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Research on Subject Areas of Innovation Ecosystem: A Discipline Co-occurrence Analysis

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Abstract

Based on data from the Web of Science database, co-occurrence analysis and network visualization technique were conducted to explore the structure and patterns of interdisciplinary collaborations in innovation ecosystem research. This study presented the descriptive statistics of disciplines involved in relative research and interdisciplinary network over time. The results suggested that the scope of disciplines involved in innovation ecosystem research is broad and the distribution is unbalanced. Management and business are the core subject area while Regional & Urban Planning, Environmental Studies, and Environmental Sciences are playing key role in research and practices.

Keywords: Innovation Ecosystem Research; Interdisciplinary Collaboration; Discipline Co-occurrence Analysis

1 INTRODUCTION

Economic globalization and market integration make the competitive environment more complex and changeable. Along with the blurring of industrial boundary and enterprise boundary, the innovation paradigm presents a systematic, ecological and dynamic trend. At the same time, Silicon Valley ecosystem, P&G's open innovation platform and Apple's innovation ecosystem have made the great success, which makes the innovation ecosystem become an important topic concerned by the theoretical study and industrial practice.

Be a research field rising in recent years, innovation ecosystem comes from the category of ecology and gradually extends to many fields such as economics, management and business research. It has a highly integrated diversity of disciplines, deeply reflects the dynamic and development trend of interdisciplinary, and provides a reference for solving the current complex social problems [1].

2 LITERATURE REVIEW

With publications on innovation ecosystem research proliferating in recent years, there have been efforts to elucidate the status of research in the field. A majority of such efforts have been devoted to qualitative reviews, including understanding the concept and theory, and analyzing the structure and evolution of system. Oh et al.(2016) reviewed the concept of innovation ecosystems and described the research gap[2]. Using meta-synthesis method, Bassis et al.(2018) performed a critical literature review to clarify to what extent the theory of innovation ecosystems and systems of innovation are complementary[3]. Furthermore, Rabelo et al.(2015) conducted a systematic literature review and illustrated the factors influencing the evolutionary of innovation ecosystems[4]. Similarity, Iyawa et al. (2016) explored and identified components of digital health innovation ecosystem[5]. Dedehayir et al.(2018) also undertook a systematic review of the literature to analyze the roles during innovation ecosystem genesis[6].

Moreover, more efforts have also been devoted to quantitative research. Zhang et al.(2017) adopted the co-citation analysis and network meta-analysis to clarify the trends, mainstream and hotpots and current situation[7]. Using a hybrid method of bibliometric and content analysis, Gomes et al.(2018) also conducted a systematic literature review to highlight the most influential paper, to discuss the concept, and to conclude six research streams[8]. Meng

et al.(2018) used the method of main path and content analysis to analyze the important scholars, influential journals and key literature in the field of innovation ecosystem[9]. Consequentially, Suominen et al.(2019) conducted the bibliometric coupling and co-citation analysis methods to explore the thematic differences in literature[10].

Although previous efforts offer great insights into the various issues of innovation ecosystem research, a study revealing the specific patterns of interdisciplinary collaboration in innovation ecosystem research is still lacking. To fill this gap in the literature, this study aims to map the interdisciplinary collaboration network of disciplines related to innovation ecosystem research, and to grasp the status and development of innovation ecosystem research.

3 METHODOLOGY

3.1 Data Set

To retrieve sufficient innovation ecosystem related papers, the Web of Science literature database was initially used for paper retrieval. In order to have sufficient coverage of the papers and avoid too much useless data and avoid adverse effects on the research results, the following query has been searched in the topic:“innovation ecosystem” or “innovation ecosystems”. The data were extracted in September 2019, with the search in the topic field covering the period from 2001 to 2019. Finally, a total of 236 articles were retrieved and selected as the analysis sample.

Based on the statistical analysis of the retrieval data according to the annual number of papers published, the number of innovation ecosystem research papers published from 2001 to 2019 was showed in Fig.1. Although there were only a few studies before 2012, the number of papers has been a steady increase since 2013 and the quantity reached to a high tide in 2018.

