THE EFFECT OF INNOVATION ON SMALL AND MEDIUM ENTERPRISES: A BIBLIOMETRIC ANALYSIS

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Innovation plays great role in organizational competitiveness and sustainable business processes and it should be a key success policy for small and medium-sized enterprises (SMEs) all over the world. To this effect, the purpose of this study is to present a comprehensive understanding of the scientific studies made on the field of innovation and its effect on small and medium enterprises performance. A bibliometric study was used to analyze articles published between 1976 and 2020 and create an illustrative map of innovation in small and medium enterprises; a sample of papers gathered through Web of Science Core Collection database. Accordingly, there were found 2219 documents which were published in 332 sources. VOS viewer was employed to portray network analysis of, authorship, keywords visualization, citations, and countries dealing with the subject. SCIMAT software was also used to do longitudinal thematic analysis. Even though many countries, universities, research institutes, funding agencies, and authors contributed for the growth of this field of study, almost all are from developed nations. This study is one amongst the very few studies made using bibliometric analysis in this field. Moreover, the thematic network diagram reveals two other new themes in the subject, which are taken as knowledge seed, and have high potential for a future study.

Keywords: SMEs, innovation, SCIMAT and VOSViewer software, bibliometric analysis

Introduction

Studies showed small and medium-sized enterprises (SMEs) have a paramount importance in accelerating the social and economic development both in developed and developing countries. For instance, as Duncombe (2007) and Nyeko et al. (2013) indicate, employment generation, entrepreneurship, industrial expansion, and export promotions are some of the notable contributions of small and medium enterprises to economic development of countries. SMEs create the foundation of economic growth and social development in all countries around the world in general, and in developing countries in particular (Djebarni and Al-Hyar, 2009). As Abdissa and Fitwi (2016) indicate in their study, 'small and medium enterprises contribute to more than 60% of GDP and more than 70% of overall employment in low-economy countries whereas over 95% of total employment and about 70% of GDP in middle-income countries'. In the European Union and in the Visegrad countries, the situation is the same; SMEs represent the vast majority of employees and enterprises (Seroka-Stolka and Jelonek, 2013; Sáez-Martinez et al., 2016; Oláh et al., 2019; Šebestová and Sroka, 2020).

According to Kozan et al. (2006), small and medium enterprises are promoted due to the fact that they are easy to start and simple to operate. In addition to this, the authors indicate the entrepreneurial motives and traits are also among the various reasons to start small businesses. Moreover, Ayyagari et al. (2007) revealed the significance of small and medium enterprises and recommended policy priority specifically in developing countries to reform the policies that divided the formal and informal sector to engage the poor in high value added business.

Today, innovation is considered as a key determinant for organizational competitiveness and success, which exhibits the direction and progress of the regional and the world economic development (Gao et al., 2017). In addition to this, as innovation is a significant element of global competitiveness, efficiency and employment performance, it have several advantages for small and medium enterprises (Lee et al., 2010). Flexibility, rapid response, adaptability to market changes, informal communication coupled with less bureaucracy, rapid decision-making, and greater entrepreneurial spirit are among the primary advantages (Hervas-Oliver et al., 2014) and drive national ecomomies towards economic growth (Braha et al., 2015).

Innovation can also be defined as the methodology of managing, allocating, and timing organizational technology tools, workforce assets, and work processes to achieve a given output in an efficient and expedient manner (Badiru, 2020). The concept of innovation is diversified, depending mainly on its application. According to Contador et al. (2019), innovation is taken as new ideas associated with actions that produce results coated with originality that benefit audience, and measured by their ability to solve issues that are more complex. As innovation is the creation of an enabling environment for people, process, and technology (Kaur and Parneet Kaur, 2020), small and medium enterprises had started to apply information and communication technologies to show their competencies in different economic sectors (Amara and Becheikh, 2006).

Innovation helps to manage businesses in a sustainable way, which will have positive impacts not only on environment, but also on society by improving local communities and local businesses. According to Silvestre (2015) and Maier et al. (2020), innovation is a key mechanism for addressing sustainable development; moreover, innovation can be driven by sustainability (Nidumolu et al., 2009; Ghassim and Bogers, 2019).

Small and medium-sized enterprises are commonly defined as reactive, flexible, and innovative organizations (Expósito and Sanchis-Llopis, 2019). These types of firms usually operate in very competitive markets, and hence the introduction of innovative products, processes, and/or new organizational business models enables them to stand out from the competition, by improving their results and business performance, both in the short- and medium-term. Embracing R&D and innovation activities is particularly relevant for small and medium enterprises, as these strategies are crucial to productivity growth, firm's competitiveness, and ultimately their survival (Añón-Higón et al., 2014). There is a consensus that small and medium enterprises play a very important role in innovation and almost all small and

medium enterprises are involved in open innovation compared with large firms (Hossain and Kauranen, 2016).

Due to their size, SMEs lack internal means and resources to coordinate innovation activities which makes them more reliant on open innovation partnerships in their ecosystems (Möller and Janssen, 2009). The study of Liang et al. (2019) also confirms that small and medium enterprises' linkage with other partners has a positive impact on their innovation performance. On the other hand, literature suggests that small and medium enterprises have advantages in that they are often characterized by an entrepreneurial style with lean organizational structures (Klewitz and Hansen, 2014). The study of Hossain and Kauranen (2016) revealed that small and medium enterprises are less bureaucratic, and more flexible for strategy- and decision-making, greater risk-taking and knowledge concentrating, and faster reaction to market fluctuations.

Contemporary researchers use the bibliometric research method to discover and examine large volume of information in order to see the patterns of scientific studies made on some specific subject matters (Silva and Teixeira, 2009). Bibliometric approach is very helpful for developing summary of a research field as it pinpoints the top trends by using different bibliometric indicators such as the number of publications and citations, the most influential countries, the most relevant authors, the most prominent institutions supporting research, as well as the citations of papers in major articles (Martínez-López et al., 2020).

Very scant bibliometric studies have been made on the impact of innovation on small and medium enterprises performance. Salvador et al. (2013) conduct a bibliometric analysis on the title 'clustering recent trends in the open innovation literature for small and medium enterprises strategy improvements' and recommended clustering of the key features related with small and medium enterprises. The analysis of Chesbrough and Bogers, (2014) showed an overall classification of researches on innovation without integrating with other research perspectives.

Thus, as a novel contribution, this particular bibliometric analysis examines the trends of scientific studies made by scholars on this subject matter by using bibliometric indicators such as top cited articles, countries dedicated to the subject, journals concentrating on the research area, number of publications with their respective citations, contributing countries, authorship networking, and country networking.

The primary goal of the research was to make a good base for further, empirical researches in relation with the role of innovation as a part of sustainable development of SMEs.

Materials and methods

The authors developed research questions to make a bibliometric investigation on the effect of innovation on small and medium enterprises. The questions are arranged as follows:

- ❒ Research question 1: How many articles were published on this subject, and who are the main contributors?
- ❒ Research question 2: What are the countries doing to cooperate with Small and Medium Enterprises?
- ❒ Research question 3: Are there top articles referred to and what is the most prominent topic in this subject?
- ❒ Research question 4: What is the major content of the publications?

One of the most important factors to show how much the researcher is into the topic and its indicator for the expansion of the subject of the study is the growth trend and the number of publications (Ahmed and Huang, 2019; Udomsap and Hallinger, 2020; Hernández-Torrano and Ibrayeva, 2020; Xie et al., 2020). Top contributors' countries and their social networks show the core focus of the study (Zou et al., 2018; Veloutsou and Mafe, 2020; Peng et al., 2020).

In order to have systematic thinking the visualization and the network come into place (Pauna et al., 2019). VOS viewer is powerful software used for scientific study network analysis (Lawal et al., 2019; Corsi et al., 2020; Yıldız, 2019). The VOS software uses natural language processing (NLP) and provides the clustering, mapping and visualization of the bibliometric networks (van Eck and Waltman, 2010).

The researcher's way to set the direction of the study in the subject of research can be measured through top cited articles; hence, this study uses the top cited article analysis (Hernández-Torrano and Ibrayeva, 2020; Xie et al., 2020; Veloutsou and Mafe, 2020; Martínez-López et al., 2020). To have a deeper inspection in the content of the subject, the keywords analysis is very important, since the keywords are representatives of the publications´ context (Veloutsou and Mafe, 2020; Xu et al., 2019). Keywords show the top topic in the area, and the network of the keywords shows the collaboration of the keywords and topics.

