Print ISSN: 2008-448X
Online ISSN: 2538-3310
International Journal of Business and Development Studies
University of Sistan and Baluchestan
Homepage: https://ijbds.usb.ac.ir

Analyzingthe Ecological Pillars of Innovation Ecosystem Based on Bibliometric Method

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ARTICLE INFO

Article type:
Research

Article history
Received: 20.06.2021
Accepted: 18.11.2021

Keywords:
Ecosystem , Innovation,Innovation Ecosystem, Bibliometrics

Abstract:
The innovation ecosystem plays a valuable role in the development of innovation and entrepreneurship. The emergence of an innovation-based economy requires the development of an innovation ecosystem in the context of the region. In most countries, especially less developed countries, the ecosystem is not properly formed and the first step to its formation is the theoretical and experimental knowledge of this area. Therefore, this study aims to investigate the dimensions and components of the innovation ecosystem. We applied bibliometric method, citation analysis, applied evaluation techniques and content analysis of documents in this research. The purpose of this research is to review studies in this field and to present a conceptual and integrated model using content analysis of documents by organizing previous research. The statistical population of this research includes all the documents presented in the Web of Science database with 438 documents related to the innovation ecosystem until 2020 and has been evaluated and illustrated using VOS viewer software. Based on the content analysis of the documents, research on the "innovation ecosystem" is divided into five sections. The first part of the research is related to the structural factors. The second part is related to the type of the relationships and interactions, and the third part is related to the results. The fourth part is about the actors and the fifth part is about how they have performed. Finally, the conceptual framework of the research is presented based on the content analysis of the documents

Cite this article: H. Aramesh (2021). Analyzingthe Ecological Pillars of Innovation Ecosystem Based on Bibliometric Method. *International Journal Of Business and Development Studies*, 13 (1), 141-166. DOI: 10.22111/ijbds.2021.6584.

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Publisher: University of Sistan and Baluchestan

1- Introduction

Innovation is considered as a production-oriented process and it is assumed that innovation is the main factor in gaining economic advantage (Trischler et al.2020). On the other hand, in recent years, researchers' interest in the concept of "ecosystem" has expanded greatly, and many research has been done on what is an ecosystem and how does it work (Xie & Wang, 2021). The concept of "innovation ecosystem" has been considered since the mid-2000s as a framework for business development and the emergence of emerging industries (Arenal et al, 2020). By developing an innovation ecosystem, companies can expand their products, core services or business infrastructure and use them to improve their performance (Beltagui et al., 2020).

Of course, the origin of the "innovation ecosystem" may be close to the concepts of "business ecosystem" and "innovation system". But it should be noted that innovation is necessary for a business ecosystem in which customer needs are met through interaction, collaboration and competition. Therefore, the main feature of any ecosystem is a common evolution (Arenal et al, 2020). Fukuda and Watanabe (2012) argue that the concept of "innovation ecosystem" implies that innovation occurs through interactive networks at different levels. The network covers a wide and complex range of stakeholders in both the public and private sectors. Unlike biological ecosystems, this network is an innovation ecosystem involving economic models that instead of energy dynamics in a system, consisting of complex relationships between actors or institutions, and its main and practical goal is the development of technology and innovation (Ghazinoory, 2020). How such an ecosystem which can reduce barriers to innovation is crucial for managers and policymakers (Noelia et al, 2020). Broader ecosystem approaches are shaped by the interaction of "actors", including companies and institutions that provide knowledge, resources and set "rules" (Feijoo et al, 2012). The innovation ecosystem is formed by the interaction of key actors and the participation of institutions and stakeholders (Dedehayir et al, 2018). Also, top innovation positions, which are capable of innovation and exploratory innovation, are essential for the success of companies (Zang, & Meng, 2020). In addition, this concept is also used in the international arena and achieving the goals of sustainable development at the global level requires the achievement of important innovations in various fields. Multinational corporations can also contribute to these goals by fostering innovation due to the simultaneity of research and innovation and the maturity of innovation ecosystems (Nylund et al, 2021).

In recent years, the concept of innovation ecosystems has received a lot of attention; therefore, it has drawn perspectives for innovative activities (Thomas& Autio, 2014). However, in terms of knowledge, related theories are still in the early stages of development and there is no consensus among researchers in this field (Asplund, 2021). Therefore, the development of

innovation ecosystem can improve the performance of innovation and lead to the improved performance of organizations (Leckel et al., 2020). Today, given the emphasis on sustainable development and the dynamics of the innovation ecosystem's components, and given that all institutions of the innovation ecosystem as a whole, are required to cooperate and coordinate in order to guide countries in the path of innovation, science and technology; The innovation ecosystem is a promising approach to improving innovation and addressing inter-organizational collaboration issues in collaborative innovation for sustainability. Because it enhances the flow, integration and allocation of innovative resources and knowledge in the ecosystem (Yin et al, 2020). Therefore, this research has examined the texts and documents in the Web of Science database by bibliometric method, in the period of 2006-2020. This research aims to identify gaps in this field by analyzing the literature and provide a comprehensive classification of research. Also, this study aims to provide a conceptual and integrated model with a comprehensive picture of the research conducted. For this purpose, first, the theoretical foundations of the research are reviewed. Then, the research method (methodology) is introduced and in the next section, the results are analyzed. Finally, a discussion and conclusion are presented.

2-Theoretical foundations of research

2-1. Bibliometric

Bibliometric is the knowledge of measuring science; Which includes all quantitative methods and models related to the creation and publication of knowledge and technology. Vocabulary co-occurrence is one of the bibliometric methods that includes statistical analysis of published articles and documents based on keywords. This method is one of the methods of the content analysis. Keyword co-occurrence shows the degree of relationship between a set of documents and by comparing the resulting maps in a specific time period, the dynamics of science in the field under study becomes clear (Dhanavanth et al, 2018). The most important role of bibliometric studies is to chart the development and expansion of science at the national level and beyond at the international level. These studies allow researchers at different levels to have an idea of the flow of production, publication and use of science, and based on that, to plan in the field of research.

