Sustainable Entrepreneurship Ecosystem: A Bibliometric Analysis

Nhung Thuy Tran and Dat Minh Nguyen

Abstract The article focuses on analyzing the development of academic literature related to the sustainable entrepreneurship ecosystem. The bibliometric analysis method was used to systematize and evaluate the reference level of studies related to the entrepreneurial aspect. The study presents academic papers with the keyword "sustainable entrepreneurship ecosystem" from mid-2018 to early 2021 on the Dimensions database. The results provide an overall framework that integrates sustainability elements with the necessary theories, methods, and approaches in building a sustainable entrepreneurship model. However, like most other factors, the startup and technology ecosystem is driven by the growth and support mechanisms of the country. The harmony between the startup ecosystem and sustainable development policy depends on different fields as well as different countries. Therefore, future studies should focus on a specific startup ecosystem in the same region to evaluate more accurately and specifically in both theory and practice. This article can be viewed as an approach that synthesizes a new concept of the startup ecosystem in the context of sustainable development.

Keywords Startup · Concept · Bibliometric · Entrepreneurial ecosystem · Sustainability

1 Introduction

The concept of entrepreneurial can be referred to as the startup and scaling phases, it can be treated as a driver of innovation and sustainable economic growth, and most of the companies will go through this stage to enhance and strengthen the growth of the company (Nueno, 2015, 27). With fast-growing industry and intensive competition with each other, startup companies tend to utilize different techniques to increase the chance of success, one of which is when they inserted in an entrepreneurial ecosystem (EE) (Arruda et al., 2015), this will increase the chance of competing and enhance

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business development. On the other hand, with the emerging of globalization and corporate social responsibility that now become vital in business performance, those factors force startup companies to improve their brand image through best practices; with the strong involvement of the stakeholders in the decision-making (Bărbulescu et al., 2021), this also means that the interconnection between the external and internal connection existed to create innovation, persuade the know-how networking to be evolved in time, and startup companies can adapt better in the market.

The concept of "Sustainability" has been introduced for a long time by the United Nations and is described as "*meeting the needs of the present without compromising the ability of future generations to meet their own needs*" together with the ecosystem concept is generally defined as "*a system, or a group of interconnected elements, formed by the interaction of a community of organisms with their environment*". This means that depending on the different countries, and industry, actors will include different elements and interact with each other.

In addition, sustainability entrepreneurs (SE) tend to look under the triple bottom line model to match business management and provide strong, stable growth not only with the business, but also with the three aspects which are environmental, social, and economic dimensions (Nakyejwe et al., 2021). There is lots of debate around the definition of sustainability entrepreneurship which we appreciate the concept of the triple bottom line, which shows how is the perception of the company when acting according to the triple bottom line model, and Belz and Binder (2015) suggested that the business performance and the gain of economic, social, and ecological must be balanced.

Sustainability entrepreneurship ecosystem (SEE) can be viewed with the triple bottom line (TBL) for better assessment by answering questions related to the surrounding environment of the business and how to maintain accountability to the pillars, supporting the programs in a complex and dynamic environment, but also competing and innovative in the market. However, so far, the concept of sustainability entrepreneurship ecosystem and how to properly define it is still uncertain since the debate between different researcher and practitioners (Belz & Binder, 2015).

The paper identifies the key concepts related to SEE through academic research and uses the bibliometrics analysis method to systematize and evaluate the reference level of studies related to the entrepreneurial aspect. The results provide an overall framework that integrates sustainability elements with the necessary theories, methods, and approaches to building a sustainable entrepreneurship model.

2 Theoretical Framework and Overview of the Related Research

2.1 The Concepts

As mentioned, the concept of a sustainability entrepreneurship ecosystem can be in doubt when a company joins the market, the profit ideology might be prioritized and know-how implementation can barely be applied because this will create competitive advantages, and the failure of the SEE will exist when entrepreneurship leader is going to take control of the evolution (Feld, 2012).

When the SEE is working as a community, most of the actors in the community will show an interest in innovation and promote high technology products but also observe the best practices on the social and environmental, this will also persuade the act of the enterprise within the community to follow the concept of three bottom pillars, and Fig. 1 shows the image of the three bottom pillars that how the enterprise is going to be sustainable by accounting for different pillars.

This TBL assumed that the enterprise needs to spend and pay attention as much to the social and environmental as the economic, but when companies try to work on sustainability based on the project, the restriction in costs, knowledge and technologies, and any external environment limitation (Opoku et al., 2018), this is suggesting the needs of understanding and connection between difference pillars.

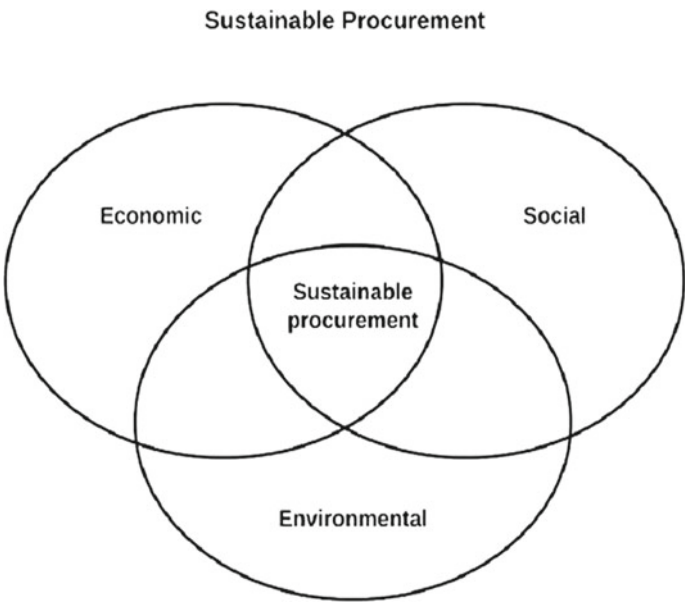

Fig. 1 Three bottom line model. *Source* Elkington (1997)

