

RESEARCH TRENDS IN THE HIGHER EDUCATION DIGITAL ENTREPRENEURSHIP ECOSYSTEMS: A BIBLIOMETRIC ANALYSIS

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Abstract: Entrepreneurship is considered as one of the solutions to support the economy of a country. The rapid development of information and communication technologies introduces opportunities to create new digital ventures. Many countries are keen to support and encourage more people to build digital startups. There are many success stories about entrepreneurship ecosystems that contribute to the success of digital ventures. One of the critical factors of the success of an ecosystem is the availability of campuses that support innovations and talents. Thus, it is crucial to find the optimum digital entrepreneurship ecosystem for education to produce new and sustainable digital entrepreneurs—this research attempts to find out the research trends in digital entrepreneurship ecosystems in higher education. The method used in this research was bibliometric analysis using three software, including Publish or Perish, Mendeley Reference Manager, and VOSviewer. The results are presented in a graphical network map of terms in several relevant keywords. This research concludes that while many studies about the entrepreneurship ecosystem during 2015–2021, studies about the development of digital entrepreneurship ecosystems in higher education are still lacking.

Keywords: digital entrepreneurship ecosystem, higher education, student startup, bibliometric analysis

Introduction

Entrepreneurship's role in economic development and national prosperity is essential to support a country's economic growth (Cavalllo et al., 2019). The combination of entrepreneurship and innovation produces new job opportunities, industry reinvention, improvements in efficiency, enhanced regional competitiveness, and other aspects.

The rapid development of information and communication technology influences new entrepreneurial efforts and encourages various new businesses, especially using digital technology. The availability of hardware, software, and infrastructure enables software developers to develop different kinds of new software. Those factors would allow entrepreneurs to establish new products and services that rely on digital technology solutions or information and com-

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munication technologies. These kinds of small to medium new ventures are called new digital ventures or digital startups.

Within the last one or two decades, digital entrepreneurs worldwide have revolutionized how a venture or company does business. Some startups successfully became giant companies, such as Google, Facebook, Apple, Amazon, eBay, and many more. The entrepreneurial ventures offer digital products, services, or distribution (Hair et al., 2012) and utilize the support of the Internet and other information and communications technologies. Meanwhile, digital academic entrepreneurship is academic entrepreneurship that uses new digital technologies heavily to build digital spin-offs of university research products or innovation or alumni startups (Secundo et al., 2020). It includes research collaboration between universities and industry, patent applications, new firms based on idea spin-offs, entrepreneurial education of highly skilled individuals, and business incubators (Secundo et al., 2020).

Many countries consider that Digital Start-up development is a strategic step to improve their economy. The global startup economy's value creation rapidly improved by 25,6% from 2015 to 2017 compared to the 2014-2016 period (Global Start-up Ecosystem Report, 2019). Current research states that the digital economy contributed approximately 5% of global Gross Domestic Product (GDP) in 2017, with the actual value delivery-based calculations as high as 20% (RMIT, 2017). In 2017, Asia collected USD19.3 billion in Venture Capital (VC) investment, and for the first time, it surpassed that of USD18,4 billion collected by the United States. China, followed by India, are two countries that grab huge investments. During 2017 and 2018, approximately 35% of Unicorn

startups came from China, and many startups in India successfully attracted investors to obtain more than USD1 billion in the company valuation (Krishna, 2018). In China, Alibaba, Baidu, and Tencent have become the world's biggest digital companies and East Asia Region leaders (RMIT, 2017).

The availability of supporting ecosystems is essential to support the growth of startups. Silicon Valley is an example of a region that provides a complete ecosystem needed by startups. Israel is also known for its success story for promoting a vibrant and robust high-tech startup ecosystem due to continued R&D investment, encouraging the development of tertiary education and skills, including welcoming migrants with highly skilled talents (Krishna, 2018). London and Cambridge are two successful clusters in the United Kingdom that produce big tech startups. These locations provide one of the world's best facilities to support research & development and financial institutions' availability. Bangalore, India, is another thriving tech startup hub outside the United States (Subrahmanyam, 2017), the home of several public sector R&D, education institutions, and many reputable IT companies. An India - Singapore joint venture built a tech park in Whitefield, followed by others in a different location in the city. Thus, many considered Bangalore the "Silicon Valley of India" (Subrahmanyam, 2017).