The bibliometric information can map a field of science to show the intellectual evolution there (Sharifi, 2020) first studies on 'urban sustainability assessment' were published in early 1990s. Since then, the field has grown rapidly, with over 300 papers published annually in recent years. The main objective of this study is to present a bibliometric analysis of about thirty years of research on urban sustainability assessment. The literature database includes 3877 articles published in the Web of Science. VOSviewer and SciMAT are two science mapping software tools that were utilized for this purpose. VOSviewer is utilized to detect major focus areas and to identify influential authors, publications, and journals using various network analysis techniques such as term co-occurrence, co-citation, and bibliographic coupling. Also, SciMAT is used to understand how the intellectual base of the field has evolved over time and what are the major themes that have contributed to this evolution. For this purpose, the study interval was divided into four sub-periods (i.e., 1991–2000; 2001–2009; 2010–2015; and 2016–2020. To review the intellectual property of the literature of a science, different methods can be used. The co-word analysis or keyword analysis is one of the main tools to determine the content of a research area (Callon et al., 1991). Keywords in the publication can play the role of the DNA or the fingerprints of research (Börner et al., 2003). The degree of similarity in keywords in publications can show the similarities in them (Börner et al.2003). In 2011, Cobo and his colleagues introduced a strategic diagram mapping showing the thematic network stability between periods, and the thematic evolution techniques for displaying the main themes and content of literature of a science field. For analyzing the conceptual structure of a topic, the co-word analysis is used by scholars (Cobo et al., 2011). Co-keyword analysis is used for mapping the science, whereas the clusters of keywords and their interconnections are identified (Abdi Khalife et al., 2020; Aparicio et al., 2019; López-Robles et al., 2019; Santana and Cobo, 2020; Sharifi, 2020; Xie et al., 2020) first studies on "urban sustainability assessment" were published in early 1990s. Since then, the field has grown rapidly, with over 300 papers published annually in recent years. The main objective of this study is to present a bibliometric analysis of about thirty years of research on urban sustainability assessment. The literature database includes 3877 articles published in the Web of Science. VOSviewer and SciMAT are two science mapping software tools that were utilized for this purpose. VOSviewer is utilized to detect major focus areas and to identify influential authors, publications, and journals using various network analysis techniques such as term co-occurrence, co-citation, and

bibliographic coupling. Also, SciMAT is used to understand how the intellectual base of the field has evolved over time and what are the major themes that have contributed to this evolution. For this purpose, the study interval was divided into four sub-periods (i.e., 1991–2000; 2001–2009; 2010–2015; and 2016–2020. Cobo and his team called this cluster the theme of the research. The strategic themes diagram is a two-dimensional diagram with four quadrants. This two-dimensional diagram displays the centrality as x-axis and density as y-axis. This strategic diagram demonstrates the position of different themes in the science in four different quadrants. The analytical result part of this article explains what the position of each theme in each quadrant means. The most significant keyword in each theme is selected as the name of that theme.

In their article, Cobo and his colleagues illustrated the strategic diagram of themes that demonstrate the network of themes (Cobo et al., 2011). They called this network a thematic network that represents the frequency and the relation of the themes in the study field. The size of the spheres represents the number of documents with those themes, while the thickness of the connection lines shows the correlation of those themes.

Two other analyses in the science themes can help to have better understanding of the subject. These two analyses are the stability between periods and thematic evolution. Both of them are analytical indicators of the evolution of the themes of the subject in the past. For this analysis, the time interval should be selected, and the evolution and the changes of the subject can be analyzed by the two graphs (Cobo et al., 2011). Cobo and his colleagues tried to introduce the systematic approach for providing an understanding of the content of the research in the past.

Data collection

To create an illustrative map of the domain innovation in small and medium enterprises (SMEs) a sample of papers was gathered through one of the most relevant scientific citation databases Web of Science Core Collection database (Diem and Wolter, 2013; Franceschet, 2010; Huertas González-Serrano et al., 2020; Liu, 2013; Soosaraei et al., 2018; Sweileh et al., 2014) particularly Egypt, Kingdom of Saudi Arabia, and Tunisia. However, Kuwait has the highest research productivity per million inhabitants. Main research areas of published documents were in "Food Science/Technology" and "Chemistry" which constituted 75% of published documents compared with 25% for worldwide documents in nutrition and dietetics. A total of 329 (15.96%. The search was performed on September 29, 2020, and saved in the form of "Tab-del: mited (win, utf-8)" for analytical purposes. The period was set to include all available publication years in the Web of Science Core Collection (WSCC) database, which is automatically set from 1976 to 2020.

This research method (bibliometric technique) is also more suitable for academic field with enormous numbers of publications than qualitative analysis, especially in the study of exploring the internal relationship of the literature. The findings will be based on quantitative statistical analysis and reliable dataset, which generally consists large quantity of peer-reviewed publications that can cover most regions and disciplines and the visualizing network analysis in this method can be used to classify scope and structure of the discipline by discovering the influential authors or papers and main clusters of current research (Ye et al., 2020).

For the purpose of this particular study, two main keywords were employed; the first one is small and medium enterprises and the second one is innovation, and different variations (synonymous) of these two main keywords were used. Full Record, and Cited Reference contents were respectively used for co-authorship and co-occurrence analyses (e.g., network maps of authors, countries, and keywords) and citations analyses (e.g., network map of scientific journals). Thus, 2219 documents were published in 332 sources during the period 1976–2020. These documents were (co)-authored by 4296 authors.

VOS viewer (version 1.6.15) software was used to perform the bibliometric analysis in this study. This software allows for the creation, visualization, and exploration of maps based on bibliometric network data. The output results were displayed in clusters to allow for clear visualization of the existing connections among the bibliometric data.

Results and discussions

Category visualization

Articles cover different aspects of research areas: Business economics, Engineering, Operation research management science, Computer science, Public administration, Social science, and Environmental science economy (Figure 1). Web of science assigns indexed papers to one or more research areas. The 2219 considered in our sample were assigned 71.384% to Business Economics, 12.799% to Engineering, 9.734% to Operation research management science, 7.301% to computer science, and 5.678% to Public administration.

As for research performance by institutes (Figure 2), the pioneering institute in innovation research, the University of Zhejiang, accounted for the highest number of articles (a Leading University in Asia) in Pro-Innovation Education, Vibrant Research with Impact, Engaging with the World, and Community with Sparkling Ideas. Zhejiang University is one of China's oldest, most selective and most prestigious institutions of higher education. The results match the idea that China is the first country in the number of publications about innovation; followed by the Bucharest University of Economic Studies that is a public university in Bucharest, Romania. It has become one of the largest economic higher education institutes in both Romania and South-Eastern Europe.

The University Sains Malaysia (USM) is also the premium Research Intensive University

Figure 1 Web of science research categories
Source: web of science analysis results

Figure 2 Organization visualization
Source: web of science analysis results

Figure 3 Funding agencies
Source: web of science analysis results

Figure 4 Sources visualization
Source: web of science analysis results

in the country and has adopted an innovative approach to higher education. It has departed from the traditional faculty system to the broad-based school system. Another university is the Lappeenranta University, a pioneering science university in Finland, bringing together the fields of science and business since 1969.

Funding agencies

Sometimes searching is about finding trends across a field of study, such as who are the funding agencies for my research. At the top of these agencies there comes a Chinese institution, then the European Union and the Portuguese Foundation for science and technology comes one after the other (Figure 3). So, this finding gives a clue for researchers in this field of study to easily raise a fund from the specified agencies to support their research and publication. One can also take note of these funding agencies affiliation countries promoting the importance of innovation for the efficiency of small and medium enterprises.

Figure 4 shows the ten main sources publishing articles related to Innovation; the sources are journals that reflect the inter-disciplinarily of this research field. They include Economics, Business economies, Innovation, Small business management and sustainability. The two leading journals are Small Business Economics and International Journal of Innovation Management.

The common element of all the sources categories in those top ten journals was "small business management", which clearly reflected the close nexus between innovation and the management field. The documents type varies according to Table 1. More than a half of the document type is a journal article, which is 57.323% of the total document followed by proceeding papers of conferences, and a small portion of the document i.e. 0.315% is in the form of book.

Trend of publication in web of science core collection

As for yearly publications, the relative increase was in the years 2008–2009 and 2016–2020. China is the country whose authors have published the most of the documents, followed by England, the United States of America (USA) and Spain.

Figure 5 shows the increase in publications during the years 2016–2019, where SMEs represented the backbone of the economy, and dedicated all efforts to strengthen innovation in SMEs performance to gain competitive advantage and sustainability in the end.