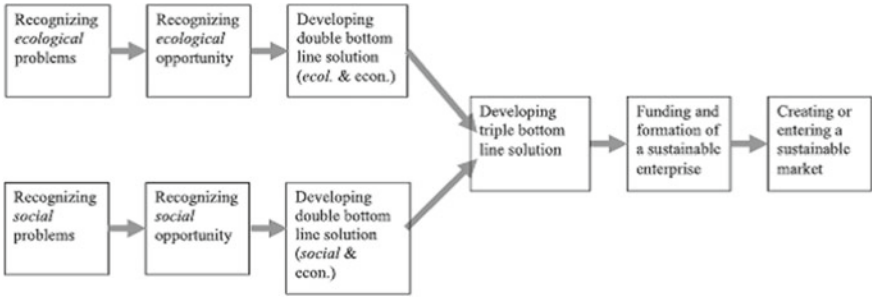

Fig. 2 Sustainable entrepreneurship process. *Source* Belz and Binder (2015)

To maintain transparency and accountability for sustainability and balance the social and environmental dimension, Belz and Binder (2015), have suggested a sustainable entrepreneurship process to make sure that the enterprises are well aware of the environmental and social problems. Figure 2 indicates the process as a "sustainable entrepreneurship process".

Isenberg (2011), suggested the ecosystem model with six domains including market, policy, finance, culture, supports, and human capital and stated that the domains are based on the entrepreneur's perceptions and how they are going to impact the decision and success of an enterprise. Based on clusters of Isenberg's ecosystem models, enterprises are not only acting on the behalf of the market and shareholders but also responsible for the action with other stakeholders (Zivdar & Sanaeepour, 2022). The entrepreneurship ecosystem is not only applied to for-profit enterprises but also emphasizes the importance of numerous entrepreneurial actors. Apart from taking their functions of each dimension, Isenberg's model observed the SEE as the connection and multi-relationship between each pillar and entrepreneurship (Stephen et al., 2022).

The success and failure of SEE might depend on the region and territories, thus with the knowledge and understanding of labor to build up the ecosystem, hence become sustainable in the future through sharing knowledge, ideas, also the entrepreneurship culture can vary, and based on the finding of Leedertse et al., the measurement of effective EE cannot always lie on data driven and should be used bottom-up techniques to find out the optimal solution that drives to sustainability.

SEE when working with the sustainable development must have focused on innovation by providing new or improvements in the products (Bărbulescu et al., 2021) and forming depend on the stakeholders, for example, becoming a product or service or improvement of the technology. While companies treated as SEE, similar to EE, will have a positive impact on the start of new sustainable ventures developing technologies and products through research and development (Divito & Housz, 2017).

In today's society, cross-border transactions becomes popular with the development of technology, seeking for the market might not have boundaries and SEE can be used to foster scale economic and financial return together with attracting foreign

talent from abroad and multiple benefits to the country (Arruda et al., 2015) (for instance accelerate economic progress).

To build a good SEE within a country, the intervention and the support of the government policy are important, as such creating the market and knowledge about the product, and regulatory bodies (Arruda et al., 2015), which also mean the seriousness that the government and policymakers are thinking about the sustainability and different government, understand entrepreneurship as an indispensable element to preserve the competitiveness of the economy. Based on the actor of public policy, the government's intervention in the sustainable of entrepreneurial ecosystem has existed, but somehow the responsibility is to prevent excessive obstacles to entrepreneurship; basically, the government can be treated as a feeder and balancing between the heavy intervention and self-regulating mechanism (Panetti et al., 2021). Besides, the policy domain can be evolved from the embryonal ecosystem which focuses on creating the space for entrepreneur's performance to the EE which is focused on sharing and partnering between public and private entities, together with boosting the low-tech industry within the same ecosystem through digitalization and modernization programs (Panetti et al., 2021).

Apart from the support of government policy, education and human resources contribute to the SEE through awareness and innovation (Erina et al., 2017). Expanding knowledge through education and training is a must and the involvement of businesses in building talent tools and digital skills (Aminova et al., 2020). Ostergaard and Marinova (2018), suggested that the skills and knowledge in education and human resource pillars should include short-term and long-term courses together with the importance of leadership in the entrepreneurship ecosystem.

2.2 Overview of the Related Research

The concept of a sustainable startup ecosystem is a relatively new term in the study of an entrepreneurial ecosystem. Some typical studies are divided into two main groups, a group often refers to the startup ecosystem from the perspective of sustainable development, according to which *a sustainable entrepreneurial ecosystem is an ecosystem that can contribute to social welfare and toward a sustainable economy* (Aminova et al., 2020). Most of the studies under the perspective of an ecosystem are characteristic of the surveyed area due to the influence of ecosystem structure or are carried out in a certain unit of the ecosystem such as the field of education, government mechanisms, institutions laws, and specific industries. Therefore, the applicability in different regions will have heterogeneous results and effects, and context-specific factors can either support or limit a sustainable startup ecosystem (Volkmann et al., 2019). The second group represented by the studies of Binder and Belz, Demirel et al., and Sarango-Lalangui et al. argues that "*sustainable entrepreneurship is the discovery, creation and exploitation of opportunities that can generate future goods and services that maintain the naturalness of the social-environment and benefit development for others*". Most of these studies develop entrepreneurship in different

aspects such as *entrepreneurial classification*, *technology prospects*, and *social facilities*. Davidson and Vaast suggest some startup models for specific cases such as the *lean model*, *innovation model*, *digital business models*, and *functional models*. In general, until now, theoretically, it has not yet clarified the concept and characteristics as well as the true effectiveness of a SEE compared to a traditional one (Volkmann et al., 2019). Sustainable businesses may require different ecosystems to provide support in different ways than traditional startup ecosystems.