The existence of campuses around Silicon Valley is one of the factors that contributed to its phenomenal growth. Stanford University, its affiliates, and alumnae played a significant role in establishing Silicon Valley. One of the earliest established companies in this area is Hewlett-Packard, founded by Bill Hewlett and David Packard; both are Stanford University alumnae. Due to the success, many universities try to

adopt the Silicon Valley area concept to apply on their campuses.

The strategies to produce a successful business can be learned and taught (Ries, 2011). A startup's success not only comes from talent being in the right moment and the right place, but also through the right processes. Higher education is considered ideal for developing startup companies because of several supporting factors: many students have high ambition and good academic abilities, have diverse backgrounds, are still young, and have no or less financial or family responsibilities.

The phenomenal and exponential growth of startups in limited countries raises questions about how higher education can boost the growth of startups in many more countries. Many researchers attempt to study entrepreneurship ecosystems from many different angles, while the study of the digital entrepreneurship ecosystem in higher education is still lacking. Thus, we formulate the research questions as follow:

- How has the academic literature studied the digital entrepreneurship ecosystem in higher education so far?
- What are the possible trends for future research on the digital academic entrepreneurship ecosystem in higher education?

This bibliographic analysis attempts to contribute to entrepreneurship ecosystem research by presenting trends in the higher education entrepreneurship ecosystem research and the connection to emerging digital technologies.

The bibliometric analysis process includes finding the list of relevant papers from a reputable database, completing the data, calculating and visualizing the data. Bibliometric analysis is considered a vital step of a systematic review

(Linnenluecke et al., 2020). The software for the bibliometric analysis process is Publish or Perish (PoP) by Harzing.com, Mendeley, and VOSviewer. PoP is a citation analysis program that provides the list of papers relevant to our search keywords from several reputable databases, including Scopus, Web of Science, CrossRef, and many more. The results displayed include the title, published year, number of citations, type of articles, and several other data. Mendeley is a free reference manager that helps us organize, cite, and exchange references that can be used to complete the bibliometric metadata. VOSviewer is software to construct and visualize bibliometric networks of journals, researchers, or individual publications. The software includes text mining capabilities to build and visualize co-occurrence networks of key phrases from the scientific literature. We used VOSviewer to visualize the data to support the data analysis process.

Method

The first stage in this bibliometric analysis is searching for research publications related to the research topic using the Publish or Perish software. The selected database for this research is the Scopus database, one of the prestigious databases of high-quality papers.

Before searching for the articles, we should decide the relevant keywords to search on the software. Figure 1 depicts the article's search process using PoP. One of the critical features of this software is that it allows us to search on the Scopus database. An Elsevier API Key that we can get from the Elsevier Developer Portal is needed to use the Scopus database search feature.

Next, we enter the keywords on the title and the year range on the search forms and