Table 1 Document type

Document type	Records	% of total publication(2219)
Articles	1,272	57.323%
Proceeding papers	827	37.269%
Book chapter	117	5.273%
Early access	36	1.622%
Editorial material	34	1.532%
Review	31	1.397%
Book review	26	1.172%
Meeting Abstract	23	1.037%
Book	7	0.315%

Source: web of science analysis results

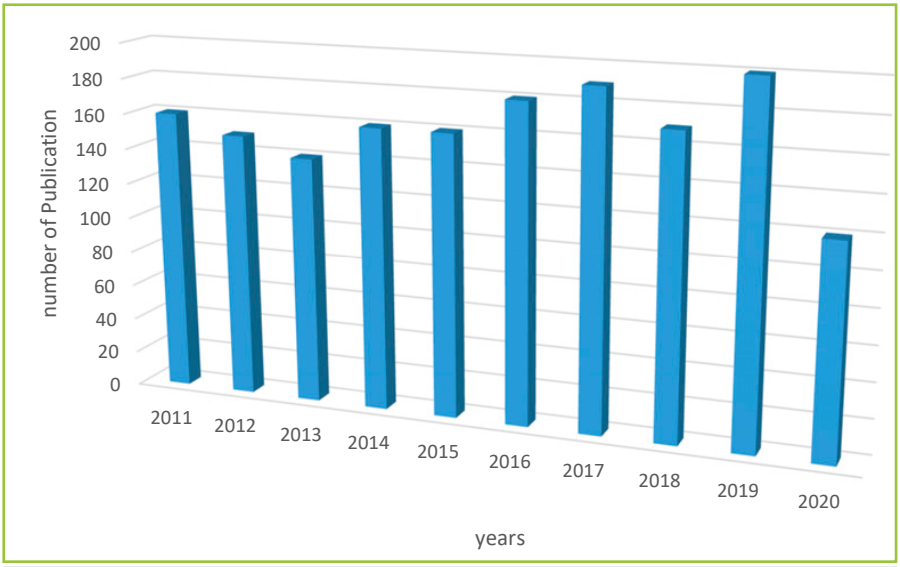

Figure 5 Trends of publications
Source: compiled from VoS viewer

Table 2 Number of publications by country

Countries/region	Number of articles	% of total publication (2219)
China	420	18.927
England	184	8.292
USA	178	8.022
Spain	175	7.886
Italy	135	6.084
France	82	3.695
Malaysia	77	3.470
Germany	75	3.380
Australia	74	3.335
Romania	66	2.974

Source: compiled from VoS viewer

The year 2019 was the most productive with 206 publication; we also observed low growth rate between years 1976 to 1999, and higher growth rate from 2000 to 2019. The productivity of the publication is increasing over the observed years since 2005 – the rapid decrease in the number of publications in 2020, can be justified by the COVID-19 pandemic and the lockdown situations.

Co-authorship (countries and citation), bibliographic coupling (countries) co-occurrence, and citation analyses conducted to create network maps showing:

1. the co-occurrence of keywords,
2. the co-authorship among researchers and countries,
3. cited scientific journals.

Each network map that resulted from the analyses contains nodes with size determined by "total link strength".

Contributing countries on the impact of Innovation on SMEs

As for co-authorship countries, the top 10 countries/regions of publications in this field are listed in Table 2 and Figure 6. From Table 2, we can observe China, England, the United States of America (USA), Spain, and Italy as the most contributing countries in which China produces more than two times as much as the others. It is also observed that most of the countries on the list are highly economically dependent on SMEs.

Citation network of countries on the impact of innovation on SMEs

In the following Table 3 and Figure 7, country's publication cluster and citation networks were examined, respectively. Top 20 countries were categorized into four clusters. Finland, Germany, Indonesia, Malaysia, Portugal, Romania, South Korea, and Spain are included in cluster one, and England, France, China, USA, Australia, and Canada are in cluster 2, and the rest of countries are in cluster 3. It is also observed that most of the countries on the list are highly economically developed countries. This may be due to the active business operations, the cultural background and the high density of academic institutions. The citation networks of different countries were visualized in Figure 7. One can observe from this visualization map that authors from Finland, Germany, Indonesia, Malaysia, Portugal, Romania, South Korea, and Spain are citing each other, which were differentiated by red color in the map. Authors in China, England, the United States of America (USA), Australia, France, and

