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Knowledge Mapping of Platform Research: A Visual Analysis Using VOSviewer*

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***Abstract*—Platform is a topic that has been shaped by numerous articles for years. This study makes a contribution by a bibliometric analysis of academic research on platform in management, business and economics areas. The author analyzes 619 articles on platform from the Web of Science database from 1978 to 2018. Various methods are used to perform the bibliometric analysis: performance analysis and scientific maps. Furthermore, VOSviewer is used to map the bibliographic data. This study shows networks of references, journals and authors, indicating their impacts on the platform's research. The results will enhance understanding of platform research and enable future scholars to focus their own studies effectively.**

Keywords—platform; bibliometric analysis; co-citations; VOSviewer

I. INTRODUCTION

With rapid development of the global markets, competition becomes increasingly fierce. To achieve sustainable competitive advantage, an innovator may choose to "open" its technology by allowing outsiders to participate in its development and commercialization [1], which makes the innovation paradigm has evolved from sole firm's R&D behavior into cluster's cooperative R&D behavior [2]. Platform is the very cluster that support multiple interactions across various actors and can facilitate sustainable technical development [3][4][5][6]. As a consequence, firms advocate to build a platform with their various cooperators (such as vendors, customers, governments, intermediary), which results many markets in today's economy are organized around platforms, including mobile and PC operating systems, online games and so on [7]. There are some excellent platform-based companies in China, such as Alibaba and Tencent, both of which are able to obtain sustainable expand in the market because of the platform. The chase of firms towards platform make it a trending topic in academia, and resulting the exponential study rise in this field.

What is a platform? An early definition is that a platform is a common structure including a set of subsystems and interfaces from which a stream of products can be developed [8]. Bresnahan and Greenstein emphasize the role of a platform in promoting cooperation, and consider it as a bundle of standard components around which buyers and sellers coordinate efforts [9]. Hereafter, a more general and straightaway definition is brought forward, platform is the products and services that integrate groups of users in two-sided networks [10]. A platform may encompass physical components, tools and rules to facilitate development, a collection of technical standards to support interoperability, or any combination of these things [4]. There are different kinds of platforms, thus, scholars try to classify it. Gawer and Cusumano classify platform into two categories: internal and external platform [11]. Internal platform is a set of assets organized in a common structure from which a company can efficiently develop and produce a stream of derivative products, which is a firm level definition [8][12]; while external platform is products, services, or technologies that act as a foundation upon which external innovators, organized as an innovative business ecosystem, can develop their own complementary products, technologies, or services [13]. The "network effect" can explain the different value of platforms: the more users who choose the platform, the more valuable the platform becomes to the suppliers, users and owners because of growing access to the network of users and often to a growing set of complementary innovations.

The academia and enterprises studying and practicing platforms has resulted a rapid growth in literature on platform. However, there is a lack of comprehensive, quantitative reviews exclusively focused on platform. Our work in this study provides a thorough and in-depth picture on the status quo of researches in the platform field. We analyze 619 publications on platform from the Web of Science database (WoS) from 1978 to the end of 2018. By analyzing bibliometric indicators achieved on WoS, we illustrate the distribution of publications, most influential journals, most cited publications, most important authors, most outstanding institutions and countries. Furthermore, by analyzing data with VOSviewer, we present the co-citation of cited references, co-citation of authors and co-citation of journals.

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II. METHODOLOGY

A. Bibliometric Analysis

Bibliometric analysis is a quantitative method to retrospect and descript published papers, which are helpful for researchers evaluating academic studies in a focal field [14][15]. By using secondary data, bibliometric analysis examines secondary data acquired on digital database from a quantitative and objective perspective [16]; therefore, it is able to introduce a systematic, transparent, and reproducible review process and, then, enhance the reliability and quality of review [17].

According to Noyons and his co-authors, performance analysis and science mapping are two prime procedures [18]. Performance analysis is used to evaluate the publication performance of various levels, which uses techniques like citation analysis, counting publications by authors, institutions, universities or countries [19]. A unique feature used in performance analysis in this study is citation counts, which provided by WoS and represents the relative importance and influence of publications. Moreover, to evaluate the relative impact of the authors, journals, institutions and countries, we calculated the average citations per articles.