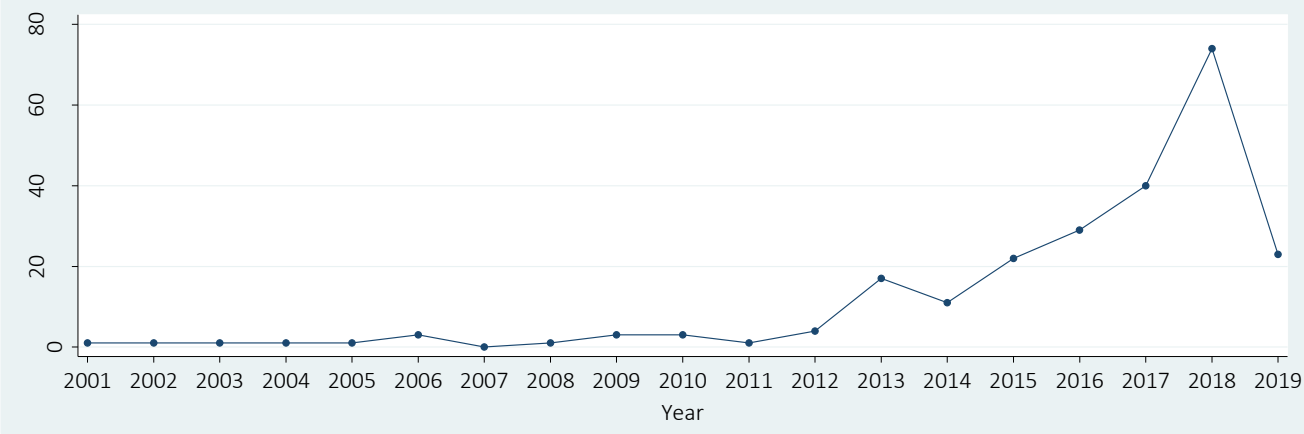

FIGURE 1. YEAR DISTRIBUTION OF INNOVATION ECOSYSTEM PUBLICATIONS

3.2 Research Method

The disciplinary composition of a given research field reveals extent to which the research field is shaped by confluence of disciplines and their respective roles. It can be used to describe the intellectual structure of subject areas by means of discipline co-occurrence analysis and more specific in case of WOS data as Subject Category co-occurrence analysis[11].

This study used the co-word analysis method to depict the subject network of research, in which the nodes are the subject while the links represent the co-occurrence of these subjects. VOSviewer is a software tool for constructing and visualizing bibliometric maps. Unlike most computer programs that are used for bibliometric mapping, VOSviewer is especially useful for displaying large bibliometric maps in an easy-to-interpret way, and pay more attention to drawing and clustering[12].

4 RESULTS

4.1 Descriptive Patterns of Disciplinary Research

In this study, 77 disciplines are identified, and their statistical data is listed in Figure 2. In innovation ecosystem research, the number of papers, disciplines and their co-occurrence are increasing over time; but the average number of disciplines involved with each paper only slightly varies, and generally only involves one or two disciplines.