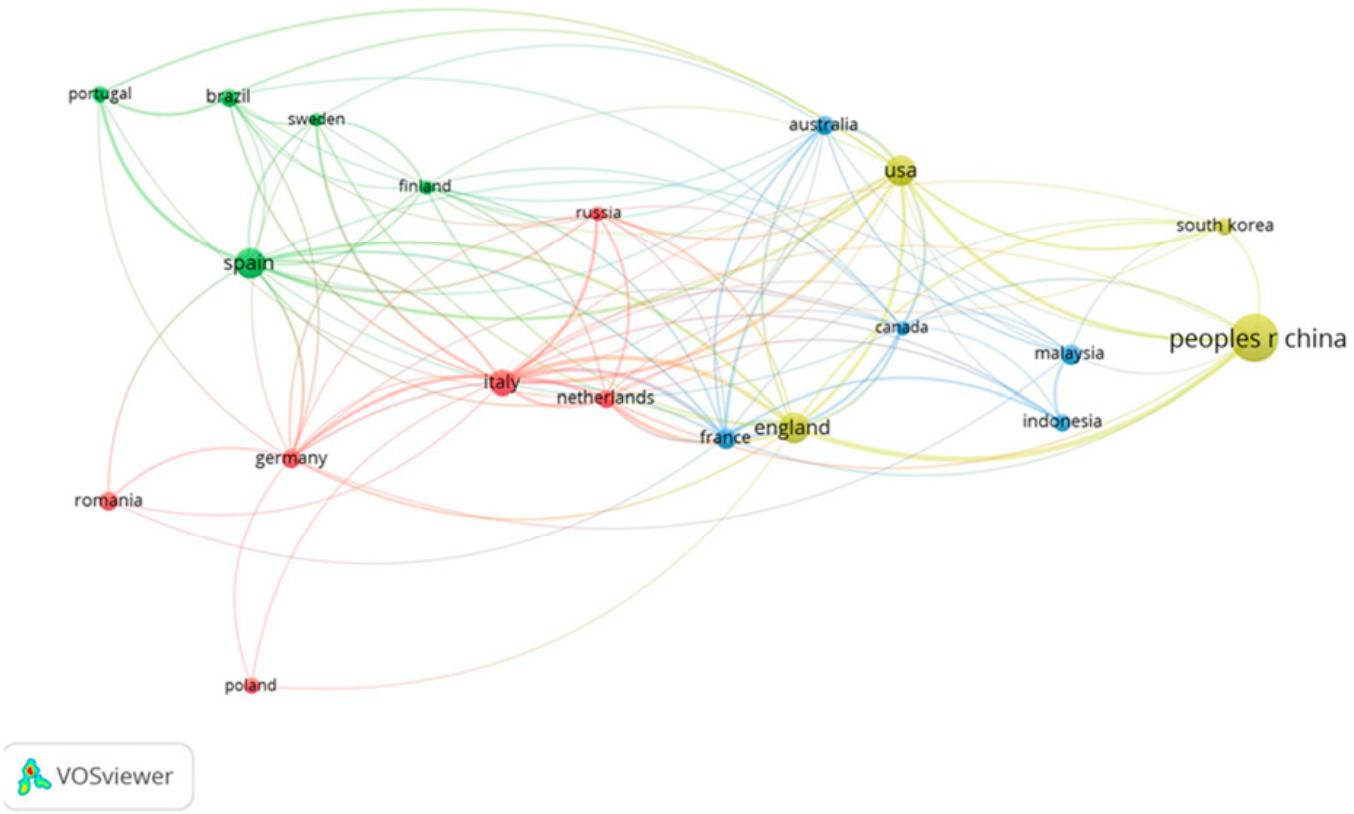

Figure 6 Co-Authorship of countries
Source: VOS viewer

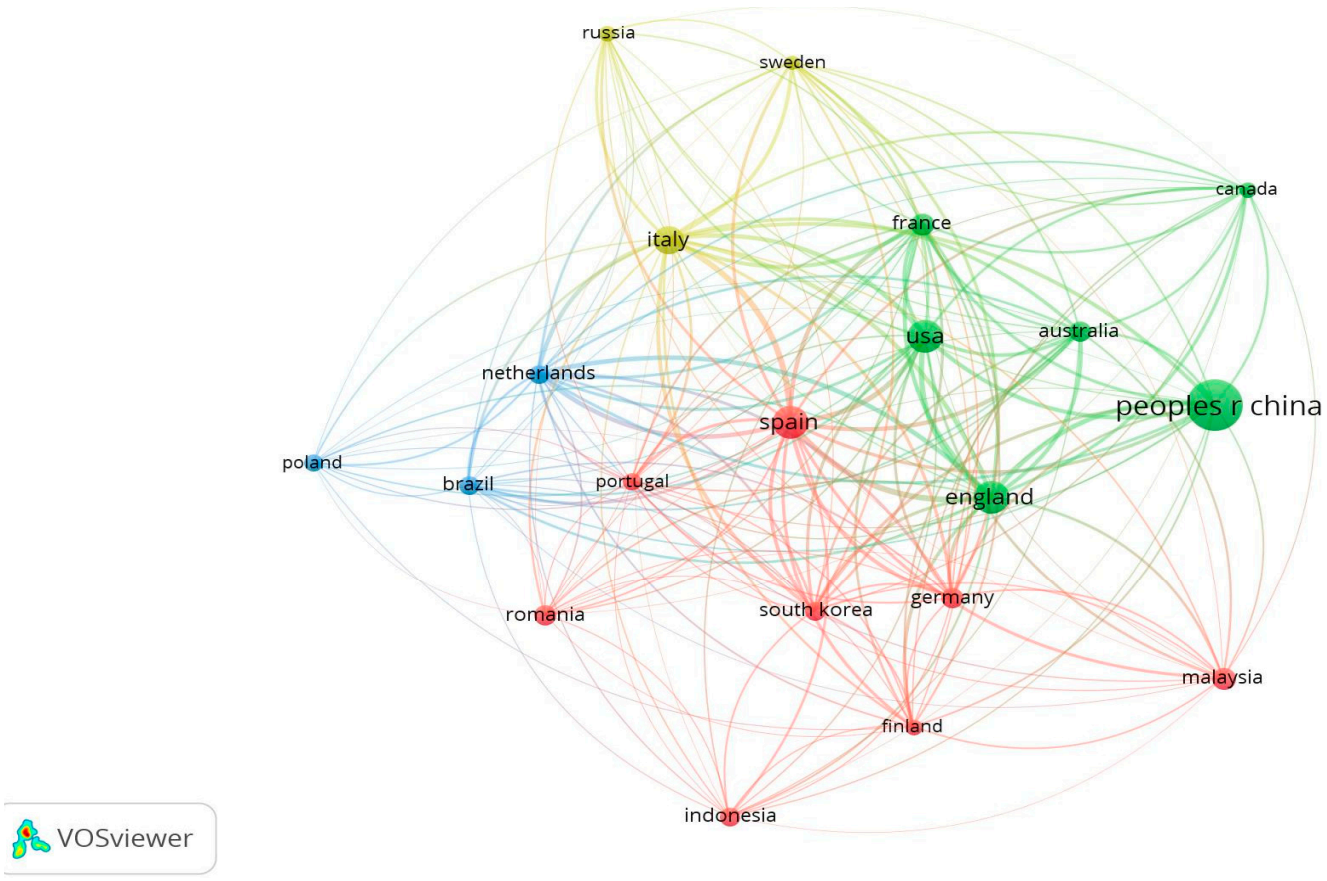

Figure 7 Citation of countries visualization
Source: VOS viewer

Table 3 Number of publications by Country

Row	Country	Cluster	Number of publication	Row	Country	Number of publication	Cluster
1	Finland	1	41	11	England	179	2
2	Germany	1	71	12	France	82	2
3	Indonesia	1	57	13	China	420	2
4	Malaysia	1	77	14	USA	170	2
5	Portugal	1	50	15	Brazil	55	3
6	Romania	1	66	16	Netherland	58	3
7	South Korea	1	56	17	Poland	49	3
8	Spain	1	175	18	Italy	135	4
9	Australia	2	74	19	Russia	40	4
10	Canada	2	44	20	Sweden	34	4

Source: own completion from VoS viewer

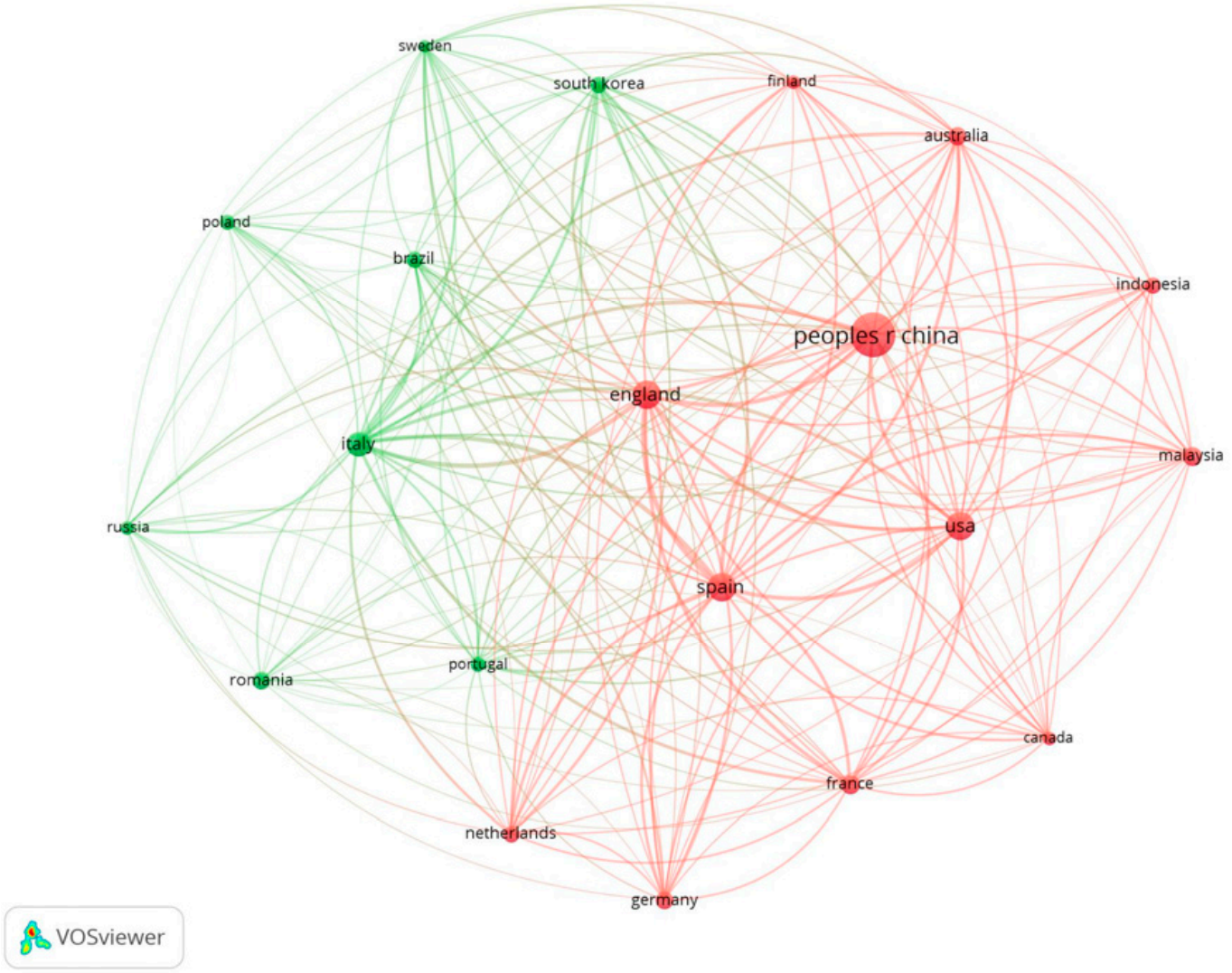

Figure 8 Bibliographic coupling – countries
Source: VOS viewer

Table 4 Keyword Occurrence

Row	Keyword	Cluster	Occurrence	Row	Keyword	Cluster	Occurrence
1	absorptive-capacity	1	442	16	knowledge management	1	145
2	antecedents	1	221	17	management	1	620
3	capabilities	2	398	18	market orientation	1	330
4	collaboration	2	346	19	medium-sized enterprises	3	256
5	competitive advantage	1	275	20	model	1	269
6	determinants	3	406	21	networks	2	395
7	dynamic capabilities	1	271	22	open innovation	2	370
8	entrepreneurial orientation	1	245	23	orientation	1	205
9	entrepreneurship	2	370	24	performance	2	1,343
10	firm performance	1	446	25	product development	1	243
11	firms	2	552	26	product innovation	3	382
12	growth	2	288	27	research-and-development	2	799
13	impact	1	532	28	strategy	1	388
14	industry	2	282	29	technological innovation	3	68
15	knowledge	2	636	30	technology	2	549

Source: own completion from VoS viewer

Canada are citing each other i.e. have good citation networks clearly shown by arrows connecting the nodes in yellow color. Authors affiliated to the Netherlands, Brazil, and Poland are networked by blue arrows and citing each other´s works.

