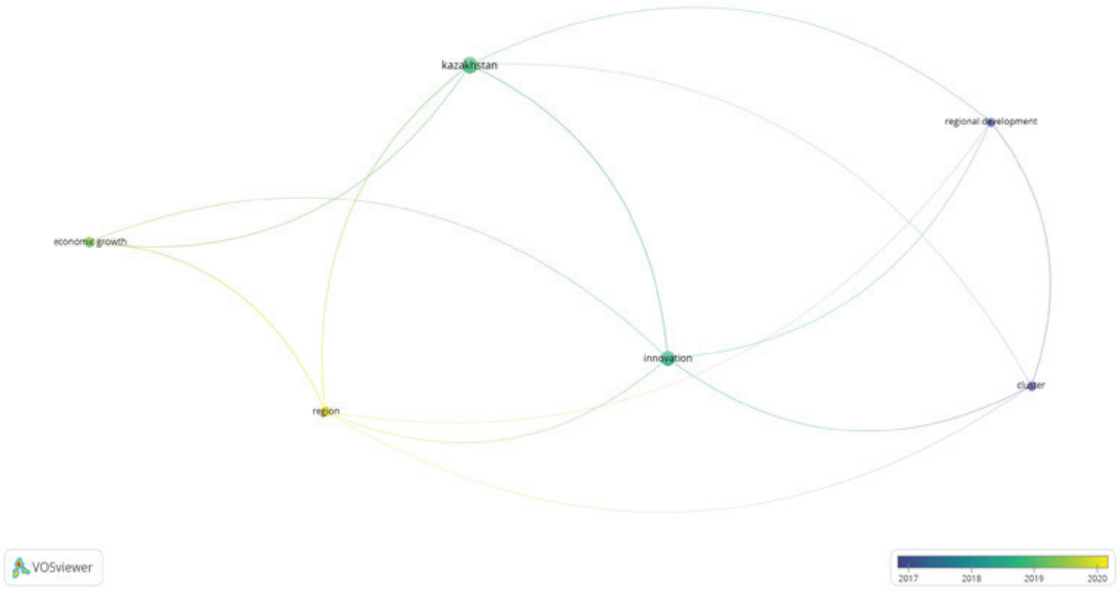
1) bibliometric analysis allows to identify the level of scientific research on the problem under study, as well as identify the main trends associated with it;

2) the results of scientific research are introduced into public policy and contribute to the development of evidence based policy-making.

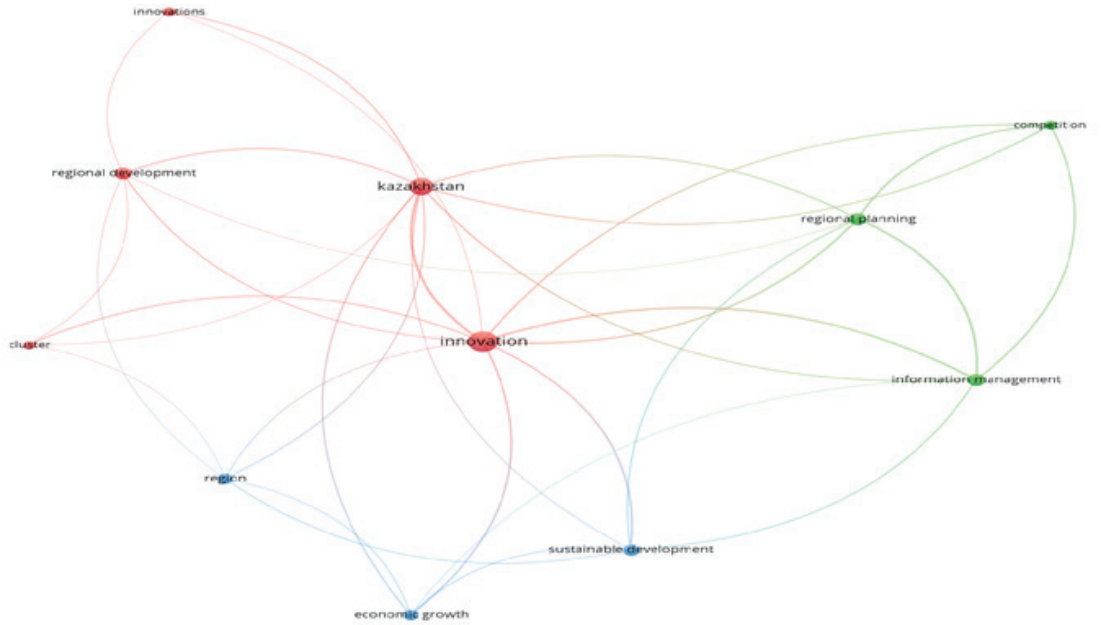
Thus, this research is based on the idea that the more research there is on the problem being studied, the higher the likelihood that the scientific results obtained will be used in solving the problem being studied.