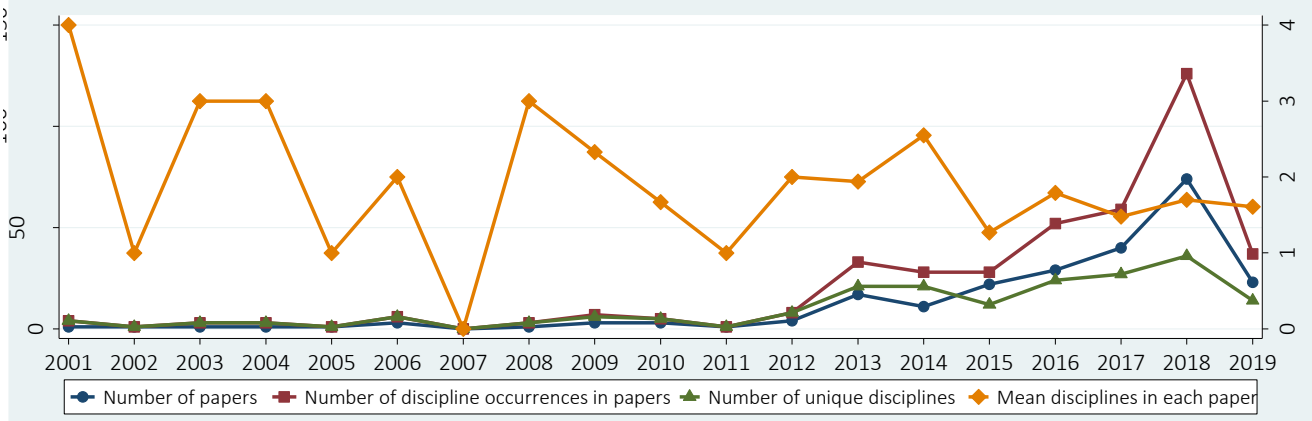

FIGURE 2. THE BASIC STATISTICS OF PAPERS AND SUBJECT CATEGORIES OVER TIME

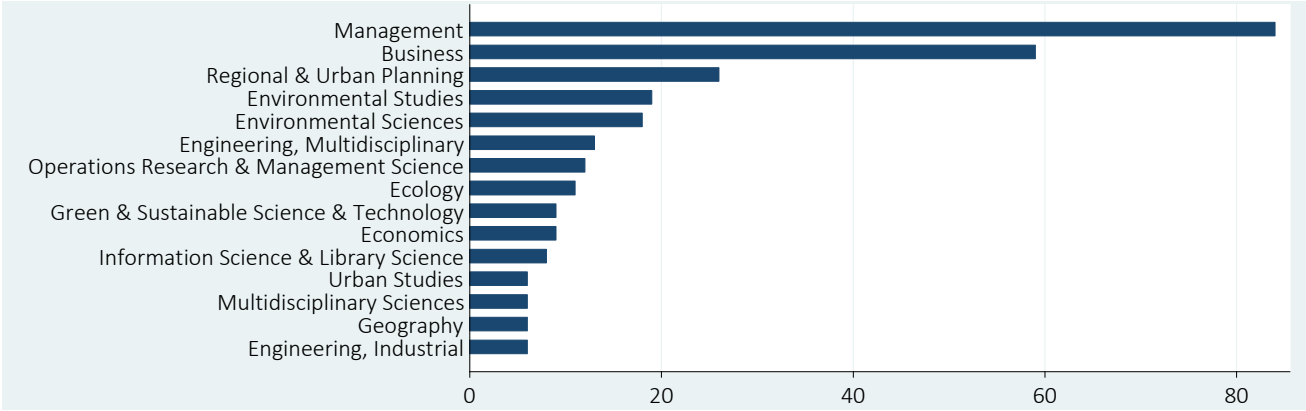

FIGURE 3. DISTRIBUTION OF LEADING SUBJECTS AREAS

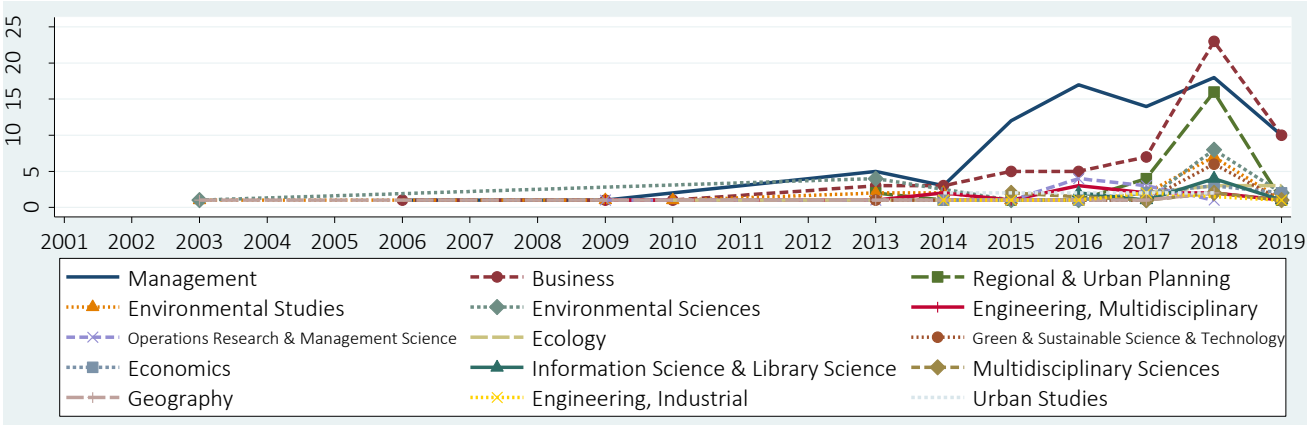

FIGURE 4. LEADING SUBJECT AREA DISTRIBUTION DURING 2001-2019

Figure 3 lists the top 15 disciplines involved in innovation ecosystem research, each with greater than six occurrences. The leading disciplines are Management, Business, Regional & Urban Planning, Environmental Studies, Environmental Sciences, Engineering-Multidisciplinary, Operations Research & Management Science, and Ecology. The two largest disciplines, Management and Business, account for 35.3% of the total occurrences of disciplines. These top fifteen disciplines contribute 72.1% of all discipline occurrences, demonstrating an unbalanced distribution in innovation ecosystem research.

The temporal distribution of subject areas wise innovation ecosystem publications during the research period as

illustrated in Figure 4 is reveals the intellectual progress of innovation ecosystem research in different subject areas. This analysis clearly shows that the dominance of Management followed by Business, and Regional & Urban Planning in the research field throughout the research period.

4.2 Interdisciplinary Collaboration in Innovation Ecosystem Research

Interdisciplinary collaboration communities detected in innovation ecosystem research are shown in Table 1. These results also prove the above conclusions that distinct interdisciplinary communities exist, led by a few central and important disciplines such as Management, Business, Regional & Urban Planning, Environmental Studies, and Environmental Sciences. The number of interdisciplinary collaboration communities ranged between two and twelve overall, indicating that interdisciplinary research in innovation ecosystem tends to be mature and stable.

TABLE 1 THE INTERDISCIPLINARY COLLABORATION COMMUNITIES OF INNOVATION ECOSYSTEM RESEARCH

Period	Community	Number of disciplines	Representative disciplines
2001-2010	C1-1	6	Management(8); Business(8); Economics(2); Regional & Urban Planning(1); International Relations(1); Engineering-Industrial(1)
	C1-2	2	Environmental Studies(1); Ecology(1)
	C1-3	2	Biodiversity Conservation(1); Environmental Sciences(1)
2011-2013	C2-1	4	Management(5); Information Science & Library Science(2); Multidisciplinary Sciences(1) ; Computer Science, Information Systems(1)