Bibliographic coupling – countries analysis

The minimum number of countries, 36, met the threshold 20, for each of the 20 countries, the total strength of the bibliographic coupling links with other countries was calculated and the countries with the greatest link strength were selected. As shown in Figure 8, the 20 countries are classified in two clusters identified by the red and green colours. From this Country's analysis, the People's Republic of China, England, USA, and Spain have the greatest linkage with one another, whereas Italy, South Korea, Brazil and Romania have strong bibliographic coupling links.

Key word analysis

Table 4 summarizes the top 30 keywords in the 2219 articles published on the effect of innovation on small and medium enterprises over the years 1976–2020. Performance, management, impact, R&D, knowledge, and technology are the most frequently used keywords, which indicates these terms are topics related to innovation and small and medium sized enterprises performance. The occurrence of group of terms can help to build visualization map to know most important themes of the subject under investigation and the relationship among the keywords. Minimum number of the occurrences of a key word (62) after eliminating 6 keywords are SME, SMEs, Small and medium-sized enterprises, and Small firms.

Co-occurrence of keywords analyzed enabled further interpretation of the information into clusters by using clustering algorithm giving further details on these clusters. A value between 0 and 1 is generally used to measure the internal homogeneity of clusters, or how similar an object is to its own cluster compared to other clusters. Higher values show more effective clustering is formed and the object is well matched within its own cluster. Clustering of keywords indicates that the result of clustering is appropriate to use in analyzing. As was found, different clusters indicated different aspects of innovation issues and concerns over the SMEs operations. Table 4 clusters found represent the major concerns of innovation integration into SMEs.

Top cited articles on the subject

Table 5 summarizes the top cited articles of Innovation in SMEs in the order from the highest to the lowest. This measure is useful in the sense that separates each article depending on its field and it is a known fact that depends on the field, the number of citations used per article is different. Therefore, it is a good way to highlight important articles from different fields. These papers signalize, in some way, research paths in the literature. From the top cited article; Open innovation in SMEs: Trends, motives and management challenges van de Vrande et al.(2019) multinational enterprises. This exploratory paper investigates if open innovation practices are also applied by small- and medium-sized enterprises (SMEsranked first with 806 total citation and 67.17 citation per year followed by Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs Rosenbusch et al.(2011) with 586 total citation and 58.6 citation per year and Open innovation in SMEs – An intermediated network model Lee et al. (2010) with 520 total citation and 47.27 citation per year stand second and third, respectively.

Open innovation in SMEs: trends, motives and management challenges

This exploratory paper investigates if open innovation practices are applied by small- and medium-sized enterprises (SMEs). Drawing on a database collected from 605 innovative SMEs in the Netherlands, this article with most citation number (806) was published in 2009, which has the peak rate of publications about with 58% increase in comparison to the previous year.

The second most cited article asks the question whether innovation is always beneficial. It is a meta-analysis of the relationship between innovation and performance in SMEs. This study applies meta-analyses techniques to aggregate prior empirical research on the innovation-

Table 5 Top cited articles

Rank	Title	Authors	Publication year	Total citation	Citation per year
1	Open innovation in SMEs: Trends, motives and management challenges	van de Vrande et al.	2009	806	67.17
2	Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs	Rosenbusch et al.	2011	586	58.6
3	Open innovation in SMEs – an intermediated network model	Lee et al.	2010	520	47.27
4	Relationship between cooperation networks and innovation performance of SMEs	Zeng et al.	2010	443	40.27
5	The Effects of Government-Industry R&D Programs on Private R&D: The Case of the Small Business Innovation Research Program	Wallsten	2000	419	19.95
6	Sustainability-oriented innovation of SMEs: a systematic review	Klewitz and Hansen	2014	344	49.14
7	Co-opetition and Technological Innovation in Small and Medium-Sized Enterprises: A Multilevel Conceptual Model	Gnyawali and Park	2009	305	25.42
8	Innovation practice and its performance implications in small and medium enterprises (SMEs) in the manufacturing sector: a resource based view	Milé Terziovski	2010	301	27.36
9	Drivers of innovativeness and performance for innovative SMEs in South Korea: Mediation of learning orientation	Rhee et al.	2010	267	24.27
10	Inbound open innovation activities in high tech SMEs: the impact on innovation performance	Parida, Westerberg and Frishammar	2012	258	28.67

Source: own completion from VoS viewer

performance relationship. It determines the direction and strength of effect innovation has on the performance of small and medium-sized firms (SMEs). Furthermore, the meta-analysis approach allows presenting evidence whether moderators affect the innovation performance relationship. Analysis aggregates 42 empirical studies on 21,270 firms.

Longitudinal thematic analysis

The collected publications from 1976 to 2020 were dispatched in four periods. The first period from 1976 to 2008 with 357 publications, the second period from 2009 to 2012 with 545 publications, the third period from 2013 to 2016 with 614 publications, and the fourth period from 2017 to 2020 with 703 publications were depicted. The SCIMAT software was used to perform longitudinal thematic analysis on innovation in small and medium size enterprises. For analysis, just the keywords with two times occurrences and more were considered. In addition, the minimum number for the edge of network was set on three. Figure 9 shows the overlapping map for four different periods, in this figure the first circle in the left side represents the first period, which is from 1976 to 2008. The number in the middle of the circle is the number of identified keywords. For the first period, 671 keywords were identified. The number on horizontal arrows that connect the circle of different periods shows the number of similarity of keywords between two periods, and the number in parentheses shows the similarity index. Numbers on upper outgoing arrows is the number of keywords that are not transferred to the next period. For example, in the first period, 416 keywords did not transfer to second period. The numbers on upper incoming arrows show the number of new keywords on that specific period. In this case, for the second period, the number of new keywords is 1010. In reference to Figure 9, the rate of similarity increased through the time, but the increase is not significant and in the last surveyed period (from 2017 to 2020), around third quarters of the keywords are new keywords to the topic. It shows the high rate of changes and evolution in the subject.

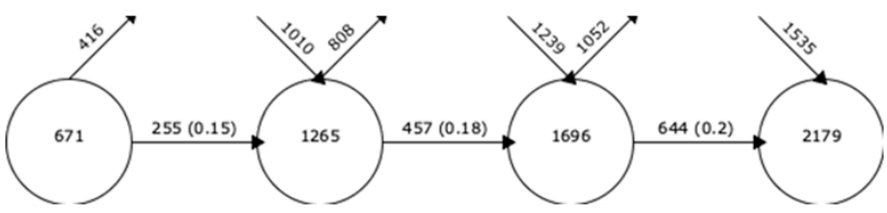

Figure 9 Overlapping map for four period of time, first to fourth period from left to right
Source: SCIMAT software

Keywords of publications play the role of fingerprints and can characterize the theme of publications. The longitudinal thematic analysis is shown in Figure 10 (Cobo et al., 2011). Table 6 shows the identified themes in different periods.

The first period contains four main themes. These themes are "Innovation, SMEs, Research and development (R&D), and Knowledge". The first two themes are the search keywords and it is not surprising to see these themes in all four periods. "Research and development" theme is also present in all four periods and it shows the importance of R&D in innovation in any scale of enterprises. The "knowledge" theme dissolved in the other themes after the second period.

In the second period from 2009 to 2012, ten new themes were indicated. Four of them were exactly the same as in the previous period of time themes and three themes were extracted from the previous themes. These three themes are "Performance, Small firm, and Market orientation". In this period, three new themes were introduced: "Enterprise management, Adaptation, and Systems".