2.2. Innovation ecosystem

An ecosystem refers to the complexity of the organisms and the environment in which they interact. An important goal of the ecosystem is innovation. The concept of innovation ecosystem often states that innovation occurs through interactive networks at different levels. The network has a wide and complex range of stakeholders in both the public and private sectors. All stakeholders as part of the innovation ecosystem are widely involved in the innovation process

and their behavior improves the efficiency of the ecosystem (Oksanen et al,2014). The strong performance of an innovation ecosystem requires reducing uncertainty in innovation processes. Changes in a highly disordered environment increase uncertainty in technological performance, as well as the market response and the ability of stakeholders to attract and apply the necessary changes. This relationship between change and uncertainty in an innovation ecosystem necessitates the spontaneous response of each stakeholder and the coordination of the stakeholder network. The combination of independence and coordination of the global ecosystem makes it possible to achieve sustainable development. Innovation aimed at improving performance for survival in conditions of uncertainty is an important feature of natural ecosystems that reflects complex sustainable stabilization processes, especially in the face of environmental variability. As a natural ecosystem, stability in the face of external shocks (which is sufficient to meet the demands of sustainable development) is an important goal of the innovation ecosystem. Ecosystem stability requires three main factors: resilience, flexibility and performance redundancy. Resistance means the capacity of a system to maintain its position against disruption. Flexibility means the rate at which a system returns to its original state after a malfunction. Performance redundancy is also the ability of a system to perform a performance process at a similar rate (regardless of disruption in that system) (Allison et al, 2008). Martin states that interaction in an ecosystem has three essential characteristics such as: coexistence, co-evolution, and adaptive cooperation. Coexistence actually originates from the evolutionary game between species. Adaptive cooperation and coordination (proportionality to each other that results in co-evolution) is to change with each other. Species in an ecosystem have the ability to change the requirements of environmental conditions. They change the way they interact with other species and, as a result, organize themselves through adaptive collaboration. For an ecosystem to be internally stable, co-evolution is essential. These processes are combined to create sustainability, both internally and externally, in such a way that the whole ecosystem continues to function sustainably. Factors that differentiate the innovation ecosystem from concepts such as the innovation system and the innovation cluster include greater systematic clarity (communication between components), digital aspects (the role of information and communication technology), open innovation, , attention to general and specialized aspects of research, great emphasis on the distinctive roles of industry and organizations and the importance of market pressure (Oh et al, 2016). In a summary, the innovation ecosystem differs from other concepts due to the dynamics of the development process, which includes co-evolution, self-organization, upstream and downstream activities, adaptation, and entrepreneurial culture. The most important features of the innovation ecosystem are co-evolution, dynamic internal interaction, self-organization, adaptation, self-control, entrepreneurial culture, micro and macro flows, knowledge flow,

learning, historical context, customer demand and dynamic communication (Gobble MM, 2014). In addition, the study and analysis of an innovation ecosystem requires attention to some important characteristics of innovation ecosystems, including the subject of the life cycle. Moore (1993) believes that the life cycle of innovation ecosystems can be described in four stages, which are: 1) birth, 2) leadership 3) self-improvement and 4) death.
First, the collaboration of actors with the goal of creating new or enhanced value, is formed to meet customer needs. In the second stage, the ecosystem expands to conquer new territories. In the third stage, the claiming actors fight each other to expand their territory or lead the ecosystem. In the fourth stage, the current ecosystem is forced to reform or modernize due to the emergence of a new ecosystem, or due to the changes in ecosystem conditions, or it declines. Bernus and Rabelo, 2015) ،(Rong & Hu and Liu, Chen,2016).

3. Research Methodology

The present study in terms of purpose is applied and in terms of methodology is descriptive; with a bibliometric approach in which both lexical and citation analysis techniques have been used. The co-occurrence analysis of keywords is a method of content analysis that is obtained through the co-occurrence of words or concepts in texts and sources (King, 1987). Scientific maps are drawn using various techniques and methods, one of which is the co-occurrence of words. In this method, the keywords of documents in the title, abstract or text of articles are used to study the conceptual structure of a field. In other words, the keyword co-occurrence indicates the degree of cognitive relevance between a set of documents. The co-occurrence patterns in a set of texts are used to identify the relationship between ideas in the field of textual topics. In this analysis, indicators are used for the co-occurrence frequency of two items such as proximity and similarity index, which is to measure the relationship between items. Based on these indicators, concepts are clustered in groups and drawn as a network that are used to highlight the main issues in a field and find hidden connections in that field (Zolfaghari et al., 2016, cited in 1999). Based on the method of co-occurrence analysis of words, scientific topics can be extracted and the relationship between them can be discovered directly from the content by comparing the resulting maps (Sedighi, 1393, quoting Calon et al., 1991). To do this, VOSviewer software version 11.6.15 was used. The study population is articles published in English from 2006 to 2020, indexed by SCI-EXPANDED, SSCI, A & HCI, ESCI and related to the keyword innovation ecosystem in the web of science database until 7/22/2020. The search strategy for articles on the web of science database was used as follows:

***Article Search Strategy**:*
TOPIC: ("Innovation * ecosystem *") Refined by: DOCUMENT TYPES: (ARTICLE) AND LANGUAGES: (ENGLISH) Timespan: All years. Indexes: SCI-EXPANDED, SSCI, A & HCI, ESCI.
This research is an applied research that combines citation analysis (bibliometric) and content analysis techniques to analyze the literature.
The research steps are shown in Figure (1):

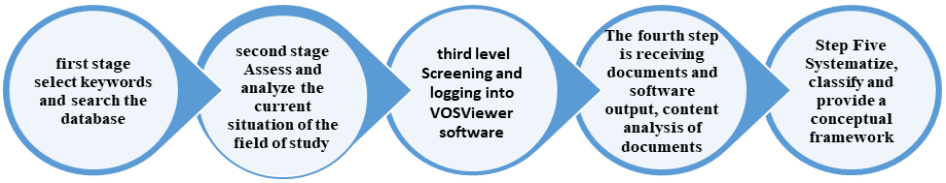


Figure (1): The research steps

4. Resutls

To review the research process and the progress of scientific articles' publication in terms of the number of articles per year, leading countries in this field, top authors, active research areas as well as top institutions in the field of innovation ecosystem, we defined the keyword "innovation ecosystem". Then the search strategies such as document type: article; English language; Year of publication: All years; were identified in the web of science database. The results of a search on the Web of Science website showed that the publication of articles in the field of interest has started since 2006 and 438 documents related to the field of innovation ecosystem have been indexed by 100 authors from 60 countries in this database. Information about the characteristics of the top five works in this field is given below. The H index is the work of this field in the web of science 35 database.