	C2-2	3	Green & Sustainable Science & Technology(2); Environmental Sciences(2); Engineering-Environmental(1)
	C2-3	3	Environmental Studies(2); Urban Studies(1); Geography(1)
	C2-4	2	Business(6); Regional & Urban Planning(5)
2014-2016	C3-1	8	Business(19); Management(15); Regional & Urban Planning(11); Social Sciences, Interdisciplinary(3); Information Science & Library Science(2); Engineering, Multidisciplinary(2); Development Studies(2); Operations Research & Management Science(1)
	C3-2	5	Environmental Sciences(7); Green & Sustainable Science & Technology(5); Environmental Studies(5); Ecology(3); Engineering, Environmental(1)
	C3-3	3	Transportation(1); Economics(1); Geography(1)
	C3-4	3	Biotechnology & Applied Microbiology(2); Biochemical Research Methods(1); Genetics & Heredity(1)
	C3-5	2	Materials Science, Multidisciplinary(1); Engineering, Manufacturing(1)
	C3-6	2	Education & Educational Research(4); Health Care Sciences & Services(1)
2017-2019	C4-1	12	Environmental Studies(11); Regional & Urban Planning(9); Environmental Sciences(8); Ecology(5); Geography(4); Urban Studies(4); Marine & Freshwater Biology(2); Green & Sustainable Science & Technology(2); Public Administration(1); Biodiversity Conservation(1); Geography, Physical(1); International Relations(1)
	C4-2	8	Agronomy(4); Forestry(3); Water Resources(3); Plant Sciences(3); Meteorology & Atmospheric Sciences(3); Chemistry, Analytical(2); Soil Science(2); Geosciences, Multidisciplinary(1)
	C4-3	7	Materials Science, Multidisciplinary(3); Metallurgy & Metallurgical Engineering(1); Nanoscience & Nanotechnology(1); Physics, Applied(1); Mineralogy(1); Mining & Mineral Processing(1); Chemistry, Multidisciplinary(1)
	C4-4	6	Management(56); Business(26); Operations Research & Management Science(11); Engineering, Multidisciplinary(10); Engineering, Industrial(5); Mathematics, Interdisciplinary Applications(1)
	C4-5	5	Information Science & Library Science(3); Computer Science, Information Systems(1); Telecommunications(1); Computer Science, Interdisciplinary Applications(1); Engineering, Electrical & Electronic(1)
	C4-6	4	Food Science & Technology(3); Biotechnology & Applied Microbiology(2); Nutrition & Dietetics(1); Genetics & Heredity(1)
	C4-7	4	Medical Ethics(1); Medicine, Legal(1); Law(1); Ethics(1)
	C4-8	3	Tropical Medicine(1); Parasitology(1); Public, Environmental & Occupational Health(1)
	C4-9	3	History & Philosophy Of Science(2); Sociology(2); Agriculture, Multidisciplinary(1)
	C4-10	2	Biochemistry & Molecular Biology(1); Chemistry, Medicinal(1)