Science mapping is used to explore the structure and evolution of a focal research area [20][21]. In this research, we used co-citation analysis and co-occurrence analysis. Co-citation analysis of authors aims to identify eminent authors by analyzing citation records [22]. Co-citation analysis of journal contributes to understanding related scientific journals in a focal area [23]. Co-citation analysis reflects the importance that researchers attach to a cited article. As a consequence, the more often a publication is referred, the more predominant it will turn out to be for developing a focal area [24]. Co-occurrence analysis contributes to creating a term map, in which the frequency of occurrence of a particular term is defined by label size and the distance between two terms [25]. Therefore, co-occurrence analysis of author keywords can be applied to build a network in a particular area, which aims to explore and exhibit the intellectual framework of a particular research field [26]. In this study, we used VOSviewer software as a tool to perform the co-citation analysis and co-occurrence analysis, and then to realize the visualization of intellectual structure.

B. Data

The WoS is a high-quality digital database that is broadly accepted among researchers all over the world and has become a common tool for both retrieving and evaluating different types of publications [19]. The WoS covers a wide range of publications from different fields, which includes over 15,000 journals and 50,000,000 classified publications in 251 categories and 150 research areas [27]. In addition, the WoS is a proper database because it contains a set of data, such as titles, authors, institutions, countries, abstracts, keywords, references, citations count, impact factors and others [28][29]. In order to understand business research on platform, we collected publication information from the WoS Social Science Citation Index (SSCI), and limited to management, business and economics areas. Our study analyzed 619 publications from 1978 to 2018, as the first publication on platform that contains complete information was in 1978 (here we expurgate three anonymous documents in early years).

III. RESULTS

This section presents the following results of performance analysis, which includes the descriptive statistics, the distribution of the publications, the most cited publications, the most important authors, the most impact journals, the most influential institutions, and the most outstanding countries in the platform research field. In addition, this section also provides the results of scientific maps. In order to gain an overall perspective of developments in research on platform, we perform the co-citation analysis of references, and authors, journals and their clusters respectively; in order to illustrate the related term in platform research.

A. Performance Analysis

1) Descriptive statistics

Through searching and screening, we finally obtained 604 articles and 15 reviews (as we focused on exploring on the intellectual framework of platform research field, we limited publications in article and review categories). The sample in this study were comprised of a total of 619 publications by 741 authors affiliated with 713 institutions in 57 countries, which were published in 228 journals and referred 13,638 references (see "Table I").

TABLE I. DESCRIPTIVE STATISTICS OF THE DATABASE

Criteria	Quantity
Publications	619
Authors	1368
Journals	228
Institutions	713
Countries	57
Cited reference	13638

2) Distribution of publications

"Fig. 1" shows the chronological distribution of publications in the platform area. The first traceable article was published in 1978, and from then on, the number of publications is on the rise. The growth trend can be divided into three stages. The first stage is from 1978 to 1992, when just one or two articles are published each year, which shows it is embryonic stage. In the subsequent stage, the number of papers produced from 1994 to 2009 reaches more than quadruple of the previous stage, indicating the seedtime timeline. Within the last stage, from 2010 to 2018 , publications meet a considerable increase, which represent blossom in this period.

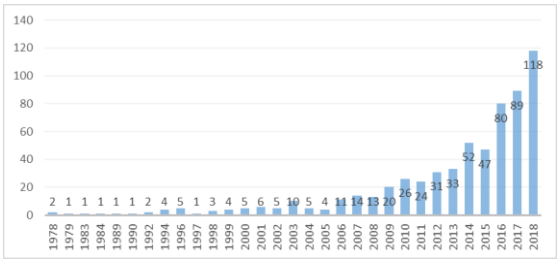

Fig. 1. Distribution of publications.