Therefore, although the number of studies using bibliometrics related to the sustainable startup ecosystem is not much, they have become very necessary to connect and build the underlying theoretical system. Some prominent studies include *religious entrepreneurship networks*, *social entrepreneurship portfolio* (Dionisio, 2019), *holistic approach to building a sustainable startup ecosystem*, *sustainability in the startup ecosystem: operating mechanism and business growth business*, and *sustainable entrepreneurship.* However, these studies use many different databases from this article, and the bibliometrics results are not the same. This leads to the conclusion that the category of sustainable startup ecosystem also has many differences.

3 Material and Method

3.1 Data Collection

The main research methods used in the paper are historical research methods and theoretical research methods, in which theoretical research methods include methods of synthesis and bibliometric analysis.

Specifically, the article uses a method of synthesizing research conducted using assessments and summary narratives. Research articles are referenced, cited, and compiled from Dimensions (Table 1).

Then, a secondary screening was performed by evaluating the abstracts and titles of selected articles (Bibliometrics) to provide answers to the research objectives and from there, formed a basic database for VOSViewer (including 2516 documents) to develop graphical visualizations of bibliographic documents, similarities to map journals, and keywords with both bibliographic coupling and co-citation analysis.

Table 1 Inclusion and exclusion criteria for the selection of documents

Criteria include	Exclusion criteria
Language: English	Not related to the sustainable startup ecosystem
Electronic publishing, open source	Incomplete research
Citations of a documents	Lower 50 citations of a documents

In this paper, after excluding the criteria, there are 807 research articles used as the basic data for analyzing. In addition, several documents related to entrepreneurship and sustainable development are also consulted.

3.2 Data Analysis

Bibliometrics is an information science method based on the idea of organizing and analyzing related data according to the progression of concepts, often used to collect text and information from academic journals to create information products such as databases of references and citations. This concept was proposed by Alan Pritchard in the late 1960s, emphasizing "*the physical factor of doing research, such as book counting, number of articles, number of publications, number of citations, generally, any expression shows findings of a statistical nature in terms of recorded information, regardless of specialized boundaries*" (De Bellis, 2009). This method is used to forecast the latest trends of research (Merigó & Yang, 2017) as well as emerging technologies, which are the basis of very popular big data analysis in the current digital era (Hendrasto et al., 2019) (Fig. 3).

The calculation of bibliometric indices should note:

- Systematicity—an attribute that is considered the most basic requirement to implement bibliometrics in determining the relationship between scientific documents, and in evaluating and ranking science for all scientific documents—subject and on all scales.
- The quality of data depends on the keywords chosen for statistics (Chen & Xiao, 2016; Nguyen & Do, 2017).
- Several demographic factors can be used to research, search, and evaluate the collected data (Nguyen & Do, 2017).

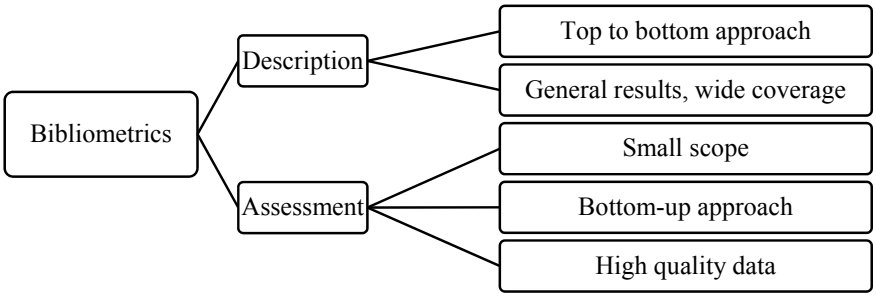

Fig. 3 Features of bibliometric analysis components. *Source* Nguyen and Do (2017)

- The determination of the formation process of data should be shown in the database, that is, the reference object and the level of instruction and extraction must be defined in the network of databases and digitizers—in a reputable rating system (Nguyen & Do, 2017).

4 Results

Before conducting keyword clustering analysis by VOSViewer, a preliminary assessment of the data file and analysis of the list of citations, co-references, and bibliographic links is conducted.

4.1 Literature Mapping: Descriptive Analysis

According to Dimensions, the topic of a sustainable entrepreneurial ecosystem first appeared in a paper of the Conference on The Human Environment organized by the United Nations, published in 1972. However, similar to the article on the spirit of social entrepreneurship in 1936, these articles did not mention theoretical concepts, but focused on making critical arguments against economic development and entrepreneurship in general from the perspective of social science, geography, and environment.