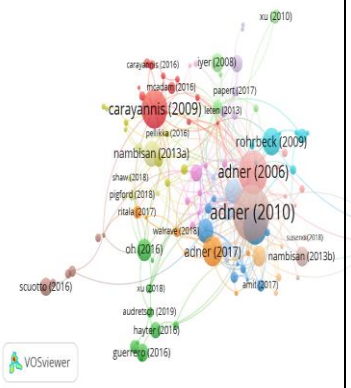
Table (1) Evaluation and analysis of the current situation in the field of innovation ecosystem studies

Feature under review	First place (number of records)	Second place (number of records)	Third place (number of records)	Fourth place (number of records)	Fifth place (number of records)
Publication year	(95)2019	(86)2018	(80)2020	(57)2017	(48)2016
country	USA (103)	United Kingdom (63)	China (62)	Finland (36)	Germany (32)
authore	CHEN J (8)	CARAYANNIS EG (6)	GUERRERO M (5)	ADNER R (5)	BIFULCO F (4)
Research area	Management (186)	Business (123)	Urban planning (45)	Environmental studies (43)	Environmental sciences (34)
Institute	TSINGHUA UNIV (15)	UNIV AMBRIDGE (12)	AALTO UNIV (8)	MIT (8)	STANFORD UNIV (8)

The results of data analysis showed that the process of research and growth of scientific articles in the field of "innovation ecosystem" has a significant upward trend. There are a significant number of articles in this field in the period of 2016 to 2020 compared to previous years. Most of the scientific products have been published in 2019, and according to the findings, it can be seen that this issue is relatively new and has been considered by researchers since 2006. Among the countries, the United States ranks first with 103 articles, followed by the United Kingdom with 63 articles and China with 62 records. It is interesting to note that Iran has only 2 records in this field and is ranked 37th among 60 countries. Most articles in the field of management and business have been published by Chinhua University of China, Cambridge Univercity of England, Alto University of Finland, and MIT and Stanford, USA. The top ten articles in this field are presented based on the total number of citations and the average citation per article per year in table(2).

Table (2) Evaluation and analysis of citation status of articles in the field of innovation ecosystem studies

Article title	Author	Year of publication	Number of citations	Average citations per year
VALUE CREATION IN INNOVATION ECOSYSTEMS: HOW THE STRUCTURE OF TECHNOLOGICAL INTERDEPENDENCE AFFECTS FIRM PERFORMANCE IN NEW TECHNOLOGY GENERATIONS	Adner, Ron; Kapoor, Rahul	2010	671	61
Match your innovation strategy to your innovation ecosystem	Adner, R	2006	428	28.2
'Mode ٣' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem	Carayannis, Elias G.; Campbell, David F. J.	2009	331	27.58
Bridging differing perspectives on technological platforms: Toward an integrative framework	Gawer, Annabelle	2014	284	40.57
Ecosystem as Structure: An Actionable Construct for Strategy	Adner, Ron	2017	199	49.75
Opening up for competitive advantage - How Deutsche Telekom creates an open innovation ecosystem	Rohrbeck, Rene; Hoelzle, Katharina; Gemuenden, Hans Georg	2009	166	13.83
Entrepreneurship in Innovation Ecosystems: Entrepreneurs' Self-Regulatory Processes and Their Implications for New Venture Success	Nambisan, Satish; Baron, Robert A.	2013	147	18.38
CUI BONO? THE SELECTIVE REVEALING OF KNOWLEDGE AND ITS IMPLICATIONS FOR INNOVATIVE ACTIVITY	Alexy, Oliver; George, Gerard; Salter, Ammon J	2013	138	17.25

Towards a theory of ecosystems	Jacobides, Michael G.; Cennamo, Carmelo; Gawer, Annabelle	2018	132	44
 Innovation ecosystems: A critical examination	Oh, Deog-Seong; Phillips, Fred; Park, Sehee; Lee, Eunghyun	2016	111	22.2

As can be seen, the names of two of the most active researchers in this field, Karayanis with 6 articles and Adner with 5 articles, are also among the top 10 works in terms of citation. Based on evidence such as citations, number of papers and authors' citation maps, according to the above map, Adner's research can be considered as one of the most influential works in the field of innovation ecosystem. In order to identify and analyze the co-occurrence network of words in the field of innovation ecosystem, all records extracted from the web of science database were entered into VOSviewer software. In synonym analysis, the word co-occurrence threshold is set. In this research, at least 5 co-occurrence is considered for each word. Obviously, small domains whose words have not reached the threshold of the co-occurrence are excluded from the results of the analysis. Although this problem is reduced in synonym analysis by lowering the co-occurrence threshold and more keywords are retrieved, the volume of low-value words in the map increases sharply and makes it difficult to understand the map. Considering the above co-occurrence threshold for the studied words, the software identified 137 words in the studied documents. Thus, the synonym map of this number of words was drawn with the help of the VOSviewer software.