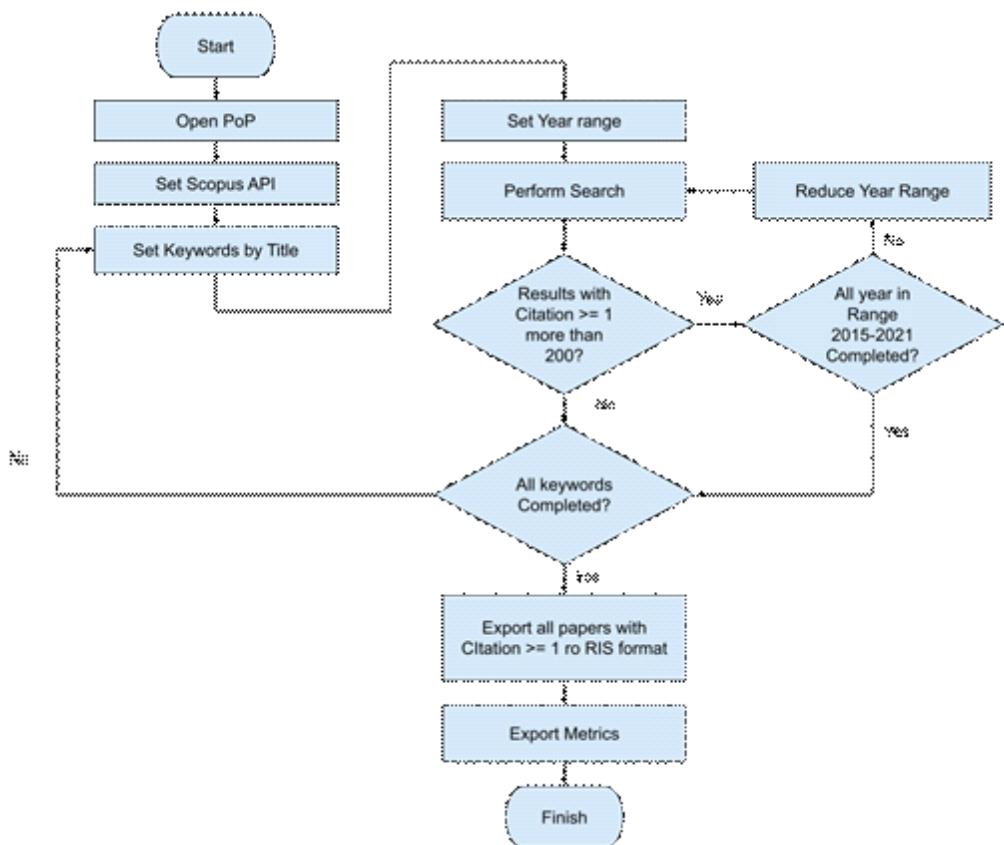


Figure 1 Publications Search using Publish or Perish Flowcharts

perform the search. We decided that papers included should have at least one citation to improve the bibliometric analysis quality. PoP limits the maximum of 200 articles on each Scopus Database search. Thus, we repeated the process with a narrower year for searches with results of more than 200 articles with citations. We then repeat the whole search process for all relevant keywords decided. After searching for all relevant keywords, we select the article that fits the criteria and exports the results in .ris files suitable to some reference manager software.

We use the Mendeley reference manager to clean and complete the bibliography metadata (Figure 2). At this stage, we merge duplicate articles, check the titles, and complete the abstracts.

After we open Mendeley, we can import the .ris file into a new folder. Following that, we can use the Tools > Check for Duplicates feature to find any duplicates. If there are duplicates, we can check all items on the list and merge the duplicates accordingly. Afterward, we review the title and abstract of each article and use the articles' DOI to complete both metadata. For this purpose, we use the Mendeley DOI lookup feature or manually search the article detail using a search engine. If we found the English version of the abstract, we included the article, then copied it to Mendeley software. After completing all articles' metadata, the .ris file is exported and ready to be processed on the next stage.

At this stage, the metadata database is loaded into VOSviewer to produce the network