Reviewing studies on Dimensions, the term sustainable entrepreneurship was officially mentioned in Hamilton's "*Entrepreneurs for a New Age*" published in the Journal of Career Development in 1981. According to this article, entrepreneurship is considered in all three basic aspects of sustainable development: society, economy, and environment. Although related studies appeared very early, the number of papers published each year before 1992 was very low (less than 60 articles per year). However, the data on Dimensions also shows that interest in this field tends to increase every year. Especially in the research period, the number of studies on the topic of sustainable entrepreneurial ecosystem increased dramatically (47,796 articles, accounting for 49.31% of the total number of related studies from 1981 to the present).

Extracting data after screening according to the mentioned exclusion criteria, there are 807 documents that match the research requirements. Figure 4 shows the number of publications that meet the set criteria and the average annual growth from 2018 to 2022. Like primary data on Dimension, the number of publications tends to increase annually and is relatively stable. Particularly in 2020, there is a sudden increase in articles on startups, more than 100 articles compared to 2019. This shows that the topic of sustainable startup ecosystem is central in research and the related theoretical–experimental system still has many research gaps.

Reviewing journals that publish many publications whose topic is related to sustainable entrepreneurial ecosystems has a very important role in assessing the

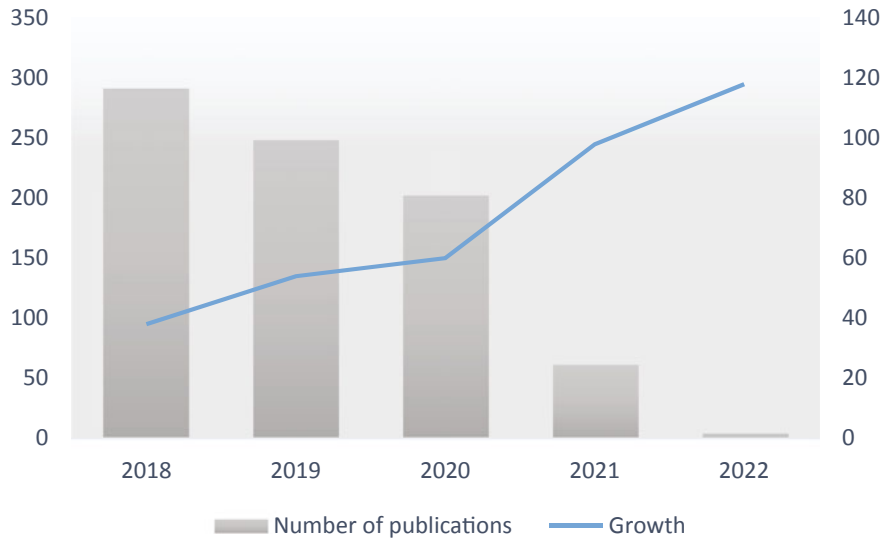

Fig. 4 Filtered total of publications and average growth from 2018 to 2022. *Source* Based on the Authors' finding

source and reputation of references. This method helps to measure the influence and impact index of research in journals and bibliographies and shows a relationship between citation and journals cited. Within 807 articles used, the paper extracted and ranked the most popular journals in this field according to the number of articles published and the total number of citations of documents on the same topic which were published in that journal. The results of the top 20 journals with the highest figures are presented in Table 2. Accordingly, *Technological Forecasting and Social Change* is the first place. There are 53 articles with 5605 citations from 2018 to 2022. *Technological Forecasting and Social Change* is an Elsevier peer-reviewed academic journal, published since 1969, with a 2021 impact factor of 10.884, focusing on technology forecasting about social, environmental, and technological factors. In the second and third place are *Sustainability* and *Journal of Business Research*, respectively. In general, the journals at the top are those that tend to research the sustainability of the environment, culture, economy, and human society, with high impact coefficients. This shows the trend of publication of the term sustainable entrepreneurial ecosystem which is often evaluated from the perspective of sustainable development as initiated by Dean and McMullen.

To get a rough overview of the data statistics, in addition to assessing trends and publications, performing micro-level performance research through the academic influence of scientists also plays an important role. The correlation between research productivity (number of articles published) and citation impact is an essential tool for quantifying scientific performance. Accordingly, the number of citations received by an article is a common bibliographic indicator to determine the quality of the paper. Table 3 lists the most important authors in the field of sustainable startup

Table 2 Journals have published research on the sustainable entrepreneurship ecosystem

No.	Journal	Number of publications	Time cited	IF
1	Technological forecasting and social change	53	5605	10.88
2	Sustainability	49	4621	3.889
3	Journal of business research	41	5568	7.55
4	Journal of cleaner production	20	1698	9.297
5	International journal of information management	17	2234	14.09
6	Research policy	15	1531	8.11
7	Small business economics	15	1487	2.582
8	Business strategy and the environment	10	775	5.483
9	Long range planning	9	1295	8.53
10	Cities	8	1177	5.835
11	IEEE access	8	814	3.367
12	Technovation	8	845	6.606
13	Journal of rural studies	7	685	2.38
14	Sustainable production and consumption	7	571	9.06
15	Journal of international business studies	6	597	11.38
16	Resources conservation and recycling	6	575	10.20
17	European planning studies	5	395	3.777
18	Journal of business venturing	5	540	13.14
19	Land use policy	5	440	5.398
20	Sustainable cities and society	5	1237	7.587