3) Most cited publications

This study uncovers the most cited publications in WoS. The sample presents an average citation rate of 22 citations. However, 15.76% of the documents have never been cited, and 49.04% have been cited between one and ten times. We show publications which have been cited over 100 times. (See "Table II")

The first most cited article *Platform Competition in Two-sided Markets* [5], accounting for 956 citations, establishes a platform competition model within two-sided markets, and further analysis the determinants of price allocation and end-user surplus for the two governance structures: for-profit platforms and not-for-profit platforms. The second most cited article *Planning for Product Platforms* [31] focuses on the product platform. Robertson and Ulrich discuss the four fundamentals of product platform planning: components, processes, knowledge and people and relationships, and advocates a loosely structured platform planning process which focus on the product plan, the differentiation plan and the commonality plan [31]. The third most cited article *Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases* [32] introduces a platform approach into the regional advantage constructing issue. By bringing together three notions (related variety, knowledge bases and policy platforms), this study constructs a regional innovation policy model, and implies that the three notions can jointly facilitate economic development within and between regions.

TABLE II. MOST CITED PUBLICATIONS IN THE PLATFORM RESEARCH FIELD

Rank	Title	Journal	Year	Citations count
1	Platform competition in two-sided markets	Journal of The European Economic Association	2003	956
2	Planning for product platforms	Sloan Management Review	1998	439
3	Constructing regional advantage: Platform policies based on related variety and differentiated knowledge bases	Regional Studies	2011	410
4	Internal and external integration for product development: The contingency effects of uncertainty, equivocality, and platform strategy	Decision Sciences	2005	358
5	How open is open enough? Melding proprietary and open source platform strategies	Research Policy	2003	288
6	The assimilation of knowledge platforms in organizations: An empirical investigation	Organization Science	2001	266
7	Crowd-funding: Transforming customers into investors through innovative service platforms	Journal of Service Management	2011	226
8	Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics	Information Systems Research	2010	212
9	Industry platforms and ecosystem innovation	Journal of Product Innovation Management	2014	204
10	Export-platform foreign direct investment	Journal of the European Economic Association	2007	199
11	Technological platforms and diversification	Organization Science	1996	195
12	Electronic word of mouth (eWOM): How eWOM platforms influence consumer product judgement	International Journal of Advertising	2009	194
13	Real options and IT platform adoption: Implications for theory and practice	Information Systems Research	2004	176
14	The platform organization: Recombining strategies, structures, and surprises	Organization Science	1996	174
15	Open platform strategies and innovation: Granting access vs. devolving control	Management Science	2010	159
16	Options thinking and platform investments: Investing in opportunity	California Management Review	1994	159
17	Bridging differing perspectives on technological platforms: Toward an integrative framework	Research Policy	2014	155
18	Appropriateness and impact of platform-based product development	Management Science	2001	152
19	How companies become platform leaders	MIT Sloan Management Review	2008	149
20	Two-sided competition of proprietary vs. open source technology platforms and the implications for the software industry	Management Science	2006	143

Rank	Title	Journal	Year	Citations count
21	Platform owner entry and innovation in complementary markets: Evidence from Intel	Journal of Economics & Management Strategy	2007	142
22	Options analysis of software platform decisions: A case study	MIS Quarterly	2000	142
23	A price theory of multi-sided platforms	American Economic Review	2010	140
24	Co-creation of value in a platform ecosystem: The case of enterprise software	MIS Quarterly	2012	135
25	Platform investments and volatile exchange rates: Direct investment in the US by Japanese electronic companies	Review of Economics and Statistics	1996	127
26	Platform envelopment	Strategic Management Journal	2011	124
27	The elements of platform leadership	MIT Sloan Management Review	2002	121
28	Competitive dynamics: Themes, trends, and a prospective research platform	The Academy of Management Annals	2012	112
29	Perspective: Creating a platform ‐ based approach for developing new services	Journal of Product Innovation Management	2001	111
30	Entry into platform ‐ based markets	Strategic Management Journal	2012	108
31	Platform-driven development of product families: Linking theory with practice	Journal of Product Innovation Management	2003	103

4) Most important authors

About 90.21% of the authors in the sample have published one paper, and 3.07% of the authors have produced three of more documents. Hence, we analysis the authors who have published three or more papers. Furthermore, considered to the impact of the author, we choose the author whose paper have been cited over 50 times.