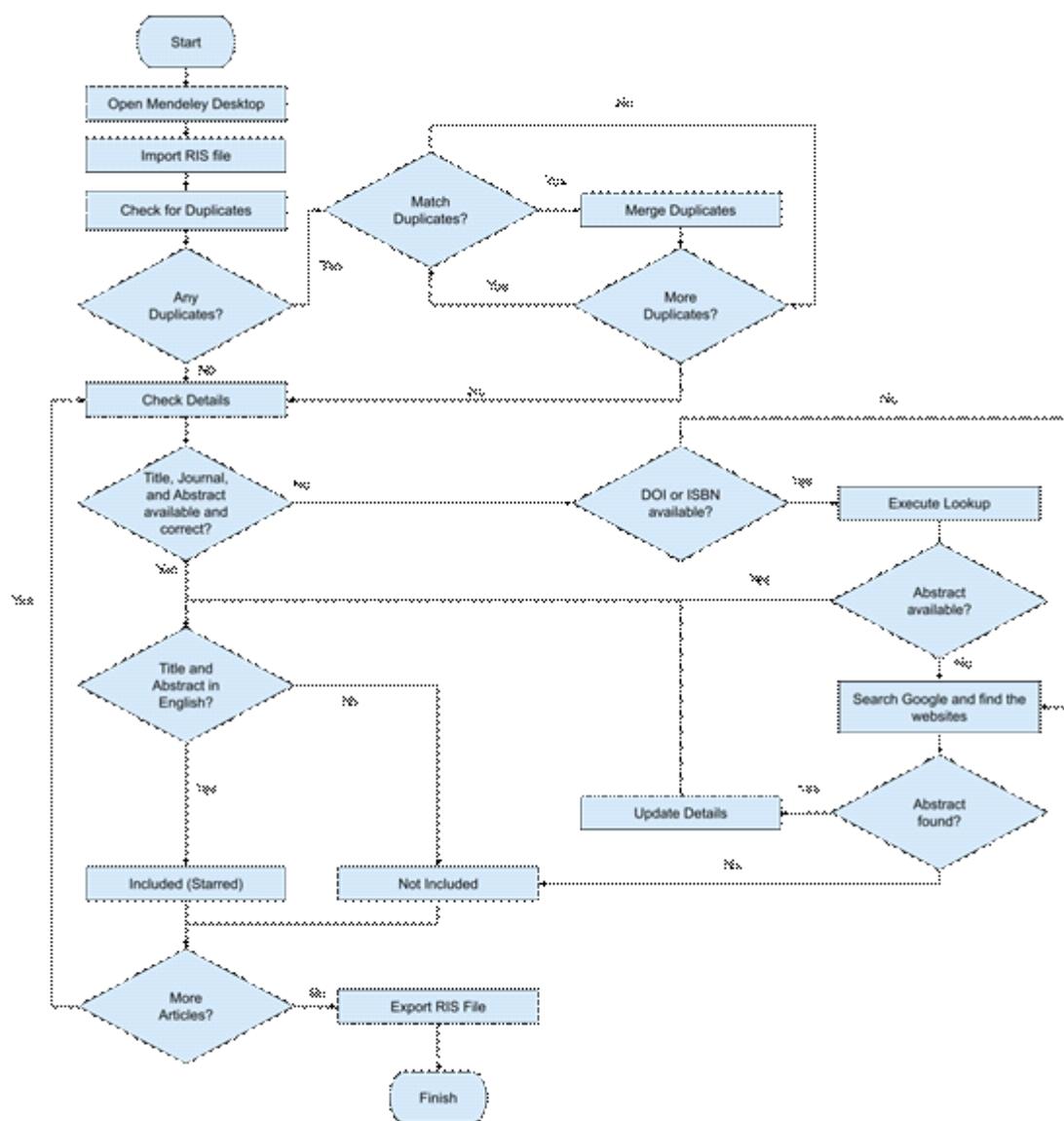


Figure 2 Cleaning and Completing Articles' Bibliography Details

map of the keywords extracted from the data. The process was conducted several times with different settings to create a clear map of the relationships between the words.

Results

As mentioned before, the first stage in this bibliometric analysis is the search for research publication data using Publish or Perish software. The selected database is the Scopus data-

base, which is considered one of the reputable databases of high-quality research papers.

Based on the research topic, the following keywords are considered relevant: entrepreneur ecosystem, digital entrepreneur ecosystem, entrepreneurship education, student startup, and student entrepreneur. To find the latest research, we limited the year range to 2015–2021. As mentioned, PoP limits the maximum of 200 articles on each Scopus Database search. Thus, for some of the searches with more than 200 articles in

Table 1 The Publish or Perish Query/Search Results using Scopus Database on Several Relevant Keywords wth Citation >= 1