Source Based on the authors' finding

ecosystem research. According to Dimensions, Iztok Podbregar is the author with the most articles published (157 papers), but Vanessa Ratten is the author with the most cited research (988 citations, an average of 9 citations). However, the H-index, which measures the cumulative influence of a scientist, is the highest by Elias George Carayannis (H-index = 66). The H-index is a powerful estimator of a scientist's total impact on a given field of research. Therefore, the H-index is not sensitive to a set of unedited articles or the citation count of one or more articles. This suggests a problem in the bibliographic indicator of citation counts as the frequency of citations received for an article may be due to the author's popularity in the field of study

rather than the relevance of the paper's content (Rey-Martí et al., 2016). In the studies of Carayannis, the author has the highest H-index, focusing on exploiting the role of the startup ecosystem in the changing context of science, technology, and society. The author recognizes that entrepreneur plays an important role in creating ecosystems and keeping them healthy and sustainable; however, "the relationship between organizational entities in an ecosystem has technical, social, economic, and political conflicts as well as goals, priorities, expectations, and cooperative behavior". In this context, sustainable and prosperous entrepreneurial systems will need an initial economic advantage, requiring support from the government. While the studies of Ratten, the author with the highest number of citations, usually studies on startup ecosystems in specific social fields such as education, sports, culture, or startup strategy business in times of economic crisis, Covid pandemic…

Table 3 Authors have published on the sustainable entrepreneurship ecosystem

Ranking	Author	No. of publications	Citations	Mean citations	H-Index
1	Iztok Podbregar	157	12	0.08	5
2	Polona prajc Polona prajc	156	10	0.06	6
3	Andreja Pucihar	113	207	1.83	17
4	Vanessa Ratten	109	988	9.06	38
5	Olja Arsenijević	101	8	0.08	6
6	Dragan Trivan	99	8	0.08	4
7	Yvonne Ziegler	98	8	0.08	29
8	Doroteja Vidmar	63	97	1.54	–
9	Mirjana Kljajić Borštnar	60	90	1.5	13
10	Joao José De Matos Ferreira	59	793	13.44	16
11	Branko Lobnikar	56	11	0.2	18
12	Gorazd Meško	55	25	0.45	30
13	Elias George Carayannis	54	468	8.67	66
14	Kaja Prislan	54	11	0.2	8
15	Rok Hacin	53	11	0.21	6

Source Based on the authors' calculation

4.2 *In-Depth Citation Analysis: Bibliographic Coupling and Co-citation Analysis*

After a preliminary assessment of the research data set, the list of citations, co-citations, and bibliographic coupling of related documents on the topic of sustainable startup ecosystems are analyzed.

Regarding citation bibliography, out of 807 documents, there are 361 articles cited related to each other and divided into 19 clusters. The topics covered by each cluster are summarized in Table 4.

The topics are related to each other through business and science, and technology. This reinforces the conclusion of Carayannis et al. on the role of businesses in the sustainable startup ecosystem, as well as the relationship between science and technology and the output of the sustainable startup ecosystem.

Bibliographic coupling is a case where two later published articles cite the same previously published paper. Bibliographic coupling analysis will produce a sequence

Table 4 Citation clustering analysis

Cluster	Number of publications	Main topic	Featured Author
1	35	Blockchain technology and entrepreneurship	Kouhizadeh, Wang
2	34	Technology and sustainability	Ranbaji et al.
3	33	Digital transformation and COVID	Sigala, Via
4	26	Entrepreneurial ecosystem	Acs et al.
5	23	Ecosystem	Jacobides et al.
6	21	Digital entrepreneurship	Ghezzi and Cavallo
7	21	Industry	Farahan
8	20	Circular economy	Ferasso et al.
9	19	Sustainability transition	Martin et al.
10	18	Eco-innovation	Dias
11	17	AI and supply chain	Dwivedi et al.
12	16	Smart city	Mitra
13	15	Sharing economy	Badescu et al.
14	14	SME	Horvarth and Szabó
15	14	Digital sustainability and entrepreneurship	George
16	12	Education	Ndofirepi, We
17	11	Sustainable development	Johnson
18	6	Social entrepreneurship	Mthembu and Barnard
19	6	Resilience of firm	Fatoki

Source Based on the authors' finding

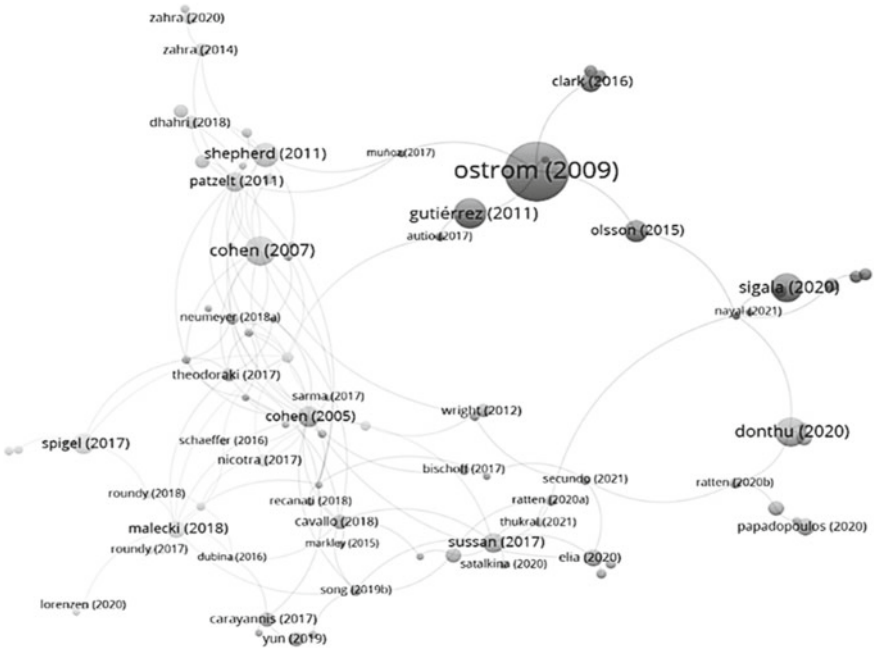

Fig. 5 Visual map of bibliographic coupling analysis. *Source* Based on the authors' finding

of documents quoting the same document, showing similarities between these documents. Figure 5 shows that there are 39 bibliographic clusters, of which Ostrom is the most co-cited document. Ostrom's study provides a framework for analyzing the sustainability of complex socio-ecological systems.