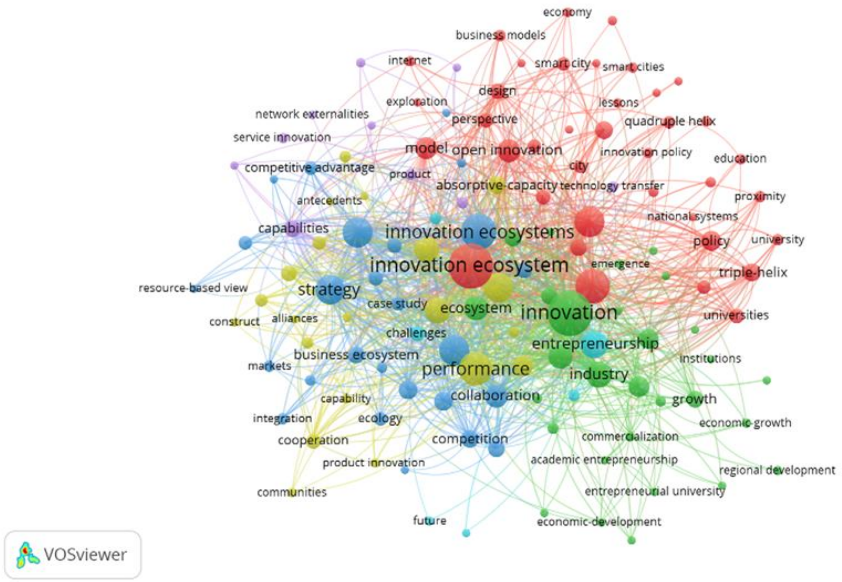


Figure (1) Synonym map of the innovation ecosystem

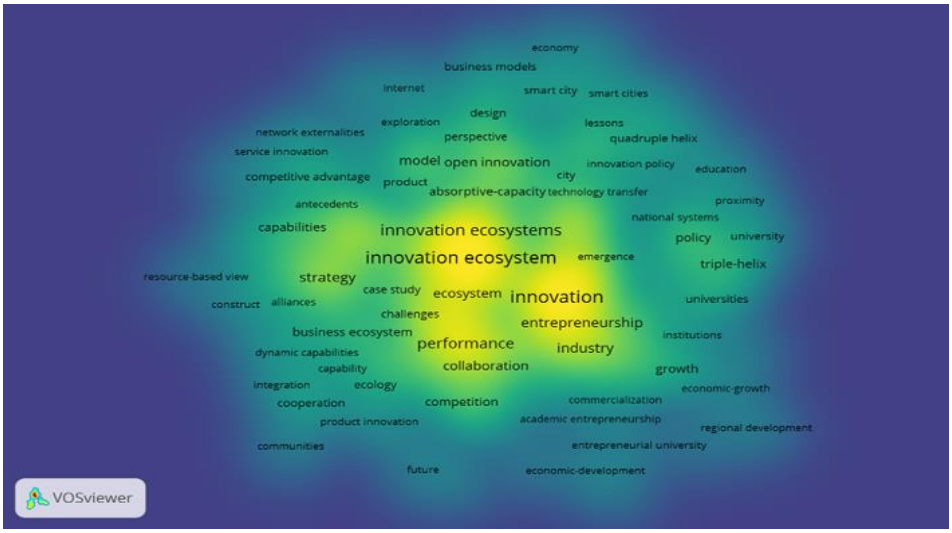


Figure (2) Synonym map of the thermal diagram of the innovation ecosystem

It is worth mentioning that in the maps that are drawn based on distance, no line is drawn and the distance between the concepts at the map level shows the relationship between the concepts. But in maps based on graphs, the distance

between the concepts does not provide information and it is the thickness of the lines that shows the amount of relations between the concepts. Also, the size of the circles indicates the amount of knowledge available about each concept. As can be seen in Figure (2), the highest focus of the studied texts is on the terms ecosystem of innovation, innovation, ecosystem, entrepreneurship, performance and efficiency, respectively. This is because they have a larger circle than other concepts. Also, the small circle of concepts such as Entrepreneur University, university entrepreneurship, economics, market indicates the lack of scientific articles in these fields. Concepts are relatively well dispersed at the map level. This indicates that the authors in the field of innovation ecosystem have addressed a variety of topics. It should be noted that in the analysis of these maps, the location of each concept at the map level determines the relative distance of each concept to other concepts, ie the relationship between the concepts. The proximity and distance of the concepts in these maps indicate the extent to which the existing texts have spoken about the relationship between the two concepts and have measured their effects on each other. If the concept of innovation is close to the concept of innovation ecosystem, it means that in the existing texts, their effects on each other have been considered. But when the concept of entrepreneurial university is far removed from the innovation ecosystem, it means that less attention has been paid to the impact of these concepts on each other in the existing literature. In short, it can be said that the size of the nodes in the scientific map indicates the greater use of those concepts in describing the works, and their color indicates the cluster of concepts. The distance and proximity of the keywords in the map show how much the concepts are related to each other. Then, by analyzing the words related to scientific articles in this field and after removing unrelated words and clusters containing one or two words, 5 clusters of words and concepts were identified. The clusters are reported in Table 3.

Table (3) Clusters of scientific maps in the field of innovation ecosystem studies

cluster	words	Concept	
1	innovation ecosystem, ecosystem, survival, complexity, helix, orchestration, strategy, platform, open innovation, ecosystem, clusters, architecture, network externalities, systems, modularity, national system, perspective, innovation system, model, reginal innovation, networks, determinants, design, transformation, dynamic, framework	innovation ecosystem, ecosystem, survival, complexity, helix, orchestration, strategy, platform, open innovation, ecosystem, clusters, architecture, network externality, systems, modularity, national system, perspective, innovation system, model, regional innovation, networks, determinants, design, transformation, dynamic, framework	**structure**