Query	Papers	Citations	Cites_Paper	year_first	year_last
entrepreneur* ecosystem [title] from 2015 to 2017	106	3.748	35,36	2015	2017
entrepreneur* ecosystem [title] from 2018 to 2019	195	3.078	15,78	2018	2019
entrepreneur* ecosystem [title] from 2020 to 2021	137	646	4,72	2020	2021
digital entrepreneur* ecosystem [title] from 2015 to 2021	14	556	39,71	2016	2021
entrepreneurship education [title] from 2015 to 2015	99	2.108	21,29	2015	2015
entrepreneurship education [title] from 2016 to 2016	115	1.952	16,97	2016	2016
entrepreneurship education [title] from 2017 to 2017	135	1.346	9,97	2017	2017
entrepreneurship education [title] from 2018 to 2018	200	1.370	6,85	2018	2018
entrepreneurship education [title] from 2019 to 2019	165	994	6,02	2019	2019
entrepreneurship education [title] from 2020 to 2021	156	658	4,22	2020	2021
student startup [title] from 2015 to 2021	7	31	4,43	2017	2020
student entrepreneur* [title] from 2015 to 2015	84	1.070	12,74	2015	2015
student entrepreneur* [title] from 2016 to 2016	106	2.002	18,89	2016	2016
student entrepreneur* [title] from 2017 to 2017	146	1.531	10,49	2017	2017
student entrepreneur* [title] from 2018 to 2018	164	1.136	6,93	2018	2018
student entrepreneur* [title] from 2019 to 2019	161	1.010	6,27	2019	2019
student entrepreneur* [title] from 2020 to 2021	188	626	3,33	2020	2021
All	2178	23.862	10,96		

the results with citation, we divided them into a range of years to get more results.

The searches were conducted on July 31st, 2021, as the results can be seen in Table 1. The search produced 2178 articles from 2015-2021 with at least one citation. There were 23.862 citations from those papers when the investigation was conducted, with an average of 10,96

citations per paper. There are many papers not included in the results as they have not been cited yet; most are recently published (2020-2021).

The search for entrepreneur* ecosystem, entrepreneurship education, and student entrepreneur* from 2015 to 2021 produced more than 200 papers with citations. Thus, the search

for these keywords repeated several times with a smaller year range. The results of the search process were:

- entrepreneur* ecosystem: 438 articles
- digital entrepreneur* ecosystem: 14 articles
- entrepreneurship education: 870 articles
- student startup: 7 articles
- student entrepreneur*: 849 articles

The results were then exported on .ris file format then imported to Mendeley. After that, we checked for duplicate articles and found 93 sets of duplicates, then reviewed each set to decide whether to merge or not. The final number of articles after the merge process was 2023 articles.

In the next step, we checked the title and abstract of each article and searched through the methods explained previously if not complete. We finally completed the metadata of 1881 articles from this process, mainly using manual copy-paste from the articles' website.

Finally, we used VOSViewer to see the connections between these articles. The settings used to get the results were:

- Type of Data: create a map based on text data
- Data Source: data from reference manager files
- Terms extracted from titles and abstract fields, structured abstract labels ignored, and copyright statements ignored
- The threshold and number of terms varies on several attempts

Discussion

On the first attempt, we set the minimum number of occurrences of terms to 10, which means each term was included if it appeared in at least ten papers. Of the 27619 terms, 960 terms met the threshold. Based on the relevance score, the number of terms that met the criteria was 576, 60% of the most relevant