According to the result shows in "Table III", with 160.67 citations per publication, Bruce Kogut becomes the most important author. The subsequent authors are Michael Cusumano, Annabelle Gawer, Joel West, Marc Meyer. Nevertheless, the top five authors who publish more are Andrei Hagiu, Annabelle Gawer, Marc Meyer, Amrit Tiwana, Carmelo Cennamo. That means Andrei Hagiu published the most with 9 papers. In consequence, Annabelle Gawer and Marc Meyer are authors who are more productive and influential.

TABLE III. MOST IMPORTANT AUTHORS IN THE PLATFORM RESEARCH FIELD

Rank	Authors	Publication	Citations	Average citation/publication
1	Kogut, B	3	482	160.67
2	Cusumano, M. A	4	487	121.75
3	Gawer, A	8	865	108.13
4	West, J	3	313	104.33
5	Meyer, M. H	5	323	64.6
6	Huang, P	3	171	57
7	Wu, D. J	3	171	57
8	Parker, G	3	150	50
9	Van Alstyne, M	3	150	50
10	Tiwana, A	5	248	49.6
11	Maffatto, M	3	146	48.67
12	Hagiu, A	9	388	43.11
13	Peitz, M	3	92	30.67
14	Huang, G. Q	3	82	27.33
15	Wright, J	3	71	23.67
16	Chen, J	3	70	23.33
17	Zhang, C	3	70	23.33
18	Evans, D. S	4	81	20.25
19	Cennamo, C	4	77	19.25
20	Belleflamme, P	3	51	17
21	Schmalensee, R	3	50	16.67

5) Most impacted journals

Three or more articles have been published by 33.18% of journals, and four or more articles have been published by 23.58% of journals. Hence, we choose journals which have four or more articles. Furthermore, considered to the effect of journals, the following analysis includes journals with at least 50 citations (as shown in "Table IV").

According to the "average citation per publication" indicator, Organization Science is the most impact journal (160 citation per publication), followed by Regional Studies (121.5 citations per publication), Decision Sciences (99.25 citations per publication), MIT Sloan Management Review (84 citations per publication) and Research Policy (80.83 citations per publication). In the contrary, the top five

journals with more publications are Information Systems Research (23 publications), the Journal of Product Innovation Management (15 publications), International Journal of Industrial Organization (13 publications), International Journal of Technology Management (13 publications), MIS Quarterly (13 publications).

TABLE IV. MOST IMPACT JOURNALS IN THE PLATFORM RESEARCH FIELD

Rank	Journal	Publications	Citations	Average citation/publication
1	Organization Science	4	640	160
2	Regional Studies	4	486	121.5
3	Decision Sciences	4	397	99.25
4	MIT Sloan Management Review	4	336	84
5	Research Policy	6	485	80.83
6	Strategic Management Journal	5	365	73
7	Journal of Product Innovation Management	15	749	49.93
8	Management Science	12	552	46
9	American Economic Review	8	319	39.88
10	California Management Review	6	234	39
11	Journal of Marketing Research	4	127	31.75
12	Journal of Public Economics	4	121	30.25
13	MIS Quarterly	13	365	28.08
14	Research Technology Management	5	129	25.8
15	Harvard Business Review	4	101	25.25
16	Information Economics and Policy	5	126	25.2
17	Information Systems Research	23	562	24.43
18	Journal of Economics & Management Strategy	12	285	23.75
19	Journal of Management Information Systems	11	884	21.56
20	Tourism Management	4	83	20.75
21	Technovation	7	131	18.71
22	Industrial Marketing Management	4	70	17.5
23	Electronic Commerce Research and Applications	9	154	17.11
24	International Journal of Operations Production Management	5	79	15.8
25	IEEE Transactions on Engineering Management	8	110	13.75
26	International Journal of Electronic Commerce	8	106	13.25
27	European Journal of Operational Research	6	79	13.17
28	Electronic Markets	5	65	13
29	International Journal of Industrial Organization	13	152	11.69
30	Journal of Information Technology	9	98	10.89
31	Public Choice	6	63	10.5
32	Journal of Business Research	8	82	10.25
33	Journal of Industrial Economics	5	50	10
34	Journal of Marketing	5	50	10
35	Journal of The Operational Research Society	5	50	10
36	Journal of Advertising Research	9	81	9
37	Infornation & Managemetn	8	70	8.75
38	International Journal of Technology Management	13	110	8.46
39	Technological Forecasting and Social Change	9	71	7.89
40	Journal of Competition Law Economics	7	54	7.71

6) Most influential institutions

In the sample, 83.87% of institutions have published one or two articles, and 90.88% of institutions have produced one to three articles. Therefore, we choose at least four publications and 50 citations as criteria to extract the most influential institutions in the platform field (as shown in "Table V").