2	Collaboration, co-creation, alliance, dynamic, coopetition, coopreration, entrepreneurial orientation, evaluation, antecedent, proximity, networks, impacts, capabilities, capability, competitive	Collaboration, co-creation, alliance, dynamic, coopetition, cooperation, entrepreneurial orientation, evaluation, antecedent, proximity, networks, impacts, capabilities, capability, competitive	**Type of relationships and interactions**
3	competitive advantage, competition, valu capture, performance, firm performance, economic growth, economic development, value creation, service, science, innovation, growth, creation , absorptive capacity, sustainable development, sustainablity, innovation ecosystem, exploitation, product, reginal development, technological innovation, service innovation, product innovation, commercialization	competitive advantage, competition, value capture, performance, firm performance, economic growth, economic development, value creation, service, science, innovation, growth, creation , absorptive capacity, sustainable development, sustainability, innovation ecosystem, exploitation, product, regional development, technological innovation, service innovation, product innovation, commercialization	**results**
4	Business , organization, market, firms, entrepreneurship, entrepreneurial university, reaserch and development, investment, institution, governance, economy, community, university, knowledge, education, SMEs, living lab, quadruple hellix, incubator, culture, policy, innovation policy, academic enterepreneurship, startup, social enterepreneurship, triple helix, smart city	Business, organization, market, firms, entrepreneurship, entrepreneurial university, research and development, investment, institution, governance, economy, community, university, knowledge, education, SMEs, living lab, quadruple hellix, incubator, culture, policy, innovation policy, academic entrepreneurship, start-up, social entrepreneurship, triple helix, smart city	**actors**
5	technology transfer, case study, dynamic capabilities, insight, integeration, resours based view, knowledge management, knowledge transfer, emirical evidence, innovation management, internet, advantage, transition, challenge, future, platform, technology transfer, social network analysis, information technology, infrastructure	technology transfer, case study, dynamic capabilities, insight, integration, resource based view, knowledge management, knowledge transfer, emperical evidence, innovation management, internet, advantage, transition, challenge, future, platform, technology transfer, social network analysis, information technology, infrastructure	**performance**

Synonym analysis of scientific articles of the web of science database is done by using VOSviewer software. As a result, the keywords were classified into 5 main clusters. Each cluster is composed of various concepts. In the following, from the result of the words in each cluster, and repeated reviews by the researcher, the subject area of the clusters and subsequent classifications are determined. In the following, from the result of the words in each cluster and repeated reviews by the researcher, the subject area of the clusters and subsequent classifications are determined. Then, using the content analysis method based on title, keywords and abstract, research in the field of "innovation ecosystem" was counted. The following are the content analysis tables of the documents:

Table (4) Coding of documents in the field of innovation ecosystem – structure

Selective coding	Axial coding	Open coding	Studies and results
structure	**process**	life cycle	The ecosystem has a life cycle and develops over time to reach maturity and eventually disappears or restores its structure due to environmental changes. (Oh, et al, 2016) &(Moore, 1996)
			The set of actors, interactions and structure of an ecosystem has a life cycle with five stages (Rabelo, Bernus, 2015)
		Feedback systems	Innovation ecosystems allow companies to integrate resources and create industry-friendly solutions. (Benitez et al,2020)
			The ecosystem has a state of feedback and self-improvement that gives it the ability to be dynamic. (Rabelo, Bernus, 2015)
		Co-opetition	Partner selection has been an important factor in the success of collaboration in operating system-based innovation ecosystems. (Wei et al,2020)
			Collaborating to solve important technology challenges, create benefits for partner companies, and advance technology innovation for companies is challenging and at the same time very rewarding.(. Gnyawali,2011)
			Joint competition between the giants creates the next competition among other companies and leads to the development of advanced technology. In addition, corporate capabilities play an important role in increasing mutual benefits as well as gaining a relatively larger share of benefits . (Gnyawali,2011)

		Dynamic capabilities	The results show that dynamic abilities play a key role in company success. They help the company acquire, renew and reconfigure its resources and lead to development. This process naturally solves the phased challenges of the innovation ecosystem and promotes its evolution (Feng et al,2020)
			Self-improvement in the ecosystem develops dynamism (Rabelo, Bernus, 2015)
		Environmental and regional factors	The value created by innovation must be purposefully returned to the same area. (Development et al,2015)
			Local texture characteristics contribute significantly to the re-innovation ecosystem. (Vlaisavljevic et al,2020)
			Institutional Map provides more room for innovation. (Primmer et al,2020)
	Operational	Networking	Environment and communication networks have effects on corporate innovation.. (Xie& Wang,2020)
			actors are confronted with networks of shared relationships in the ecosystem to turn innovations into measurable economic outcomes .(Feng et al,2020)
		Market oriented	The market-based approach is different from other concepts. In fact, the innovation ecosystem approach complements the vision of the innovation system, and this is due to the focus on the nature of the relationship between the actors(Mazzucato, Robinson, 2017)
			The ecosystem is mostly market-oriented. In addition, the innovation system pays more attention to social interactions between actors and its effects on each other's development .(Oh, et al, 2016) (Moore, 1996).
		Open innovation	Open innovation connects more companies and creates innovation ecosystems to improve its innovation capabilities by interacting with heterogeneous actors (Xie& Wang,2020)
			The innovation ecosystem is based on the open innovation paradigm. (adutvl, 2017)
			The role of policies and clusters in the development of an open innovation ecosystem is effective. (Vlaisavljevic et al,2020)
		Four and five models of innovation	Innovation ecosystem of governments, industry and academia / research institutes as well as the dynamic context of the ecosystem by identifying key aspects of skills, knowledge and budget flows and the interactions between them(Arenal et al.2020) .

			The innovation ecosystem has an operational structure in the form of the network, limited role of government, floating borders, connectivity of communications and interactions from the global level to the business environment, market-oriented, open innovation models and in the form of four and five spirals of innovation. (Oh, et al, 2016) ؛Rabelo, Bernus, 2015)

The first cluster of vocabulary results and its relevance to the literature and research background show the overall structure of the innovation ecosystem. This means that the innovation ecosystem can be considered as an evolved form of the concepts of the Innovation Network, the National Innovation System, the Regional Innovation System, the Innovation Clusters and the integration of the business environment to the global innovation markets (Moore, 1996) with features from life cycle dynamics, correction and feedback systems (Rabelo, Bernus, 2015; Jucevicius, Grumadaite, 2014; Isenberg, 2011). Also, the existence of formal and informal networks (Isenberg, 2011), performance in the form of the fourth and fifth spiral models of innovation and performance in the form of open innovation models (Durst, Poutanen, 2013), activities around a non-governmental central platform models and strategies (Oh, et al, 2016; Rabelo, Bernus, 2015) , and a process and operational structure are another features of the innovation ecosystem. Process structure means that each ecosystem has a life cycle (analysis, design, development, implementation, result), a feedback and a correction system, and a core or a central platform. In addition, it has a networked operational structure, the limited role of government, floating borders, connectivity of communications and interactions from the global level to the business environment, market-oriented, performance in the form of open innovation models and in the form of four and five spirals of innovation. The second cluster is related to the study on "key actors in the innovation ecosystem". The results of this classification are shown in Table (5):