Based on the above provisions, the following research hypothesis is put forward: in Kazakhstan there is a small amount of scientific research on regional innovation in the context of the Triple Helix model, which reflects the economic situation when the Triple Helix model is not sufficiently integrated into the state policy of regional development to study it.

The findings of the bibliometric research analysis reveal a limited number of research publications focused on "Kazakhstan Regional Innovation". As shown in the Figure 1 in recent years, bibliometric analysis considered selected 46 results in co-occurrence type of analysis and counting method in the software, with "keywords" unit of analysis in full counting. With overall 249 keywords of "Kazakhstan Regional Innovation" verified keywords the software selected 6 threshold met keywords. Those selected keywords are "Kazakhstan," "innovation," "region," "cluster," "economic growth," and "regional development." The fewer documents, the fewer circles and sizes of them and the further the links between them.



a) Web of Science



b) Scopus

Figure 1 – Kazakhstan Regional Innovation

Note: Compiled by the authors via VOSviewer.

So, figure 1 visually demonstrate the small size of the circles and the long link between them. That means that the output of the published research papers` co-occurrences and links are few and have little connection. Moreover, in overlay visualization, the most recent papers are mainly devoted to the region and economic growth. It demonstrates that Kazakhstan policymakers and scholars focus on regional economic growth development as a strategy rather than integrating innovation models or the Triple Helix model in regional development.

Figure 2 demonstrates the overall "Regional Innovation and Triple Helix" results. A keyword's minimum number of co-occurrences was 4 of all 125 keywords, and 5 meet the threshold. The VOSviewer verified these selected keywords for further analysis: "triple-helix," "innovation," "regional development," "knowledge transfer," and "policy." Since the central concept of the triple helix is based on a knowledge-based economy, knowledge transfer is the input to regional innovation development. Even in the context of "all countries", the Scopus database revealed few publications related to regional innovation in the Triple Helix context, the distance between the links is far, and the circle sizes are small, which proves the insufficient amount of literature in this realm.