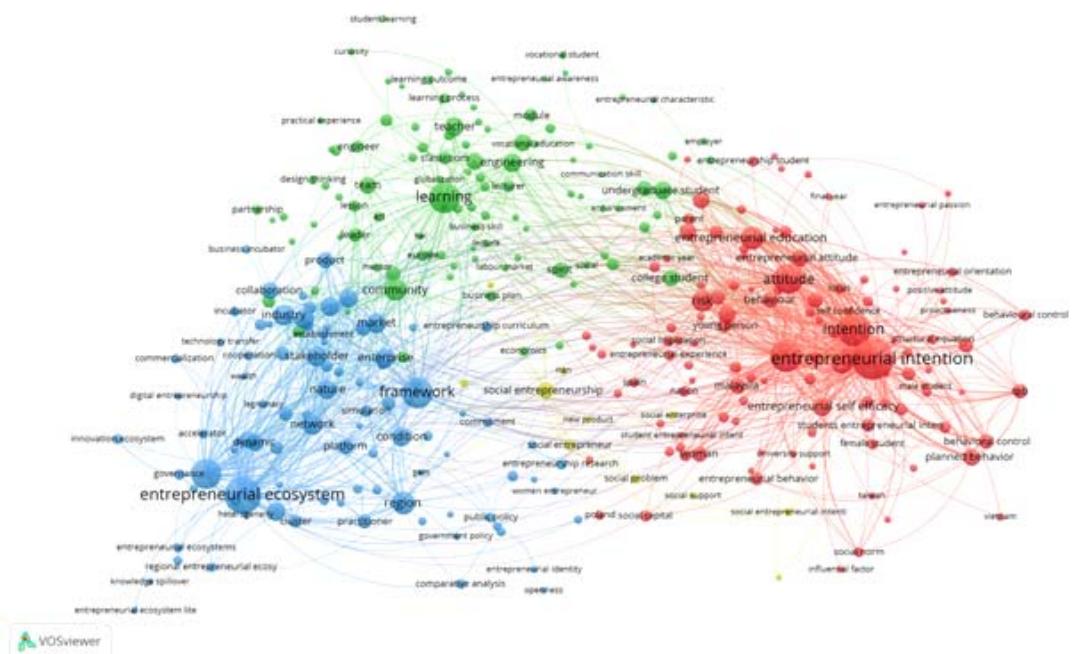


Figure 3 VOSviewer Bibliography Network Visualization

terms. Following that, we conducted a further selection manually to eliminate common terms, such as sample, variable, hypothesis, literature, questionnaire, respondent, and other irrelevant terms. To make sure if some of the terms were relevant or not, we checked the terms back on Mendeley.

Based on the process, the final selected terms were 321 terms. Figure 3 shows the results divided into 4 clusters: entrepreneurial intention, learning, entrepreneurial ecosystem, and social entrepreneurship. We decided each of the clusters' names based on the most dominant term in each respective cluster. There were 116 items in the entrepreneurial intention cluster displayed in red. There were 102 terms on the learning cluster shown with green color. The entrepreneurial ecosystem cluster displayed in blue consisted of 92 terms, whereas the social entrepreneurship cluster indicated in yellow consisted of 11 terms.

The relationship between entrepreneurial intention with several items is strong, including the university student, attitude, entrepreneurial education, and gender issues terms. Other strong related terms to entrepreneurial intention were business student, unemployment, risk, achievement, and behavior. Many closely related items still have limited research, including family support, family background, personal attitude, innovativeness, and independence.

Learning - the second term with the most number of appearances - is strongly related to many items in the entrepreneurial intention and entrepreneurial ecosystem clusters. There are several solid and closely related terms to learning: engineering, competence, team, entrepreneurial mindset, community terms. Some associated items might need more study: experiential learning, student engagement, internship, marketing, and spirit.