The largest components of these networks, including distinct communities, have been visualized to display the interdisciplinary collaboration in innovation ecosystem research. These maps are displayed as Figs. 5,6, 7 and 8. In these maps, disciplines and their relationships are shown clearly and sized proportionally, demonstrating that connections between disciplines within each community are closer than those between communities.

FIGURE 5. INTERDISCIPLINARY COLLABORATION COMMUNITIES (2001-2010)

The three communities were independent during 2001-2010. The largest component of the network was related to Management and Business. The communities related to Environment and Ecology were small research fields. The co-occurrence between Business and Management (5) had highest value followed by Business and Economics (2).

FIGURE 6. INTERDISCIPLINARY COLLABORATION COMMUNITIES (2011-2013)

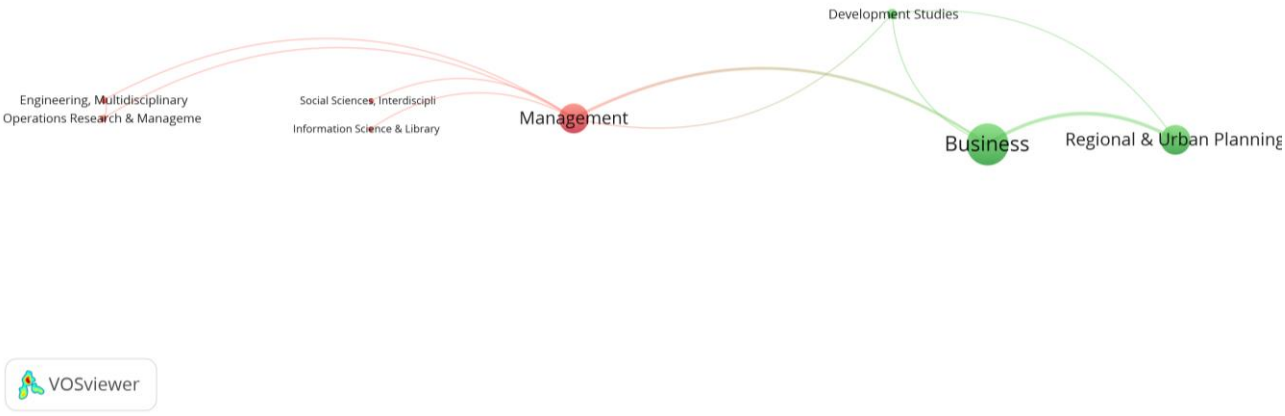

FIGURE 7. INTERDISCIPLINARY COLLABORATION COMMUNITIES (2014-2016)

From 2013 to 2015, the community related to Management and Information Science was the largest component of the network, and was not associated with other three groups. In addition, Business, Regional & Urban Planning, Sustainability, Environment, and other disciplines were aggregated into three related communities. The co-occurrence between Business and Regional & Urban Planning (4) had highest value followed by Environmental Sciences and Green & Sustainable Science & Technology (2).