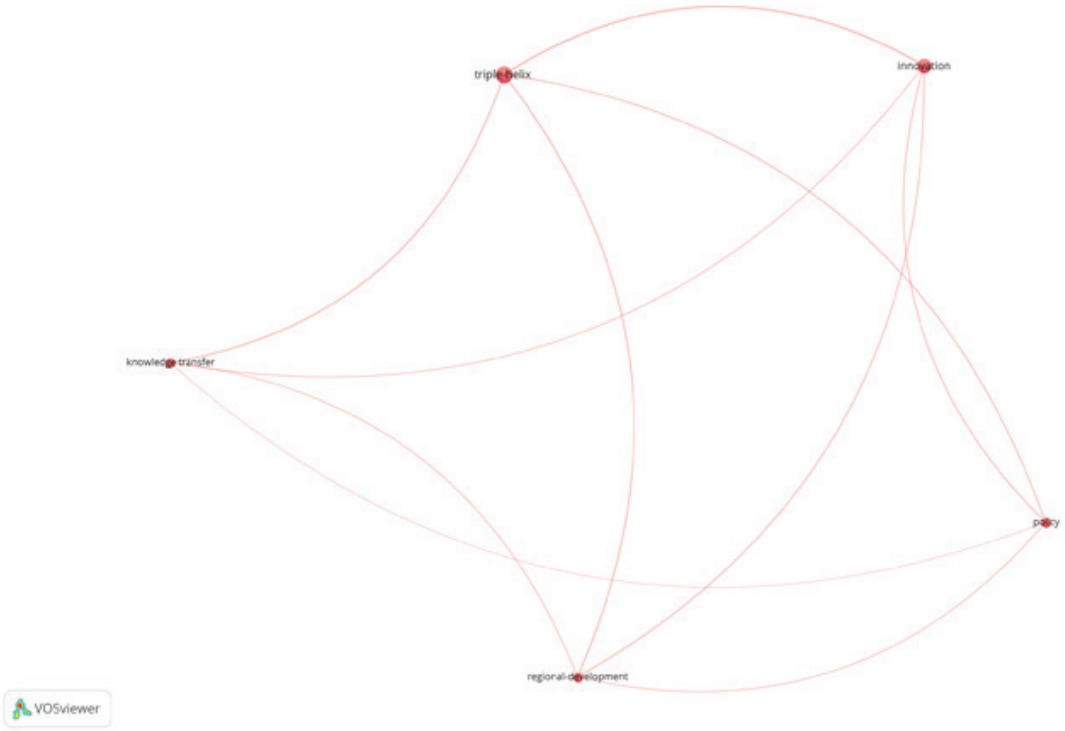


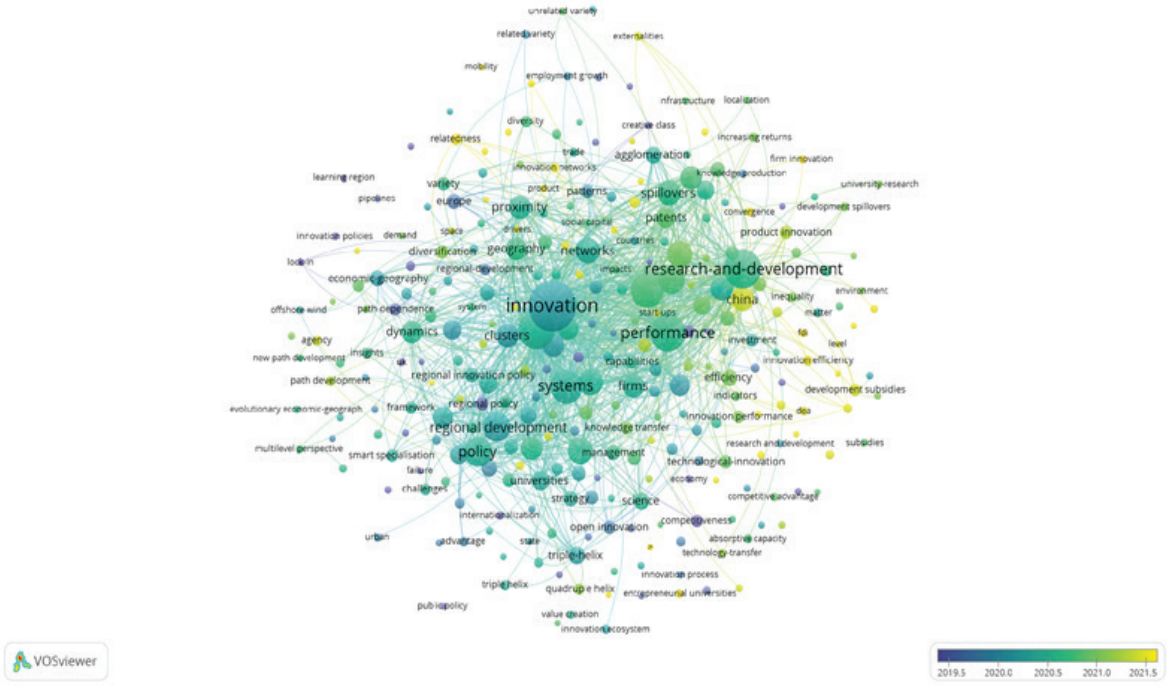
Figure 2 – Regional Innovation and Triple Helix (Scopus)

Note: Compiled by the authors via VOSviewer.