The University of Pennsylvania in the United States is ranked 1 in the platform area (121.25 citations per publication). The subsequent institutions are Imperial College London (The United Kingdom) and Bocconi University (Italy), with the 95.11 and 56.67 citations per publication respectively. Institutions with the more publications are Harvard University (The United States), MIT (The United States) and Tsinghua University (China) with 19, 14 and 13 publications respectively.

TABLE V. MOST INFLUENTIAL INSTITUTIONS IN THE PLATFORM RESEARCH FIELD

Rank	Institution	Country	Publications	Citations	Average citation/publication
1	University of Pennsylvania	The United States	8	970	121.25
2	Imperial College London	The United Kingdom	9	856	95.11
3	Bocconi University	Italy	6	340	56.67
4	University of Padua	Italy	4	224	56
5	Massachusetts Institute of Technology (MIT)	The United States	14	756	54
6	Michigan State University	The United States	5	270	54
7	Eindhoven University of Technology	Netherlands	4	182	45.5
8	Northeastern University	The United States	6	271	45.17
9	University of Georgia	The United States	6	268	44.67
10	Tulane University	The United States	4	176	44
11	The University of Maryland	The United States	11	481	43.73
12	University of Illinois	The United States	5	214	42.8
13	Korea University	Korea	4	168	42
14	Boston University	The United States	10	400	40
15	Harvard University	The United States	19	743	39.11
16	Georgia Institute of Technology	The United States	6	224	37.33
17	INSEAD	France	5	171	34.2
18	New York University	The United States	11	324	29.45
19	The University of Hong Kong	China	4	116	29
20	University of Groningen	Netherlands	6	140	23.33
21	Northwestern University	The United States	5	116	23.2
22	Tampere University of Technology	Finland	4	90	22.5
23	Linkoping University	Sweden	4	82	20.5
24	University of Oxford	The United Kingdom	5	102	20.4
25	University of Cambridge	The United Kingdom	5	99	19.8
26	Stanford University	The United States	7	136	19.43
27	The University of Chicago	The United States	5	96	19.2
28	University College London	The United Kingdom	6	108	18
29	National University Singapore	Singapore	12	203	16.92
30	University of Toronto	The United States	4	65	16.25
31	The University of Auckland	New Zealand	5	81	16.2
32	University of Missouri	The United States	4	63	15.75
33	University Mannheim	Germany	7	101	14.43
34	Erasmus University Rotterdam	Netherlands	5	70	14
35	Stockholm School of Economics	Sweden	4	44	13.75
36	Catholic University of Leuven	Belgium	5	67	13.4
37	Fudan University	China	7	91	13
38	City University of Hong Kong	China	5	61	12.2
39	Delft University of Technology	Netherlands	6	70	11.67
40	Aalto University	Finland	7	61	8.71
41	Tsinghua University	China	13	76	5.85

7) Most outstanding countries

75.44% of the countries have published less than 20 papers, and 73.68% of countries possess less than 300 citations. Hence, we choose countries which have over 20 publications and 300 citations.

From the data shows in "Table VI", the United States is the most impact country in the platform area (31.34 citations per publication). France and Sweden are ranked two and three with 43.61 and 37.75 citations per publication, respectively. Countries with the most publications are the United States, the United Kingdom and France. Therefore, we can find that, the United States and France are the two countries with both more publications and more citations within platform.