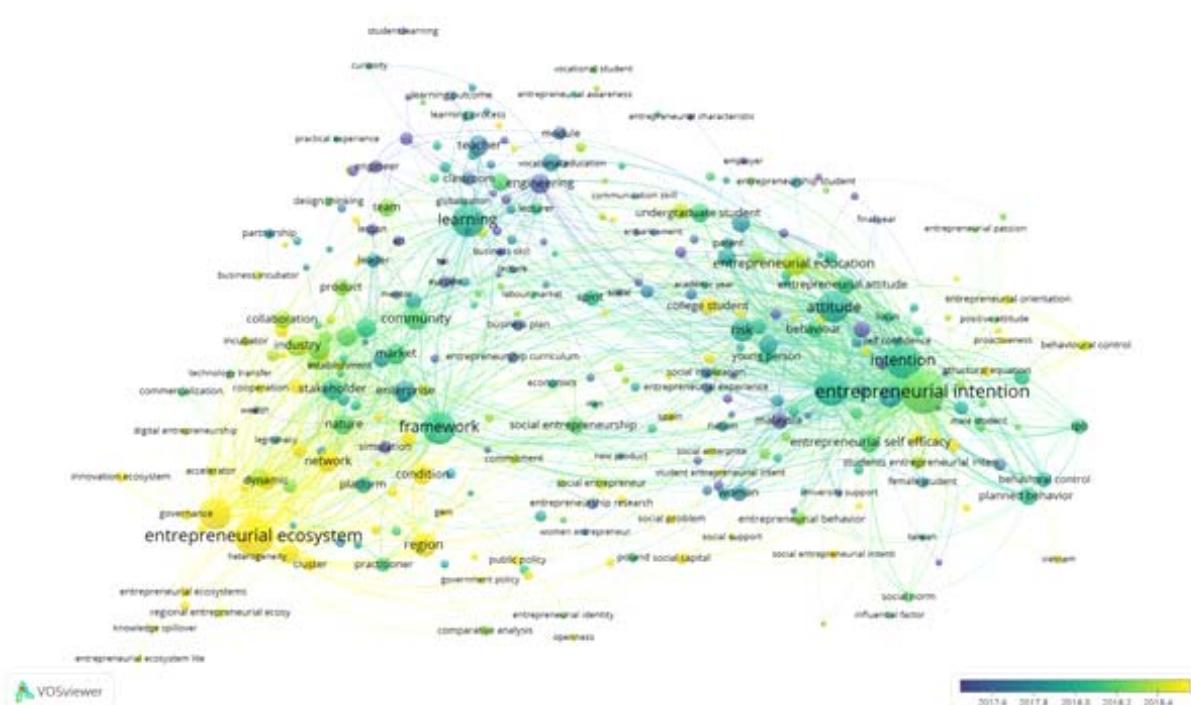


Figure 4: VOSviewer Bibliography Overlay Visualization



Figure 5 The Connection between Digital Entrepreneurship and Entrepreneurial Ecosystem in VOSviewer Result

The following terms are substantial on the entrepreneurial ecosystem cluster: region, network, stakeholder, region, industry, organization, collaboration, service, enterprise, and firm. Some closely related terms that need more study include digital technology, accelerator, agent (related to simulation), cluster, founder, and governance terms.

While not many terms on the fourth cluster, which is social entrepreneurship, the term is directly related to all three other clusters. The term is strongly related to learning, entrepreneurial ecosystem, intention, and university student.

Figure 4 depicts the Overlay Visualization of the result. The figure shows that there are many studies about engineering education concerning the business student in 2017. During 2018, many publications about the entrepreneurial ecosystem framework, entrepreneurial intention, students' attitude, and external bodies such as stakeholders, markets, and community. In 2019, the prominent research was about the entrepreneurial ecosystem concerning the

region, network, public policy, and government policy.

Further investigation from the VOSviewer result about digital entrepreneurship (Figure 5) shows that the research is still understudied. The bibliometric analysis only shows the connection to the entrepreneurial ecosystem and no relationship between digital entrepreneurship to other clusters. Digital entrepreneurship is still very new; thus, many papers may have been published in recent years and did not make it to the list of papers included in this bibliometric analysis because of the citation criteria. Another possible reason is that the terminology is still not firm. Many researchers use several terminologies for the same purpose, such as technology startups, digital startups, technology entrepreneurship, and many more.

Conclusion

The awareness of entrepreneurship education's role to support a country's economy is also shown in researchers' interest in studying the

entrepreneurship ecosystem in higher education. During 2015–2021 many academic literatures covered the entrepreneurial learning environments and students' entrepreneurial intentions. To answer the first research question about how the academic literatures studied the digital entrepreneurship ecosystem in higher education, we concluded the study of digital entrepreneurship ecosystems in higher education is still lacking. Not many researchers study how to provide healthy digital entrepreneurship to support students' new digital ventures or startups.

Regarding the second research question about the possible trends for future research on

the digital academic entrepreneurship ecosystem in higher education, we see an increasing trend in the study related to social entrepreneurship, startup, region, clusters, and college. As aforementioned, many digital entrepreneurship-related academic articles were not included in the data, as they were recently published and yet to get any citation. Additionally, the technologies penetration to entrepreneurship seems to be elevated more due to the current pandemic, which further promotes the research on digital entrepreneurship topics.

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