Co-citations analysis is a case where two previously published articles are cited by the same later published work. The fact that two articles are cited by a newer paper may indicate a certain quantitative relationship between the two articles. The degree of association depends on the number of times the two documents are cited together. Figure 6 shows that there are 20 co-citation clusters, and the co-citation clusters are relatively closely linked and asymptotically in terms of scientific content. Only a few studies by Ateljevic, Zhao, and Martin, although still belonging to existing co-citation clusters, at a long distance, show a lower quantitative relationship with the topic.

4.3 Keywords Clustering Analysis

The study analyzed recent startup articles using a data directory network with the keyword "*sustainable entrepreneurial ecosystem*" on Dimensions, mid-2018 through early 2022 based on the density of studies and extraction frequency of related studies.

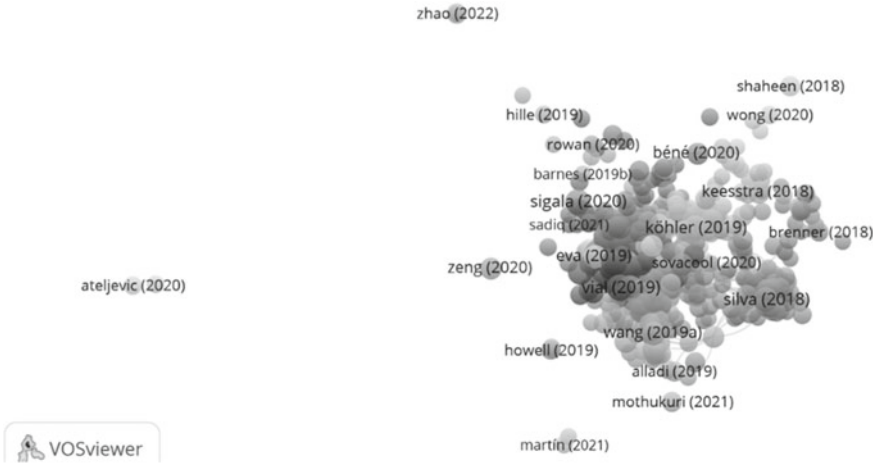

Fig. 6 Visual map of co-citation analysis. *Source* Based on the authors' finding

Titles and abstracts of related keyword studies (682 articles, filtered from 807 documents matching the original criteria) will serve as the primary data in the study. After importing the text data file into VOSViewer software, it will generate the keywords with the most frequency (minimum 20 times in a document) and directly related to the main keyword. A manual selection method was also used to refine the results according to the scope of the study (the number of eligible studies was 141 documents).

The results of bibliometrics not only describe the context studies of sustainable startup ecosystem development but also reveal the characteristics as well as roles and areas of application.

Figure 7 shows that there are not many studies on the startup ecosystem that are directly related to the keyword "sustainability". The dispersion of topics and the significant gap between ecology and aspects of sustainable development (such as climate change, energy, and education) are evidence of this argument. The most discussed in the sustainable startup ecosystem theory is the impact and barriers of technology on the startup ecosystem, for example, the study of Silva et al., Müller et al., Teece, Kohtamäki et al., Gupta et al. This is explained by the larger circle shown and the close distance between these two subjects in the figure. The other themes presented in Fig. 7 do not have much difference in circle size, showing that the sustainable startup ecosystem with related fields is still in the early stages of research. Although the topic group of startups is a frequently cited concept, explaining the ecosystem and sustainable development perspective, the connection between them and the technology element is very weak, even less than the topic of mechanism policy.

Figure 8 is the result illustrating the evolutionary network of the sustainable entrepreneurial ecosystem theory. It describes the topics associated with the keywords and the period in which these topics were discussed. From Fig. 8, it can be concluded

Fig. 7 Density of topics related to sustainable startup ecosystem. *Source* Based on the authors' finding

that most researchers did not discuss how the startup ecosystem changed the concept of sustainable development and vice versa until early 2019. Common themes are discussed in recent years focus on the response mechanism to the crisis, the COVID pandemic. While topics related to the startup ecosystem were the main theme in 2018, at the end of 2018, researchers began to look at the outputs of the startup ecosystem as well as the necessary mechanism for cooperation, as well as the role of entrepreneurs. The diagram also shows the technology and business model factors discussed only in the first months of 2019. The main reason for this problem is due to the emergence of the COVID pandemic, its influence gradually spreading, hindering the startup of businesses by individuals and organizations with new ideas, and placing existing businesses at a sensitive, risky time, which innovation cannot even overcome, requires a more appropriate business model.

From the visual analysis in Fig. 9, the results show that topics can be classified into four large groups. Each group has a certain correlation with each other, and the size of the circle represents the main issue that people discuss related to the keyword "*sustainable startup ecosystem*". The distance of each circle indicates the relationship of each topic to the other problems. The four main groups include technology, startups, relationships, and sectors.