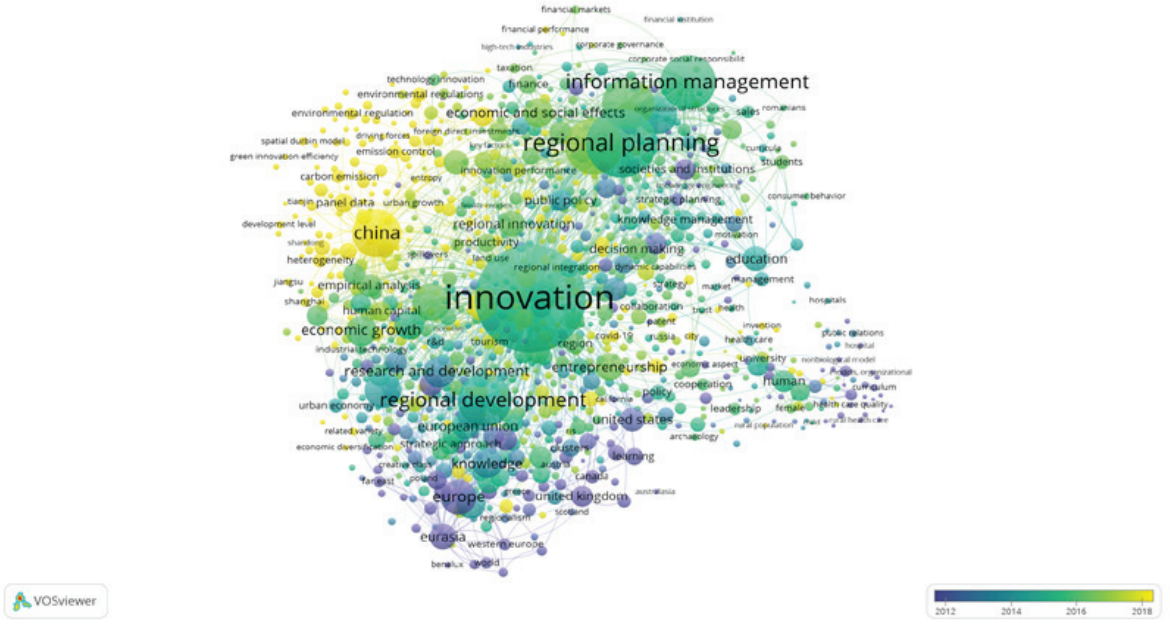
Figure 3 presents "Regional Innovation" as an overall term, including all countries in the Web of Science database in overlay visualization. The minimum number of occurrences of a keyword is 5 of all 3172, 290 meet the threshold. The keywords with the greatest total link strength selected and verified 290 subsequently. The map represents the level of topic awareness in the "Regional Innovation" realm among scholars. Thus, the research results in publications. It shows that the broad "regional innovation" concept is widely explored and concerned compared to regional innovation in the context of Triple Helix. Furthermore, the bulk of co-occurrences in recent years are presented in keywords "China" (not little circle sized in 2021.5) and its close link with "innovation efficiency".

Figure 3 depicts the "Regional Innovation" publications co-occurrences output in the Scopus database in years. The software had chosen 2012–2018, although the filtered years for data were 2018–2024. So, the minimum number of occurrences of a keyword is 5, of a total of 40057, where 3456 meet the threshold. For each of the 3546 keywords, the total strength of the co-occurrence links with other keywords had been calculated. As a result, the software verified the number of keywords out of 3456 is 1000. As overlay network visualization shows, China has been leading in regional innovation topic research publications in recent years. Although in 2014–2017, "innovation" and "regional planning" present the circle sizes and their close links with "knowledge" and "research and development", which proves that regional innovation development relies on a knowledge-based economy.

Since the bibliographic method also relies on co-occurrences, it aids in identifying informative components, in addition to the most recurrent terminologies and notions that manifest themselves in scholarly works, due to the associations between keywords and their arrangements [29], which means the articles published with the content of innovation and regional planning closely related to China.



a) Web of Science



b) Scopus

Figure 3 – Regional Innovation

Note: Compiled by the authors via VOSviewer

The publication of these articles in the databases above led to a surge in the number of publications on innovative activities. By examining the growth patterns of Triple Helix publications in education from 2004 to 2022, it is evident that there has been a rise in the number of research papers published, indicating a corresponding increase in scientific interest in this field. The most publications were

recorded in 2019 (figure 4). The publication's findings contribute to examining collaborative instances inside the triple helix.

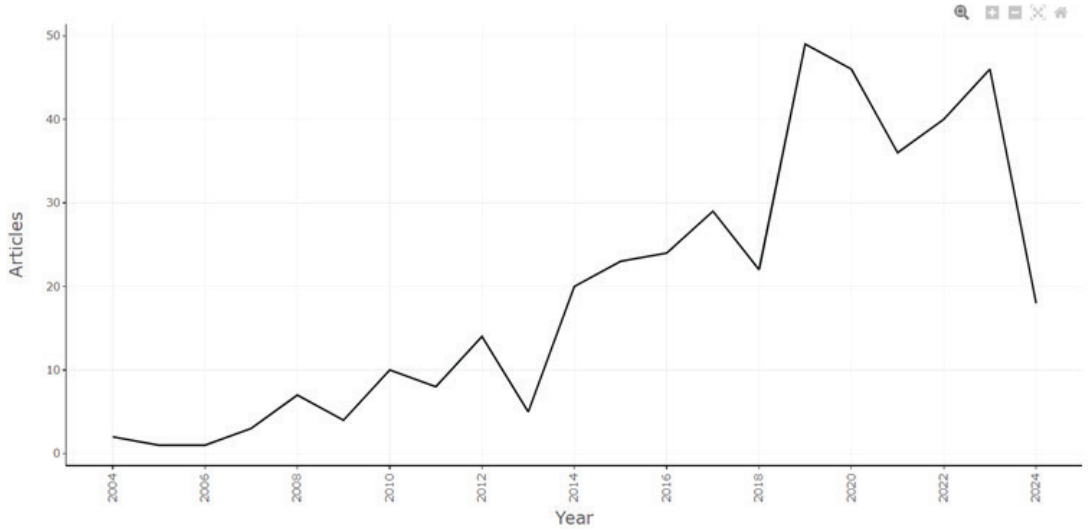


Figure 4 – Dynamics of "Triple Helix & Education" article publishing

Note: Compiled by the authors.