Table (5) Coding the documentation of the actor innovation ecosystem

Selective coding	Axial coding	Open coding	Studies and results
actors	**macro level**	government	Governments and institutions provide financial mechanisms and programs, regulations, policies and incentives in the innovation ecosystem. (Durst, Poutanen, 2013)
		universities	Van Witt (1999) states that innovative universities have been accepted as one of the main and efficient components of the innovation ecosystem (Van Vught,1999)

			Third generation universities are entrepreneurial, value-creating, wealth-creating and community-oriented, and one of their characteristics is the production of applied knowledge and their presentation in the society.(Christensen & Eyring,2011).
		Policy-making bodies	Policymakers can learn how to organize the evolution of these ecosystems. (Benitez et al,2020)
		Geographical environment and regional environment	Region and geographical location moderate the relationship between the company's innovation position and the ecological innovation network. (Xie& Wang,2020)
			Local location and the innovation ecosystem give companies access to technological capabilities .(Asplund et al,2020)
			The environment helps to stabilize the green ecosystem of innovation. (Yang et al,2020)
	Micro level	Micro research institutions	Institutional relationships influence the evolution of the innovation ecosystem. (Granstrand& Holgersson,2020)
		Entrepreneurs	Social capital is one of the important pillars of innovation development .(Feng et al,2020)
			An agent or entrepreneur who lacks motivation or ability causes failure at the micro level. (Svensson and R.K. Hartman,2018)
		Customers	Customers, individuals, companies, universities, banks, etc., who participate in several stages of an innovation initiative can achieve the final results. (Durst, Poutanen, 2013).
		Investors	Macro-level factors such as investments are considered as incentives for innovation. (P. Bradonjic, N. Franke and C. Lüthje,2019)
			To overcome this oversight, our study defines destructive innovation ecosystems and demonstrates the impact that the financial technology ecosystem has had on disrupting the financial services industry. (Palmié et al,2020)

According to the vocabulary of the second cluster, active actors in the innovation ecosystems are classified according to their role and degree of influence at both macro and micro levels.

- ✓ At the macro level: universities and educational centers, government and policy-making institutions, industries, large companies, financial and capital markets, human resources, macro-currents (economic, social, political, cultural) culture.

- ✓ At the micro level: research institutes, entrepreneurs, venture capitalists, incubators and research laboratories, media outlets, suppliers, civil society (NGOs and social and environmental requirements), customers and end users, Micro currents (economic, social, politic .(Grilo, et al, 2017؛ Durst, Poutanen, 2013؛ Isenberg, 2013؛ Rabelo, Bernus, 2015؛ Jackson, , 2011؛ COHEN, 2006) .al, cultural).

The second cluster shows the results of research related to "relationships and interactions" in Table (6):

Table (6) Coding of documents in the field of innovation ecosystem - relationships and interactions

Selective coding	Axial coding	Open coding	Studies and results
Relationships and interactions	**Types of relationships**	formal network	Innovation ecosystem based on network communication creates the key elements of dynamism and competition (Walrave,et al 2018)
		informal network	Innovation ecosystem plays a role as a formal and informal network, dynamic,and competitive. (Walrave,et al 2018 ؛Isenberg,2011 ؛ Adner, 2006 ؛Wessner, 2005)
	Types of interaction	Dynamism	Government-based alliance, University and Industry, bring up innovation in the green innovation ecosystem, and leads to the dynamism of the organizations. (Yang et al,2020)
			Interactions, while being competitive, play a role in creating value and dynamism. This is done through interdependence, with specialized and complementary capabilities, and entrepreneurial orientations. .Walrave,et al 2018).(
		Attraction of the specialized and complementary capabilities	The specialized capabilities of research organizations and pharmaceutical companies interact in the innovation ecosystem to develop new drugs. . (Wu &He,2020)
		Entrepreneurial orientations to create value	Proper management of resource use and appropriate innovation play an important role in entrepreneurial orientations to create value. (Wu &He,2020)
			Collaborative interactions are related to interdependence with specialized capabilities and complementary capabilities with entrepreneurial orientations to create value in each area(Walrave,et al 2018)

In the third cluster, the outcome of vocabulary concepts and compliance with the literature and research background refers to the form of the relationships and interactions of innovation ecosystem actors. Relationships between innovation ecosystem actors are networked (formal and informal), as well as dynamic and competitive (Walrave,et al 2018؛ Isenberg,2011 ؛ Adner, 2006؛ Wessner, 2005). In addition, collaborative interactions are related to interdependence with specialized capabilities and complementary capabilities with entrepreneurial orientations to create value in each area (Walrave,et al 2018).

Table (7) Coding of documents in the field of innovation ecosystem - how it works

Selective coding	Axial coding	Open coding	Studies and results
Performance	Strategic	Environmental and infrastructural preparation	At the strategic level of the ecosystem, performance innovation is considered as the preparation of the environment and infrastructure.(Grilo, et al,2017)
		Policy and Strategy development based on knowledge and innovation	Policy and strategy development based on knowledge management, innovation, and resource-based perspective, are considered in .the innovation ecosystem. (Oh, et al, 2016)
	Operational	Feedback and strengthening the monitoring system	Features such as life cycle dynamics and moderator system, and feedback strengthens the monitoring system. (Rabelo, Bernus, 2015؛ ،Isenberg,2011 ؛Jucevicius, Grumadaite, 2014)
		Active leadership	Active leadership, organization and coordination of all actors by a central platform and at the operational level, knowledge and learning flow management, endurance (maintaining status against disorder), flexibility (rate of return in different conditions), and technology transfer should be done in a market-oriented manner. Also, to manage and develop ideas, set up, marketing and sales, the use of empirical evidence and the analysis of social networks are essential. (Oh, et al, 2016 ؛Grilo, et al,2017 ؛Jucevicius, Grumadaite, 2014 ؛Hwang, Horowitt, 2012 ؛ Allison, Martiny, 2008 ؛Ove, Marcus, 2020)
		Organizing all key elements by one central platform	Activities around a central non-governmental platform are possible by applying strategic and operational models and strategies. (Rabelo, Bernus, 2015 ؛Oh, et al, 2016).
		Knowledge flow management	At the operational level, knowledge flow management and learning in the innovation ecosystem should be considered market-oriented. (Grilo, et al,2017).