The third period with thirteen themes represents the publications from the 2013–2016 period. Four of these themes are new themes;

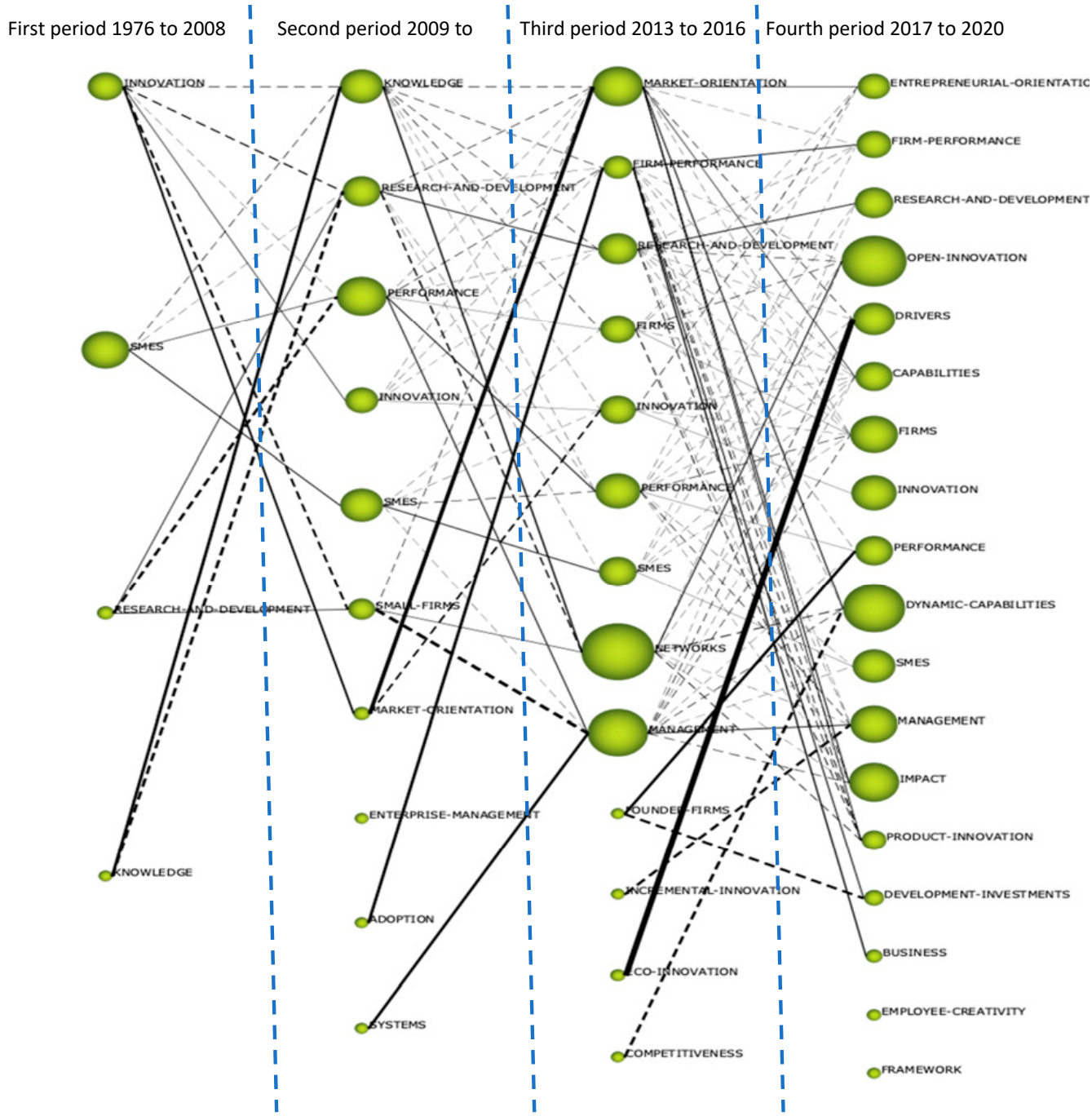

Figure 10 Evolution map for four periods based on documents count (size of each circle based on document count)
Source: SCIMAT software

these four themes are "Founder firms, Incremental innovation, Eco innovation, and Competitiveness". The interesting fact is that in this period there are five themes with more than eight connections to the next period of time themes. These themes are "Market orientation, Firm performance, R&D, Performance, and Management". It shows the connectivity of themes in different periods. The innovation in SMEs subject does not segregate subjects.

The fourth period contains eighteen themes. Just two of these themes are new subjects and all other sixteen are connected to themes of the former periods. These two new themes are "Employee creativity and Framework". The fourth period is the most recent one, and the analysis of the themes in this period shows the most important subject in the research area. The following points were identified in this period:

- "Market orientation" changed to "Entrepreneurial orientation". It seems the entrepreneurial concept became more important than the market need and orientation.
- "Open innovation" is a new theme with connection to five themes in previous period.
- "Eco innovation" is the main contributor to the "Drivers" theme in fourth period.
- "Capabilities and Dynamic capabilities" are two new themes, which are focused on innovation in SMEs capability.
- "Product innovation" is another new theme.
- The conversion of "Founder firms" to "Development investments".
- Introduction of "Business" as a new theme.

Table 6 Themes in four different periods

Serial no.	First period: 1977 to 2008		Second period: 2009 to 2012		Third period: 2013 to 2016		Fourth period: 2017 to 2020	
	theme	document count	theme	document count	theme	document count	theme	document count
1	innovation	108	knowledge	148	market orientation	187	entrepre-neurial orientation	113
2	SMEs	157	R&D	125	firm performance	117	firm performance	130
3	R&D	35	performance	173	R&D	147	R&D	133
4	knowledge	11	innovation	174	firms	143	open innovation	240
5			SMEs	275	innovation	196	drivers	232
6			small firms	100	performance	180	capabilities	154
7			market orientation	22	SMEs	281	firms	184
8			enterprise management	4	networks	271	innovation	241
9			adoption	11	management	256	performance	212
10			systems	23	founder firms	4	dynamic capabilities	268
11					incremental innovation	6	SMEs	335
12					eco innovation	8	management	238
13					competitive-ness	29	impact	223
14							product innovation	122
15							development investments	29
16							business	35
17							employee creativity	11
18							framework	25

Document count is a sum-up of primary document count and secondary document count.
Source: SCIMAT software

Reviewing the longitudinal thematic analysis shows the themes move from general ones such as "Knowledge, Firms, Market orientation, and Management" to more specific themes such as "Entrepreneurial orientation, Open innovation, Dynamic capabilities, and Product innovation". This shift does not push the general themes aside and they still play a role in the field of study.

Strategic diagrams

The SCIMAT software develops the strategic diagram for each period. The strategic diagram has two-dimensions centrality as x-axis and density as y-axis. Density shows internal development of each theme and centrality represents the external link of a theme with other themes. There would be four quadrants in strategic diagram and Cobo and his team chose a name for each quadrant (Cobo et al., 2011). Figure 11a shows the strategic diagram for the first period of study from 1976 to 2008. Figure 11b represents the strategic diagram for the second period from 2009 to 2012. The strategic diagram of studies from 2013 to 2016 is figure 11c, and figure 11d is for the last period of study, which is from 2017 to 2020.

"Motor-themes" is the upper-right quadrant developed in both dimensions. The themes in this quadrant are the main backbones of the research field. In the first period, there are no themes in the motor themes quadrant. The "R&D" is in the y-axis with high density and zero centrality and "innovation" is in the x-axis with zero density and medium level on centrality. "Performance and Knowledge" are the two themes in the second period in upper-right quadrant. For the third period of time, "Firm performance, Market orientation, Network and R&D" are the four themes in this quadrant, and for the fourth period of time "Drivers" is a theme with the highest density, it shows this theme is well-connected to the other themes in the motor-themes quadrant. "Open innovation" presents the highest centrality among this quadrant theme. "Entrepreneurial orientation and firm performance" are two other themes in the upper-right quadrant. The "Dynamic capability" is located in the border of upper-right and a lower-right quadrant, this theme has the highest centrality among all themes and it shows the external development of this theme. All introduced themes play significant roles in innovation in the SMEs topic and are very important for the researchers in this area of study.

Upper-left quadrant shows the themes with high internal strength and low external linkage. "High developed and isolated themes" is the phrase used by Cobo and his team to describe this quadrant (Cobo et al., 2011). The phrase is self-explanatory. For the first period of time, as mentioned, "R&D" theme demonstrates the highest density, and the "Knowledge" theme is the only member of the upper-left quadrant. In the second period from 2009 to 2012, "Enterprise management" has the highest density as well as lowest centrality. It shows this topic very well internally developed, but it has high potential for external development. Despite its high potential for development, the "Enterprise management" was left behind and no themes were inherited from this theme in the next period of time. "Adoption and market orientation" are two other members of this quadrant for the second period of time.