Figure 5 presents the primary data regarding articles obtained from the Web of Science database. Figure displays the occurrence of the keywords "Triple Helix and Education" and "Triple Helix and Regions" in the time periods of 2004–2024 and 2000–2024, respectively. The keyword "Triple Helix and Education" appears in 262 documents, while "Triple Helix and Regions" appears in 153 documents. These figures indicate an annual growth rate of 11.61% for Triple Helix and Education and 2.93% for Triple Helix and Regions. The latter one reflects the minimal increase in annual growth for publications related to regions.

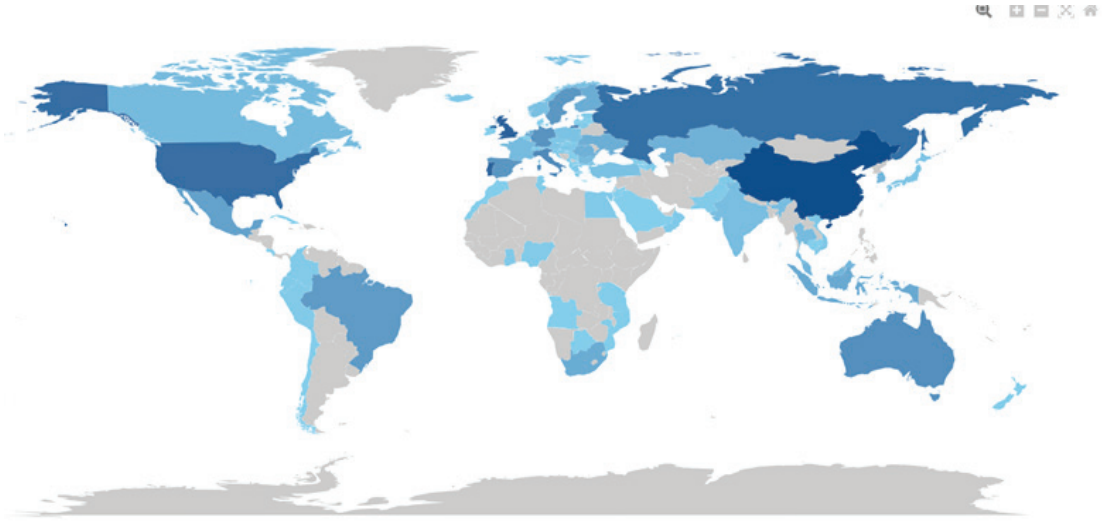
a) for "Triple Helix and Education"

b) for "Triple Helix and Regions"

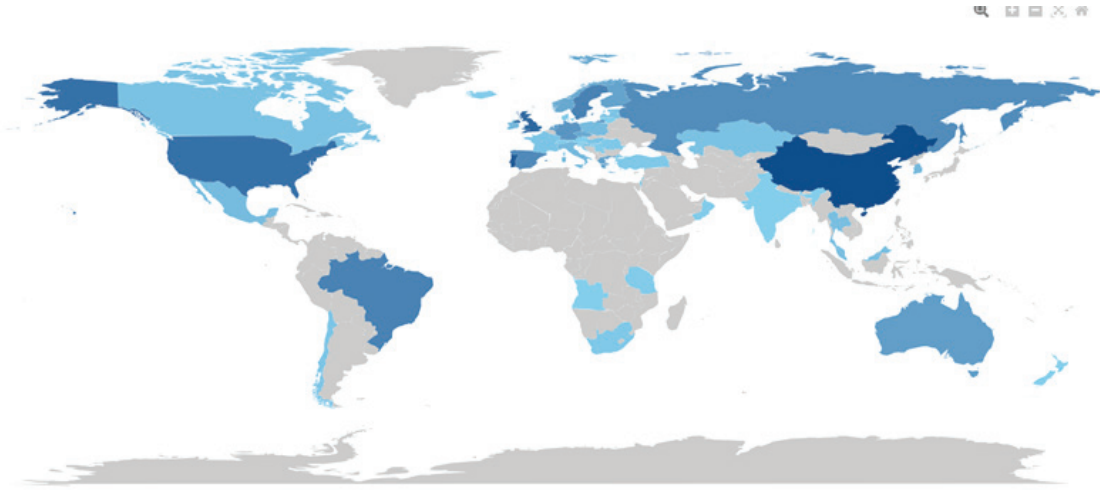
Figure 5 – Main data information for different keywords

Note: Compiled by the authors.