		Flexibility	In the innovation ecosystem, flexibility, ie the rate of return in different conditions, is considered. (Jucevicius, ؛Grilo, et al,2017 ؛Oh, et al, 2016 ؛Hwang, Horowitt, 2012 ؛Grumadaite, 2014 Ove, Marcus, 2020 ؛Allison, Martiny, 2008)
		Technology Transfer	Technology transfer, the use of empirical evidence, and the analysis of social networks are important for managing, developing, and launching ideas in the innovation ecosystem. (Oh, et al, 2016 ؛Grilo, et al,2017 ؛Jucevicius, Grumadaite, 2014 ؛Hwang, Horowitt, 2012 ؛ Allison, Martiny, 2008 ؛Ove, Marcus, 2020)
		Marketing and sales	Technology transfer, the use of empirical evidence, and the analysis of social networks for managing, developing, and launching ideas as well as marketing and sales in the innovation ecosystem are considered. (Jucevicius, ؛Grilo, et al,2017 ؛Oh, et al, 2016 ؛Hwang, Horowitt, 2012 ؛Grumadaite, 2014 Ove, Marcus, 2020 ؛Allison, Martiny, 2008)

In the fourth cluster, according to the vocabulary and their adaptation to the subject of the literature, it is possible to deduce how the innovation ecosystem works. This means that according to the structure of the ecosystem, (the actors, the type of the relationship and their interactions to achieve the desired results and outputs at the strategic level), performance must be done according to the following:

Environmental preparation and infrastructure; policies and strategies development based on a knowledge and innovation management, and resource-based perspective in the whole ecosystem, which is done in two stages, such as the formation stage and the maintenance stage; Establishing and strengthening the monitoring and correction mechanisms for feedback and correction; Attracting key actors; Active leadership; Organizing and coordinating all actors by a central platform; Attracting key actors; Active leadership; Organizing and coordinating all actors by a central platform; Market-oriented performance at the operational level; Knowledge flow and learning management; Resistance in difficult conditions; Flexibility, ie the rate of return in different conditions; Technology Transfer; Use of empirical evidence; Analyze social networks to manage, develop and launch ideas; Marketing and sales.

(Oh, et al, 2016؛ Grilo, et al,2017؛ Jucevicius, Grumadaite, 2014؛ Hwang, Horowitt, 2012؛ Allison, Martiny, 2008؛ Ove, Marcus, 2020).

Table (8) Coding of documents in the field of innovation ecosystem - consequences and results

Selective coding	Axial coding	Open coding	Studies and results
Consequences and results	Macro level	Economic growth and development	The results of this research enrich open innovation ecosystems and provide important managerial implications for the implementation of special innovation initiatives to foster exploratory innovation and corporate exploitation(Xie& Wang,2020)
		Proposed comprehensive value	The role of innovation ecosystems is important for achieving sustainable development goals. (Nylund et al,2021)
			An ecosystem is a network of interdependent actors. In this network, specialized resources or capabilities that complement each other are combined to achieve the following two goals: 1. Joint creation and providing comprehensive value proposition to end customers; 2. Revenue from value added. (Wessner, 2005)
		Economic growth and development	The impact of the innovation ecosystem on performance and sustainable development has been confirmed. (Yang et al,2020)
	Micro level	Create a competitive advantage	Sustainable and intelligent innovation ecosystem creates a competitive advantage and outlines future prospects. (Dao Yin,2020).
		Increase efficiency	Ecosystem pillars over time remove barriers to innovation and increase efficiency. . (Noelia& Rosalia,2020)
		Commercialization	an innovation ecosystem development will lead to commercialization and ultimately the increase of the profitability of the business. (Allison, Martiny, 2008)
		Increase in profit	Modeling a successful innovation ecosystem leads to the increase of the profit and formation of a sustainable economy (Asefi et al,2020).

The fifth cluster can represent the results and outputs of an ecosystem performance. These results can be examined at the micro and macro levels. At the micro level, working in the form of an innovation ecosystem can create a more competitive advantage and efficiency for businesses. It also creates and

captures value through interactions and collaborations, commercialization, and ultimately leads to the desired profit for businesses (Allison, Martiny, 2008). The results are reflected at the macro level in the form of sustainable national and regional economic growth and development, and even at the level of innovation clusters. Besides, providing comprehensive value proposition to the customers in the form of innovation in products, services, or knowledge, is another outcome of any type of the ecosystem (Walrave, et al. 2018; Adner, 2006).

5.Conclusion

Nowadays, the rapid advancement of technology and the consideration of innovation as drivers of economic development of countries and development of innovation ecosystem is increasing. The innovation ecosystem is usually developed and evolved strategically and networked around a specific technology, sector or industry in order to create entrepreneurial activities. One of the most significant steps in designing innovation ecosystems is to investigate and identify, and select and deploy main actors in the innovation ecosystems. Nowadays, the innovation ecosystem is considered prominent in terms of environmental regards; besides, it can be created or nurtured to achieve a broader vision. . (Scott Dempwolf et al,2014)

Innovation ecosystem refers to the elements or individuals, organizations or institutions other than the entrepreneur which motivates or hinder the individual's decision to become an entrepreneur or the possibility of the success if he/she starts an entrepreneurial business. The innovation ecosystem creates an environment that encourages entrepreneurial efforts (Forfás, 2009). The study has created and provided a framework in the field of "innovation ecosystem". Based on the results, research in the field of innovation ecosystem can be studied in five ways. As shown in Figure 10.