In the third stage, the six communities were also independent. The largest component of the network was related to Management and Business, followed by Environmental community. The co-occurrence between Business and Regional & Urban Planning (10) had highest value followed by Business and Management (6); Environmental Sciences and Environmental Studies (5); Environmental Sciences and Green & Sustainable Science & Technology (5); and Environmental Studies and Green & Sustainable Science & Technology (4).

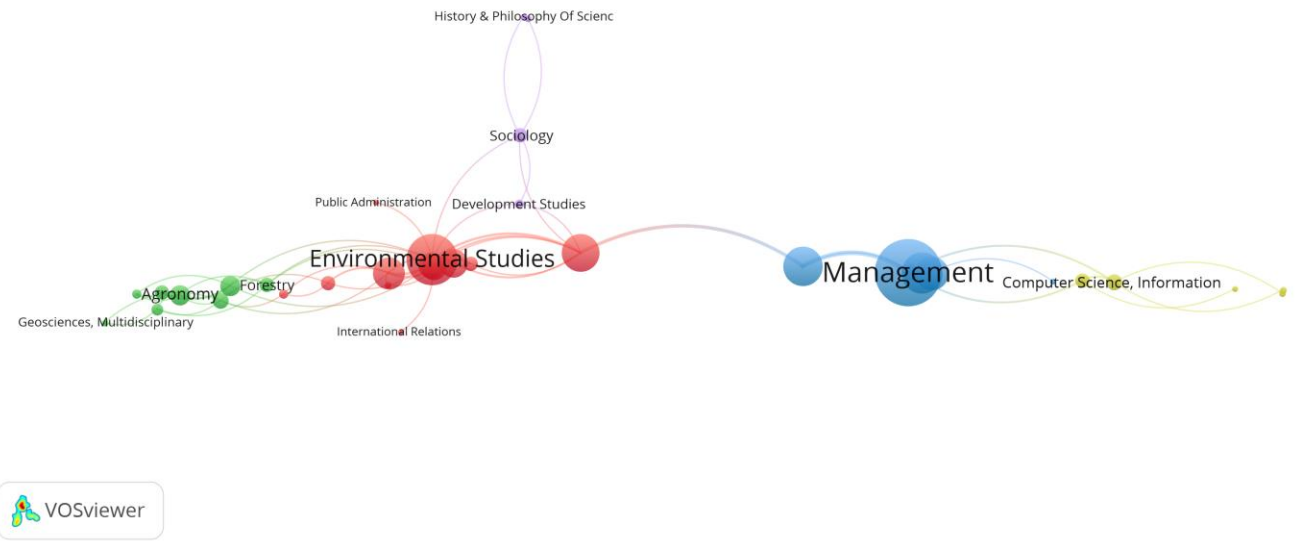

FIGURE 8. INTERDISCIPLINARY COLLABORATION COMMUNITIES (2017-2019)

During 2017-2019, Environmental community was the largest component of the network. In addition, Environment, Business and Management, Agronomy, Information, and Society were aggregated into a internet network. Other five communities were small independent research fields. The co-occurrence between Business and Management (11) had highest value followed by Management and Operations Research & Management Science (10); Engineering, Multidisciplinary and Management (7); Engineering, Multidisciplinary and Operations Research & Management Science (7); and Business and Regional & Urban Planning (6).

5 CONCLUSIONS

The findings of this study provide a clear, comprehensive understanding of interdisciplinary collaboration in innovation ecosystem research. The innovation ecosystem research papers published during 2001-2019 is spread out in 77 subject areas of Web of Science database. Larger frequency of papers in subject areas than the actual papers is significant to deduce the existence of co-occurrence of papers in more than one subject areas. More general, subject areas of Management, Business, Regional & Urban Planning, Environmental Studies, and Environmental Sciences are playing key role in innovation ecosystem research and practices. The temporal analysis of subject areas reflects the growing trend in innovation ecosystem publications in each subject area, however, fast growth is observed in Management, Business, and Regional & Urban Planning.

Our study has got some valuable conclusion, but it is not free from limitation. Future studies about innovation ecosystem research may be conducted in several areas. The research themes behind interdisciplinary collaborations should be analyzed to increase understanding. Additionally, quantitative methods should be coupled with qualitative approaches to explore the underlining issues.

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