"Founder firms" presents the highest density not just in this quadrant, but also in the whole third period of time. On the other hand, "Incremental innovation" presents the lowest centrality in this period, and the "Eco innovation" is the other member of this quadrant for the third period of time. The fourth period of time is representative of recent year's studies and

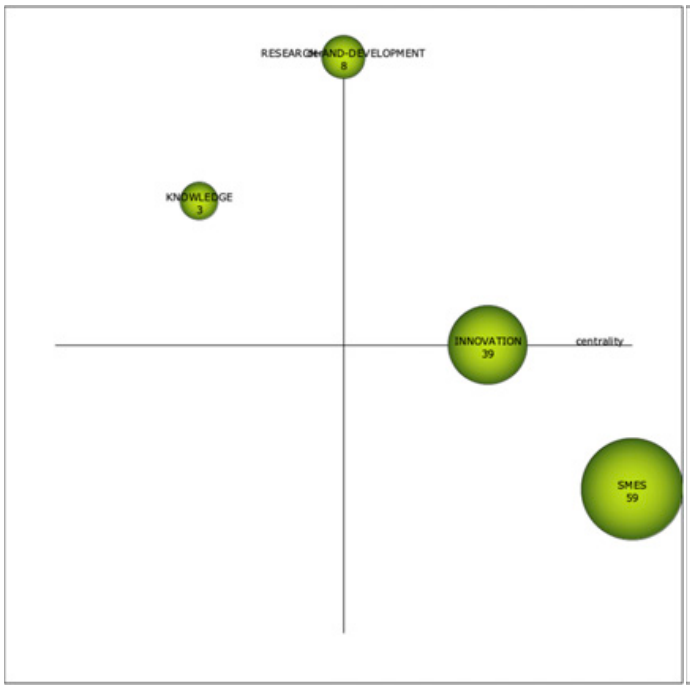

Figure 11a First period strategic diagram

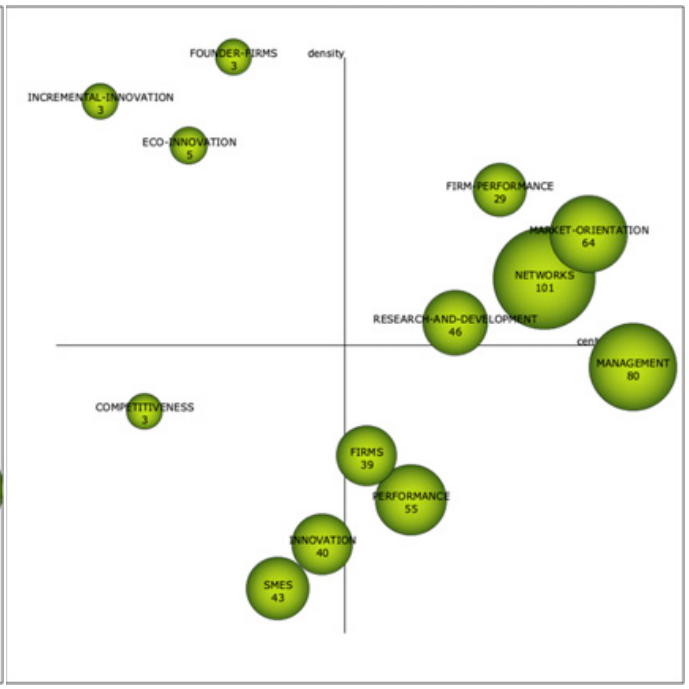

Figure 11c Third period strategic diagram

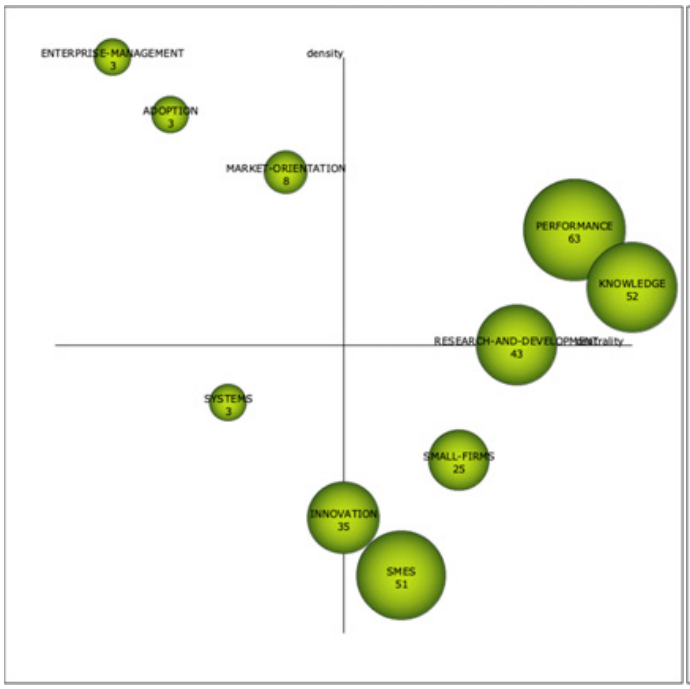

Figure 11b Second period strategic diagram

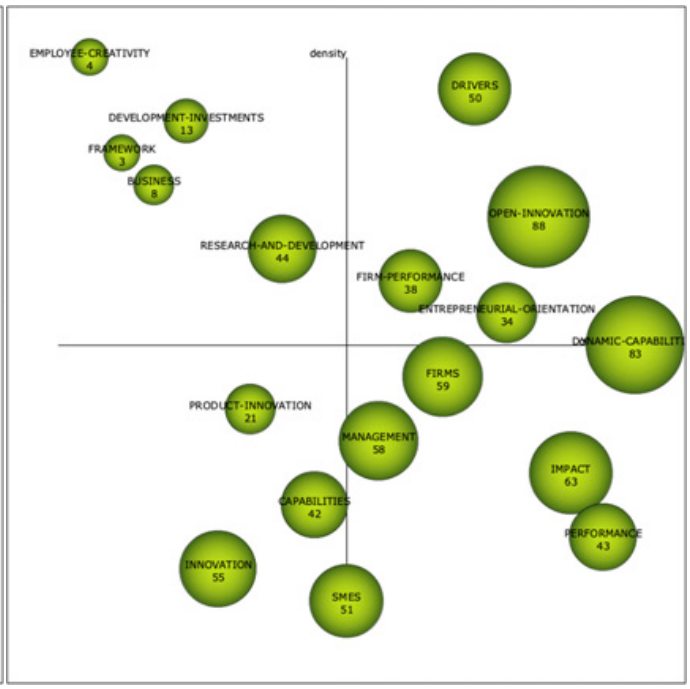

Figure 11d Fourth period strategic diagram

"Employee creativity" shows the highest density and lowest centrality. This theme may have the same destiny as "Enterprise management" in third period of time or may not. "Founder firms" is antecedent of "Development investments" and both are in the same quadrant. It shows the topic has potential for further discussion and external connection development. "R&D" moved from upper-right quadrant in the third period to upper-left quadrant in the fourth period of time, it demonstrates that the theme lost its interest for researcher, but it is still very well developed internally. "Framework and Business" are two other themes in this quadrant. Both of themes have potential for future external development.

"Basic and transversal themes" are themes with high level of connectivity to the other topic and low level of development. These themes are placed in the lower-right part of the strategic diagram. The themes in this quadrant have high potential for internal development. SMEs and Innovation are two main search keywords and the related themes to these two keywords do not have any meaningful analysis. As it is obvious, these keywords are located in the lower part of the strategic diagram. "SMEs" is the only member of the lower-right part of the diagram for the first period of time. "SMEs" is still in the same quadrant in the second period along with "Small-firms" and Innovation on the density axis in the border for lower-right and lower-left

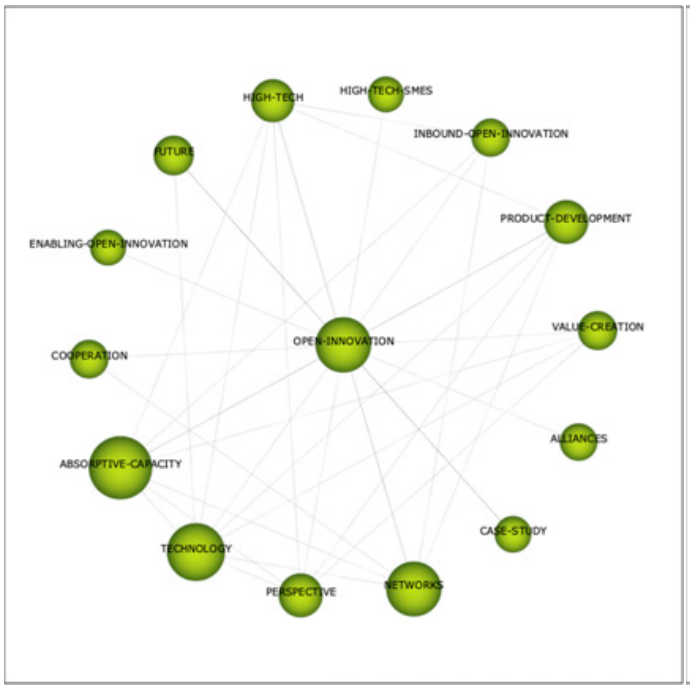

Figure 12a Thematic network of "Open innovation"

Figure 12c Thematic network of "Performance"