This bibliometric analysis presents the scientific output of different countries over a period of time. Figure 6 illustrates countries' production over 2004–2024, specifically for the keywords "Triple Helix and Education" and "Triple Helix and Regions". The intensity of the hue corresponds to the volume of scientific papers on the issue from each country. Figure 6a shows that China, the U.K., and the U.S. are the leading countries in terms of scientific publications on the investigated topic. The grey tint on the map indicates a complete absence of amount. The colour coding for Figure 6b of the "Triple Helix and Regions" keyword remains consistent. The primary publishers in this figure are the United States, China, and the United Kingdom, while Brazil exhibits lower activity but surpasses the other countries in terms of significance.



a) for "Triple Helix and Education"

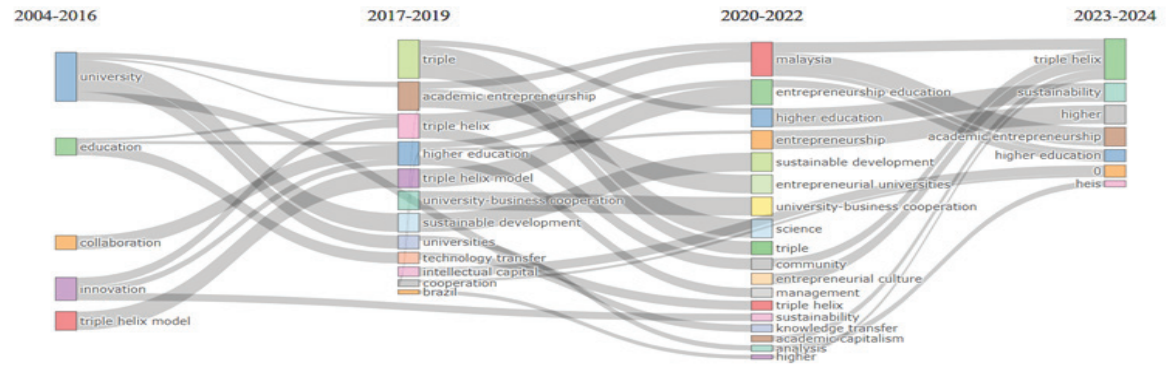


b) "Triple Helix and Regions" keyword

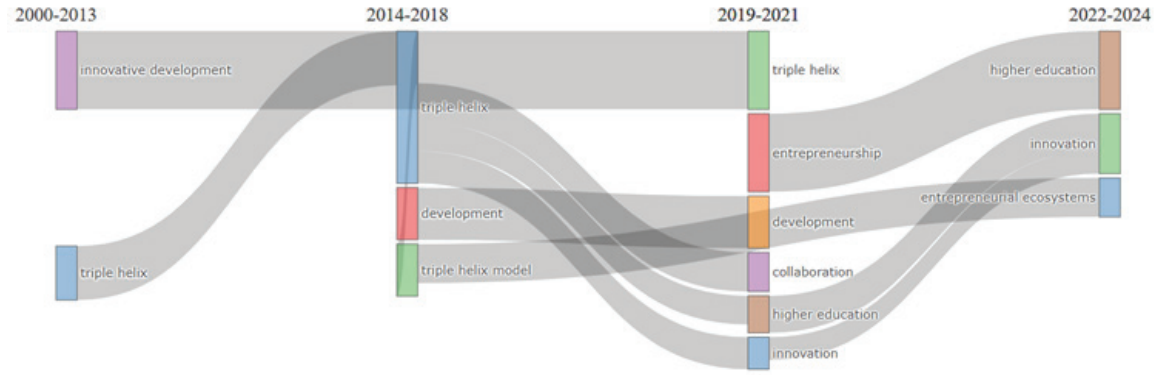
Figure 6 – Countries` production over time for different keywords

Note: Compiled by the authors.