Cluster 1: bottom left corner: Technology. Topics discussed in this area can be mentioned as solutions, blockchain, Internet, smart city, super chain, and energy. Although the number of studies that directly correlates with the startup ecosystem is small, the studies on this topic are very commonly linked. Most of the studies on this topic document the effectiveness of technology application in practice and the change in businesses, people, and society before the impact of the scientific and technological revolution. This makes sense because the role of technology in changing

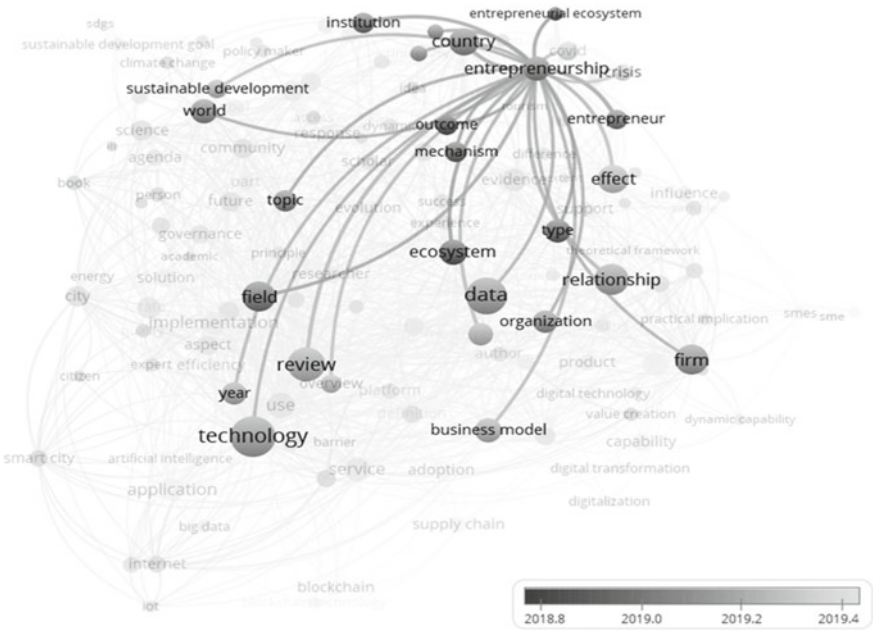

Fig. 8 Network shows evolution. *Source* Based on the authors' finding

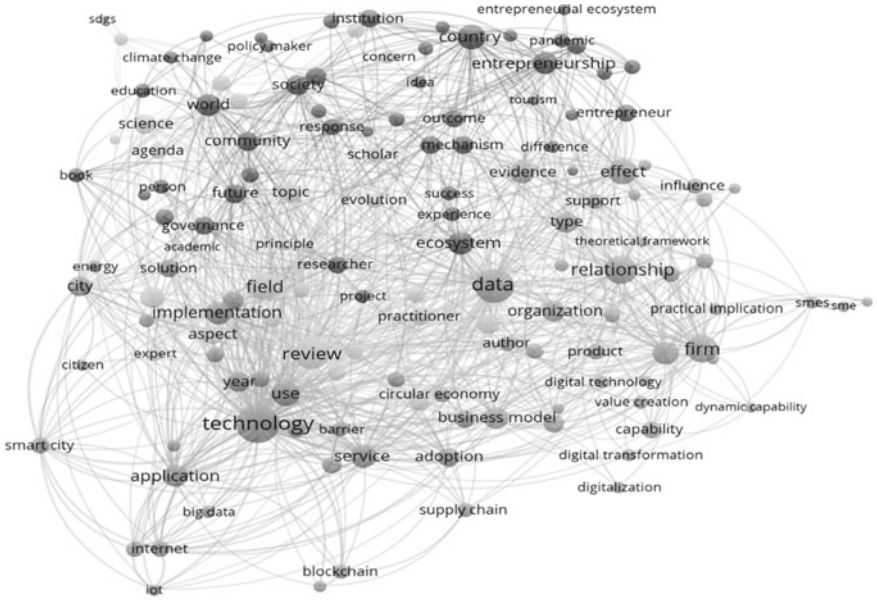

Fig. 9 Visual network clustering-related topics. *Source* Based on the author's finding

the pillars of the sustainable development perspective is undeniable, and changes in human or environmental perception can completely affect the sense of entrepreneurship. Furthermore, digital platforms are intermediaries for the exchange of goods and services, as well as a medium for knowledge exchange that enables and facilitates experimentation, business innovation, and value creation. However, the technological aspect commonly used in these studies is mainly technical and application development. In this cluster, each topic has a different mention weight as the circle sizes are markedly different. This means that researchers focus on discussing general technological terms and practical applications. The gap indicates that whenever technology-related topics are discussed, issues of their applicability and barriers will be addressed. For example, if research on blockchain, studies on initial coin offerings (ICOs), and supply chain efficiency are likely to appear. Accordingly, ICO is a new startup financing mechanism through token exchange listing. Empirical analysis of instrumental variables suggests that ICOs may bring more jobs in the future, reflecting the business's access to the liquidity of the token. Therefore, when businesses or organizations apply new achievements of science and technology to the operating mechanism, it will affect the ability and degree of linkage in the startup ecosystem that these organizations are participating.