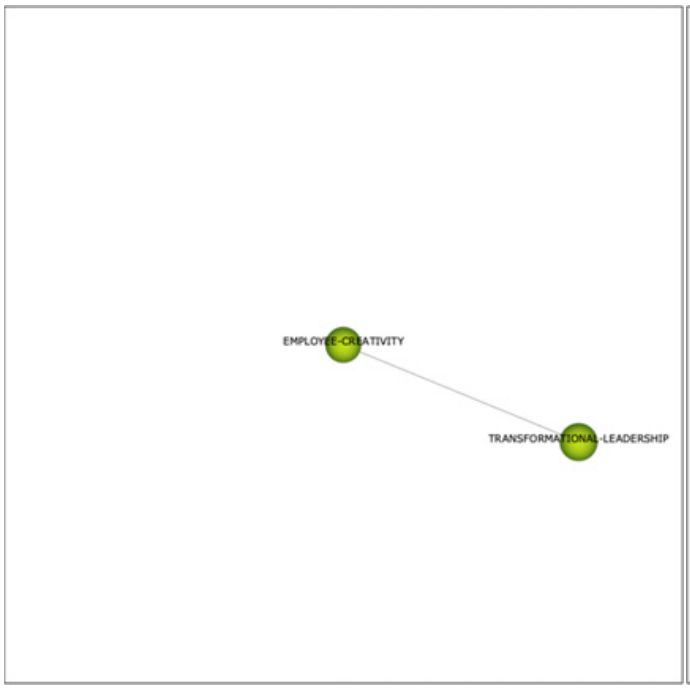

Figure 12b Thematic network of "Employee creativity"

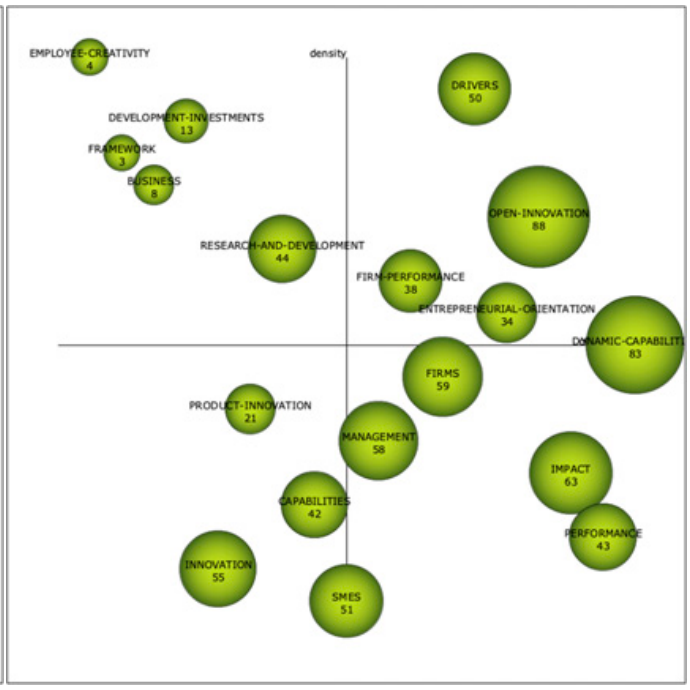

Figure 12d Thematic network of "Product innovation"

quadrant. In the third period of time there was "Management" with highest centrality along with "Firms and Performance". All these themes remain in the same quadrant in the fourth period of time and just one another theme added to this quadrant, and the new theme is "Impact". All these four themes have high potential for internal development for the future research.

The last quadrant is the lower-left quadrant with low level of centrality and density. The themes in this quadrant are either emerging or declining, hence, the name "emerging or declining themes" name was selected for this quadrant (Cobo et al., 2011). For the first period of time this quadrant was empty, and for the second period of time it had a solo member and this member was "Systems". In the third period of time, two main search keywords "SMEs and Innovation" were in this quadrant along with "Competitiveness". Based on Figure 10, "Competitiveness" contributed to the new theme, which is "Dynamic capability", and the internal and external development of dynamic capability is obvious in the Figure 11d. In the Figure 11d "SMEs and Innovation" themes are still in the lower-left quadrant. Two other themes in this quadrant are "Capability and Product innovation". It seems these two themes are knowledge seeds, and they have high potential for a future study.

Thematic network

After the thematic strategic diagram, it is the time for the thematic network. The thematic network for each theme shows the connection of that theme with the other themes and subjects. Figure 12 demonstrates the thematic network; in this figure there are just 12 samples of the thematic network. These are four networks from the fourth period selected, and each of these examples is in a different quadrant. For upper-right quadrant "Open innovation", for upper-left quadrant "Employee creativity", for lower-right quadrant "Performance", and for the lower-left quadrant "Product innovation" were selected. In the thematic network, the size of each circle for the theme shows the number of documents on that theme, and the thickness of the connection lines shows the strength of connection of those themes with the other themes. As it is shown in the Figure 12a, some of these themes around the main theme are also connected to each other, for example "High tech" is connected to "Product development". The themes in the right side of the strategic diagram are well-connected to each other, because the centrality numbers for these themes are higher; Figures 12a and 12c present these themes. Themes on the left side of the strategic diagram are less connected, and "employee creativity and product innovation" are two examples coming on Figure 12b and Figure 12d, respectively.

Conclusions

This paper focused on the effect of innovation in small and medium enterprises by using major indicators of bibliometric analysis to see the growth of the scientific studies in the subject matter. The field showed a rapid scientific growth between the study times (1976–2020) though there are also decreases due to justified reasons. 2219 publication records were extracted from the web of science core collection scientific database in September 2020, which was produced starting from the commencement of scientific study on the subject. Many countries, universities, research institutes, funding agencies, authors and co-authors contributed to the growth of the field to this level as was clearly explained in the above discussion section of this paper. As observed from the finding, most of the countries contributing to this field of science are developed nations. So, it is also recommended for low-income countries to play their share in contributing in the literature of the subject under study.

Unfortunately, from the Central Eastern European region, only Romania was represented. The lack of the Visegrad Countries in this research is probably reasoned by the low number of journals represented in the WoS, and the fact that many researchers of the Visegrad countries publish in valuable journals of the region and Europe.

In line to the study of Lee et al. (2010) which portrays innovation play great role for small and medium enterprises to sustain, business competitiveness, and employee performance; the current study also highlighted the close nexus between innovation and the management field. The two leading journals (from the top ten publishing journals) of this inter-disciplinary research filed are small business economics and international journal of innovation and management, which is the significant evidence for the importance of innovation in the efficiency of small and medium businesses.

Regarding the internalization and collaboration of countries, authors, and co-authorship on innovation and small and medium enterprises, the findings demonstrate remarkable results in the importance of these issues. Bartolacci et al. (2019) recommended that it is better to make a detailed investigation on the importance of collaboration of countries on small and medium firms and innovation in the aim of sharing related benefits and costs. In line with this, the findings showed USA, England, South Korea, and the People's Republic of China as cooperating in one cluster, German, Italy, Romania, Poland, and the Netherlands as collaborating in another cluster, while Malaysia, Indonesia, France, Australia, and Canada collaborate as indicated by arrows connecting the countries differentiated by colour in Figure 6.

Regarding the top cited articles, the article published by Rosenbusch et al. (2009) and van de Vrande et al. (2011) multinational enterprises. This exploratory paper investigates if open innovation practices are also applied by small- and medium-sized enterprises (SMEsare ranked first and second from the top ten cited articles with 67.17 and 58.6 citations per year, respectively. The top cited articles are the most influential publications that attract scientific community toward the subject area. As the finding showed, there is a significant publication growth in the field from 2011 to 2019, which confirms that the subject draws the attention of scholars and practitioners. Publications on this area showed a significant decrease in 2020 due to the fact that almost all researchers do their best to find solutions and recommend some precautions regarding the new pandemic (COVID-19).

Concerning the content of the publication and keyword analysis, performance, knowledge, technology, open innovation, entrepreneurship, management, research and development, and product innovation are the most frequently used keywords and have strong affiliation as indicated in the keyword visualization map. From this output, it can be concluded that these high frequent terms appearing in the keyword visualization map are words that are related to impact of innovation in small and medium enterprises performance, and they may be related to sustainability aspects as well, which is mentioned only indirectly in many sources.

The longitudinal thematic analysis confirms high rate of changes and evolution in the subject. Even though the themes move from such as "Knowledge, firms, market orientation and management" to more specific themes such as "entrepreneurial orientation, open innovation, dynamic capabilities and product innovation", the shift does not push the general themes aside, and they still play a role in the field of study. On the other hand, the thematic network diagram reveals two other themes "Capability and Product innovation" which are taken as knowledge seeds, and they have high potential for a future study. Thus, this study gives an insight for future investigation and has a significant impact to draw attentions of scholars on these newly identified themes in the subject, and as Maier et al (2020) concluded, new field that combines the concepts of innovation and sustainability is rapidly developing.

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