One may identify the many themes within a specific domain by utilizing a clustering method on the keyword network. Centrality serves as a metric for determining the significance of a topic, while density measures the level of development of a theme. In the analysis, each keyword is exclusively linked to a single subject. Figure 7 depicts the evolution of the theme "Triple Helix and Education" and "Triple Helix and Regions." Once again, the disparity in density and centrality is evident, highlighting the more advanced state of the triple helix in education compared to the underestimation of the triple helix in regions.



a) for “Triple Helix and Education” keyword



b) for “Triple Helix and Regions”

Figure 7 – Thematic evolution for different keywords

Note: Compiled by the authors.

Furthermore, the thematic progressions of the provided keywords (figure 7) are divided into four distinct periods. These slices demonstrate the inclinations of the issues within the examined themes. Based on the figure shown, it is clear that the research keywords for figure 7a in 2023–2024 are “triple helix”, “sustainability”, and “higher education”. On the other hand, the research keywords for figure 7b in 2022–2024 are “higher education”, “innovation”, and “entrepreneurial ecosystems”. It suggests that “higher education institutions (HEIs)”, “innovation”, and “entrepreneurial ecosystems” are crucial for future research advancements. The bibliometric study conducted using Biblioshiny and Web of Science articles has unequivocally demonstrated the necessity for further research on advancing the Triple Helix in various regions. Illustrating the extent to which regional concerns over the triple helix are falling behind on a global scale.

Based on a bibliometric study, the countries with the highest number of indexed articles are the USA, China, and England. The triple helix is most advanced in these countries, and collaboration occurs in various forms. Undoubtedly, scientific publications from these countries have proven to be fruitful, especially in Kazakhstan. Based on the foreign experiences of Brazil, China, and the USA (specifically Silicon Valley) [17, 18, 19], several business incubators are operating in Kazakhstan. These include MOST, nFactorial, TechGarden, Astana Hub, Impact Hub, SodBi, SmArt.Point, Atsna Business Campus, and others. Additionally, there are business incubators at universities such as Al-Farabi Kazakh National University, IETU, KBTU, NURIS (NU), and others. Moreover, the “QazInnovations” JSC is a domestic establishment promoting inventive progress. It offers analytical assistance to foster the expansion of the innovation ecosystem. Increasing study efforts to develop and

comprehend the triple helix model's optimal functioning will enhance the likelihood of Kazakhstan successfully implementing triple helix forms [30].

Nevertheless, there is a need for further development, exploration, and application of the Triple Helix model in the context of regional development and regional innovation in the vast territory of Kazakhstan.

Conclusion

The research has yielded significant findings about the existing body of knowledge around "regional innovation development" and the "triple helix" concept, both in a broader sense and specifically within the context of Kazakhstan. The research shows that the number of research papers that come up when searching for "Triple Helix and Kazakhstan Regions," "Kazakhstan Regional Innovation," and "Regional Innovation and Triple Helix" in Kazakhstan regions varies. The bibliometric research on co-occurrences of the keywords shows that there have been few publications or connections between publications in the areas of Triple Helix and Kazakhstan regions, Kazakhstan Regional Innovation, and Regional Innovation and Triple Helix in the last few years, from 2018 to 2023. These findings highlight the importance of policymakers and researchers considering the subject.

In Kazakhstan there is a small amount of scientific research on regional innovation in the context of the Triple Helix model, which reflects the economic situation when the Triple Helix model is not sufficiently integrated into the state policy of regional development to study it. Kazakhstani policymakers and scholars focus on regional economic growth development as a strategy rather than integrating innovation models or the Triple Helix model in regional development. Government agencies in Kazakhstan that are in charge of regional research should consider exploring and using the Triple Helix innovation model in their regional innovation and development plans. Researchers who are primarily interested in the Triple Helix innovation model and the growth of regional innovation need to look into these study areas in depth to develop more research results. The prevalence of a knowledge-driven economy characterizes the present epoch. The successful administration of the innovative model of triple collaboration in many forms is crucial for leveraging this knowledge to advance the inventive growth of regions and the country as a whole. The idea is to pay more attention to both studying how regional innovation can grow within the triple helix and putting that knowledge into practice in different parts of Kazakhstan. Each distinct geographical area has the potential to undergo development by adopting the Silicon Valley model or comparable models observed in both developed and developing nations across the globe.