Cluster 2: entrepreneurship: top of the figure, including issues about the startup ecosystem, policy, entrepreneurs, community, government, education, and society. This is a group of topics with close correlation, even including keywords, this result is consistent with the general research trend. The size of the circle in Fig. 9 shows the large number of studies involved. This shows that the right attitude in startup research will help to achieve optimal results for studying sustainable startup ecosystems. Cluster 2 focuses on discussing how the startup ecosystem can change, stimulate, or delay factors related to sustainable development from different angles, depending on the audience participating in the ecosystem such as government, entrepreneurs or educational institutions, and social organizations. Accordingly, the sustainable startup ecosystem is approached through five main factors, including national startup ecosystem, entrepreneurs' mindset, policy mechanisms, sense of community, and social improvement. Startup ecosystems can also influence entrepreneurship through industry differences (Denoo & Yli-Renko, 2019, through sustainable development policy, and socio-demographic factors. However, as mentioned in the related research review, the startup ecosystem in each region and country will have different mechanisms and structures, leading to the degree of influence on the requirements for key factors. The sustainability factor for the startup ecosystem will be different (Volkmann et al., 2019). This difference may stem from cultural factors, a specific factor belonging to the social category, which can become a driving force and barrier for the operating mechanism of a sustainable startup ecosystem. In various forms, culture has always been an important driver of innovation, which can stimulate entrepreneurship but also influence the ideology of some participants who directly participate in the startup ecosystem. Otherwise, women are gradually becoming an active topic when researching issues related to entrepreneurship, especially in countries with certain prejudices about the role of women. The number of female entrepreneurs starting a

business increased by 31% in the USA in 2018, accounting for 30% in Vietnam, but less than 10% in Central India (according to https://startupnation.com/). However, these studies also point to challenges for female entrepreneurs as they struggle to be recognized as well as difficulties in developing their own entrepreneurial identity.

Cluster 3, right corner: relationship. The illustration shows the relationship between the concept of the startup ecosystem and research data, influencing factors, empirical evidence, business model, and SME. This shows that the study of the sustainable entrepreneurial ecosystem in the recent period mainly depends on data collected from AI, case studies, big data, and research results on the influence and practical application of digital transformation factors on startups, thereby forming theoretical bases on the relationship between different factors to the sustainable startup ecosystem. Typically, Bibri's research for smart sustainable urban development, the tripartite business model of Andreassen et al., computational economics by Gao et al.

Cluster 4: field, including evolution, review, expert participation, principles, and academic topics. This topic is relatively far apart from each other. It means the study's dilution, and at the same time, no clear difference in circle size indicates homogeneity in discussion progress, interwoven with key topic clusters such as entrepreneurship and technology.

4.4 Discussion

The results of data statistics and citation analysis show that the topic of the sustainable startup ecosystem is central in research, and the theoretical–experimental system still has many research gaps. In particular, the publication trend of the term "sustainable ecosystem" is often evaluated from the perspective of sustainable development.

On the other hand, through visual analysis using VOSViewer, it is possible to see a complete picture of the research situation and the density of links between keywords related to the concept of a sustainable startup ecosystem. The results demonstrate a regular increase in the number of citations from 2018–2019, which sets the basis for the growth of interest and research intensity in this area. The decline in display in 2022 does not represent a trend reversal in research. However, it is mainly due to the impact of the COVID epidemic, as themes still appear intertwined in the Evolution Illustration Network. The gap between the topic of the startup ecosystem and the theoretical framework reflects the gap in research on entrepreneurship. The papers on technology, especially digital transformation, reflect on the improvement of the business model. Still, mainly limited to the ability to technology applications and depend on the context of the startup ecosystem rather than the empirical assumption. Therefore, the current entrepreneurship model or related economic perspective lacks solid theoretical frameworks and specific quantification methods.

Although bibliometrics can be used to identify trends in the analysis of topic areas during the research period, the internal bibliography is always limited by the number and content of keywords (Zahra et al., 2021). Therefore, topics that are far from the

main topic such as business models or technology may not be because the studies are not correlated, or not referenced, but because related keyword phrases are not used in extracted data. Also, VOSViewer cannot show the H-index, but H-index can show a bidirectional relationship between being quoted and cited. A diagram built on H-index links will show the density of keyword-related research more clearly.

Dimensions, on the other hand, is a free academic database launched by Digital Science in 2018 that includes journal articles and citations similar to ScienceDirect and Web of Science. However, some individual articles (exploratory research, uncited research) may experience an error in the indexing process resulting in a narrower scope of the journal related to the article. Therefore, the data on Dimensions processed by VOSViewer can provide an overview of the related research frameworks but is not enough evidence to forecast and determine future discussion trends. To overcome these shortcomings of the bibliometrics, there are need for future studies to conduct thematic evolution statistics and build a citation network for each author and group of authors.

5 Conclusions

The objective of the article is to build an overview list for the research process of the sustainable entrepreneurship ecosystem, ensuring the background and density of related issues as well as the frequency of discussions close to the level of the entrepreneurial ecosystem, and reference level when deploying startup activities. The study presented research trend statistics, citation lists, illustrative networks of theoretical evolution, visual networks grouping-related topics, and images describing the density of these topics. With the output of VOSViewer, it is possible to divide research topics into four main groups including technology, entrepreneurship, relationships, and fields. The results show that the factors that are decisive to the ecosystem such as technology, businesses, digital transformation, and business model have almost no direct correlation with entrepreneurship and a sustainable startup ecosystem. The density of discussion mainly focused on the correlation between research data, and technology applications to the ecosystem. According to the time frame analysis, the results show that the study of the startup ecosystem and technology or entrepreneurship is not directly correlated, while many recent studies are more inclined toward sustainability in policy, and educational and social organizations. The low density in the visual network grouping-related topics also suggests that there are still research gaps for these topics. However, the main shortcomings of the Dimensions data set are also limitations of the study such as dependence on keywords, fluctuations in scope, and failure to represent future research trends.

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