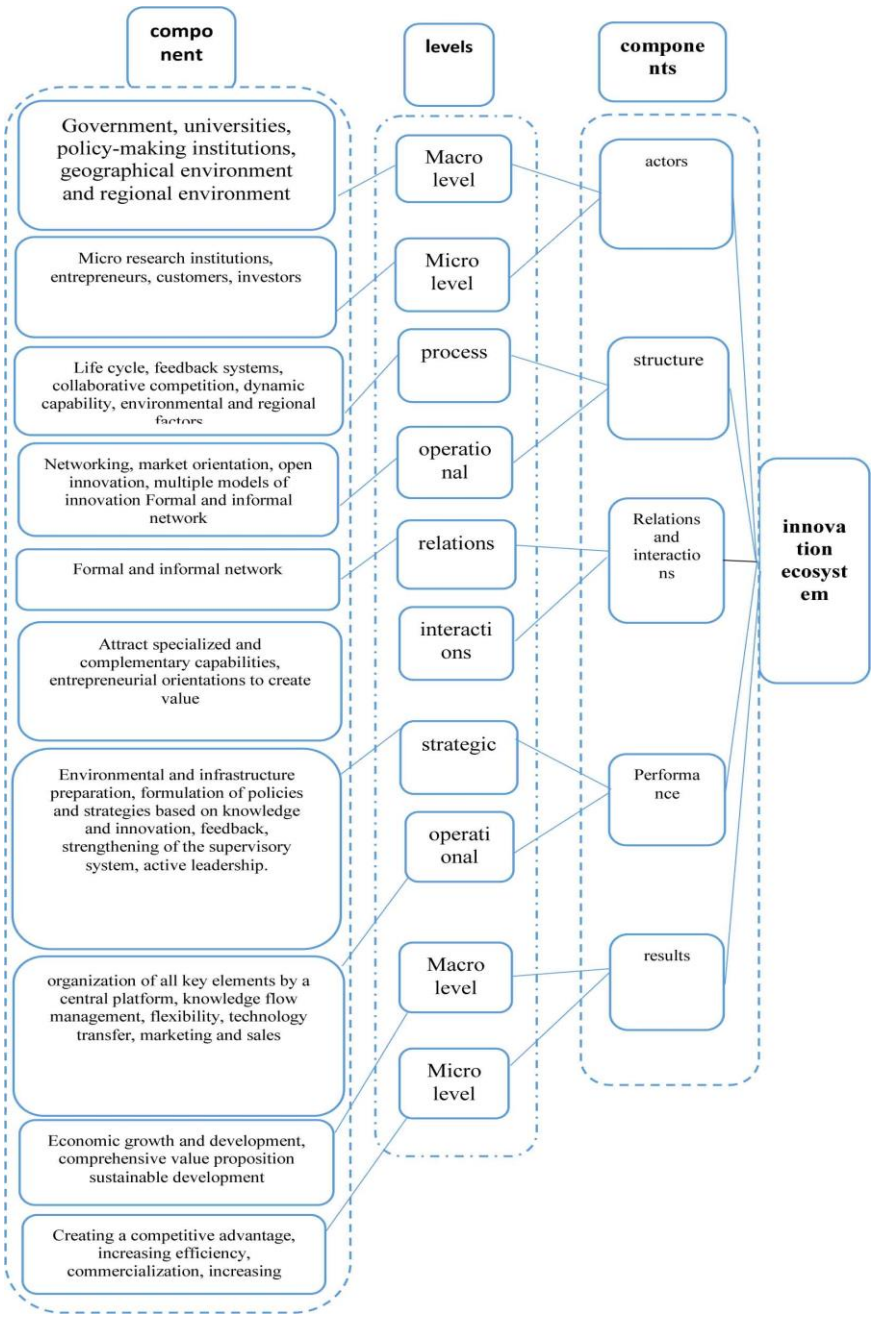


Figure (3).The framework of "innovation ecosystem". Based on the results

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تحلیل ارکان اکولوژیکی اکوسیستم نوآوری بر اساس روش کتابسنجی

چکیده

ظهور اقتصاد مبتنی بر نوآوری مستلزم توسعه اکوسیستم نوآوری در بافت منطقه است. در اکثر کشورها، به ویژه کشورهای کمتر توسعه یافته، اکوسیستم به درستی شکل نگرفته است و اولین قدم برای شکل‌گیری آن، شناخت نظری و تجربی این حوزه است. بنابراین، این مطالعه با هدف بررسی ابعاد و اجزای اکوسیستم نوآوری انجام شده است. در این تحقیق از روش کتاب سنجی، تحلیل استنادی، تکنیک‌های ارزیابی کاربردی و تحلیل محتوای اسناد استفاده شده است. هدف این پژوهش مروری بر مطالعات انجام شده در این زمینه و ارائه مدلی مفهومی و تلفیقی با استفاده از تحلیل محتوای اسناد و مدارک با سازماندهی تحقیقات قبلی است. جامعه آماری این تحقیق شامل کلیه اسناد ارائه شده در پایگاه Web of Science با مطالعه وبررسی ۴۳۸ مقالات و اسناد علمی مربوط به اکوسیستم نوآوری تا سال ۲۰۲۰ می باشد که با استفاده از نرم افزار VOS viewer مورد ارزیابی و تصویرسازی قرار گرفته است. بر اساس تحلیل محتوای اسناد، تحقیق در مورد «اکوسیستم نوآوری» به پنج بخش تقسیم شده است. بخش اول تحقیق مربوط به عوامل ساختاری بخش دوم مربوط به نوع روابط و تعاملات و بخش سوم مربوط به نتایج است. قسمت چهارم درباره بازیگران و قسمت پنجم نحوه اجرای آنها است. در نهایت چارچوب مفهومی تحقیق بر اساس تحلیل محتوای اسناد ارائه شده است.

کلید واژه‌ها: اکوسیستم ، نوآوری ،اکوسیستم نواوری ،کتاب سنجی.