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«ҮШТІК СПИРАЛЬ» МОДЕЛІ НЕГІЗІНДЕ ҚАЗАҚСТАННЫҢ АЙМАҚТЫҚ ИННОВАЦИЯЛАРЫН БИБЛИОМЕТРИЯЛЫҚ ТАЛДАУ

Аңдатпа

Бұл зерттеудің мақсаты үштік спираль моделі контекстінде өңірлік инновацияларға байланысты мәселелер бойынша, Қазақстанды қоса алғанда, ғылыми әдебиеттерге талдау жүргізу болып табылады. Осы мақсатқа жету үшін төрт негізгі іздеу жолын қолдану арқылы библиометриялық талдау жүргізілді: «Үштік спираль және Қазақстан», «Қазақстандық аймақтық инновациялар», «Аймақтық инновациялар және үштік спираль» және «Аймақтық инновациялар». Библиометриялық талдау VOSviewer компьютерлік бағдарламасы арқылы Scopus және Web of Science компьютерленген деректер қорын пайдалана отырып жүргізілді. Байланыстар мен қарым-қатынастарды орнату VOSViewer компьютерлік бағдарламалық жасақтамасын пайдалану арқылы қол жеткізілді, онда автоматтандырылған түрде бірге пайда болу және кілт сөздерді талдау әдістері қолданылады. Жоғарыда аталған салаларда, әсіресе Қазақстан контекстінде, сондай-ақ «Үштік спираль» аясындағы жарияланымдар мен байланыстарда алынған нәтижелер шектеулі. Қазақстанда «Үштік спираль» моделі контекстінде өңірлік инновациялар бойынша аздаған ғылыми зерттеулер жүргізіліп жатқаны анықталды және бұл мәселе аясында өңірлік дамудың мемлекеттік саясатында жеткілікті интеграцияланбаған экономикалық жағдай көрсетіледі. Қазақстандық саясаткерлер мен ғалымдар инновациялық модельдерді немесе үштік спираль моделін өңірлік дамуға интеграциялауға емес, стратегия ретінде өңірлік экономикалық өсуді дамытуға назар аударады. Бұл мақаланың негізгі үлесі тақырып бойынша әдебиеттер мен зерттеулердің шектеулі қолжетімділігін көрсету. Бұған қоса, әрі қарай зерттеулер жүргізу қажеттілігін көрсетеді және Қазақстанда да, басқа елдерде де аймақтық дамуға және аймақтық инновациялық дамуға мүдделі саясаткерлер мен ғалымдар үшін әлеуетті күн тәртібі ретінде қызмет етеді.

Тірек сөздер: аймақтық даму, үштік спираль, библиометриялық талдау, ғылыми мақалалар, аймақтық инновация, аймақтық инновациялық жүйе, инновациялық саясат.

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БИБЛИОМЕТРИЧЕСКИЙ АНАЛИЗ РЕГИОНАЛЬНЫХ ИННОВАЦИЙ КАЗАХСТАНА В КОНТЕКСТЕ МОДЕЛИ «ТРОЙНАЯ СПИРАЛЬ»

Аннотация

Целью данного исследования является проведение анализа научной литературы по вопросам, связанным с региональными инновациями в контексте модели тройной спирали, включая Казахстан. Для достижения поставленной цели был проведен библиометрический анализ с использованием четырех основных поисковых строк: «Тройная спираль и Казахстан», «Казахстанские региональные инновации», «Региональные инновации и тройная спираль» и «Региональные инновации». Библиометрический анализ проводился с использованием компьютерной программы VOSviewer, компьютеризированных баз данных Scopus и Web of Science. Установление связей и взаимосвязей было достигнуто за счет использования компьютерного программного обеспечения VOSViewer, в котором автоматически применялись методы совместного появления и анализа ключевых слов. Результаты, полученные в упомянутых ранее областях, особенно в контексте Казахстана, а также публикаций и связей в рамках «Тройной спирали», ограничены. Выявлено, что в Казахстане проводится небольшое количество научных исследований по региональным инновациям в контексте модели «Тройной спирали», что отражает экономическую ситуацию, когда модель «Тройной спирали» недостаточно интегрирована в государственную политику регионального развития для ее изучения. Казахстанские политики и ученые сосредотачивают внимание на развитии регионального экономического роста как на стратегии, а не на интеграции инновационных моделей или модели тройной спирали в региональное развитие. Основной вклад данной статьи заключается в том, чтобы подчеркнуть ограниченную доступность литературы и исследований по рассматриваемой теме. Кроме того, данное исследование подчеркивает необходимость дальнейших исследований и служит потенциальной повесткой дня для политиков и ученых, заинтересованных в региональном развитии и региональном инновационном развитии как в Казахстане, так и в других странах.

Ключевые слова: региональное развитие, тройная спираль, библиометрический анализ, научные статьи, региональные инновации, региональная инновационная система, инновационная политика.

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