TABLE VI. MOST OUTSTANDING COUNTRIES IN THE PLATFORM RESEARCH FIELD

Rank	Country	Publications	Citations	Average citation per publication
1	France	41	1788	43.61
2	Sweden	24	906	37.75
3	Netherlands	31	986	31.81
4	The United States	247	7742	31.34
5	The United Kingdom	75	2172	28.96
6	Italy	31	748	24.13
7	Australia	21	397	18.90
8	Finland	23	383	16.65
9	Canada	23	326	14.17
10	South Korea	25	308	12.32
11	Spain	31	353	11.39
12	Germany	46	516	11.22
13	China	64	514	8.03

B. *Scientific Maps*

1) Map of cited references

The original sample was reduced from 619 publications to 75 publications with at least 15 times. On the basis of these 75 most- cited references, this study built the network within the platform research field by co-citation analysis. Results show the 75 references are divided into four clusters, each color stands for a cluster (See "Fig. 2").

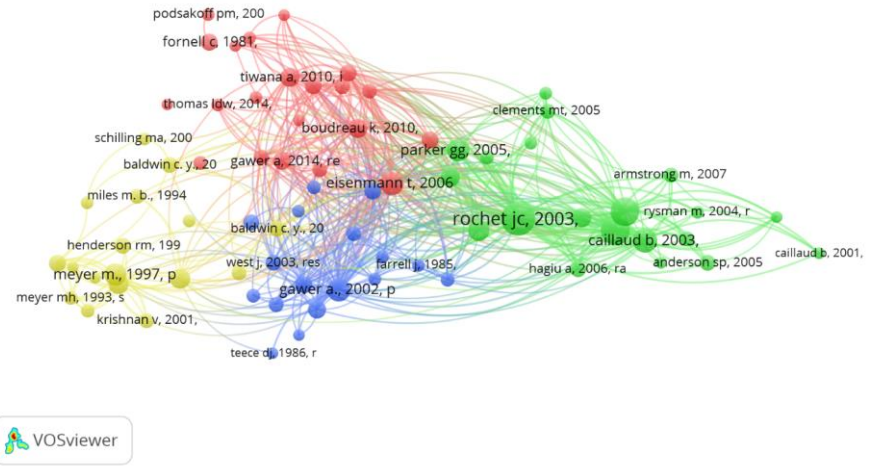

Fig. 2. Co-citation of cited references.

The first cluster relates platform to the innovation and change issues. Adner and Kapoor identify that external innovation change will influence the firms' outcome within the platform [34]. Boudreau explores the relationship between different open platform strategies and the rate of innovation change [4].

The second cluster seek to explore the industry-wide platform, studies from Rochet, Armstrong and Weyl reveal network effect of multi-sided markets from economic perspective. Rochet and Tirole establishes a platform competition model within two-sided markets on the basis of network externality [5]. Armstrong and Wright analyses two-sided markets when competition exists between two platforms, they introduce "competitive bottlenecks" into the two-sided markets framework [35].

The third part of the cluster analysis relates to open thinking on the platform. West explores the proper strategy for platform, by analyzing the hardware and software company [36]. Chesbrough, Vanhaverbeke and West define open innovation as a paradigm which firm could and should use both internal and external ideas, and internal and external paths to market, and finally advance their technology [2].

Cluster 4 involves research on the product platform topic. Meyer and Lehnerd define the product platform as a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produce [8]. Robertson and Ulrich emphasize the importance of planning the product platform for enterprise, and discuss the four fundamentals of product platform planning: components, processes, knowledge and people and relationships, and advocates a loosely structured platform planning process which focus on the product plan, the differentiation plan and the commonality plan [31]. (See "Table VII")

TABLE VII. CLUSTERS RESULTING FROM THE MOST-CITED REFERENCES (PARENTHESIS IS THE NUMBER OF CITATIONS)

Cluster 1 – Innovation and change (521)	Cluster 2 - Network effect of multi-sides markets (769)
Eisenmann et al., 2006 (59)	**Rochet & Tirole, 2003 (117)**
Boudreau, 2010 (39)	**Armstrong, 2006 (86)**
Tiwana et al., 2010 (38)	**Rochet & Tirole, 2006 (84)**
Gawer, 2014 (33)	Caillaud & Jullien, 2003 (63)
Boudreau, 2012 (30)	**Parker & Van Alstyne, 2005 (53)**
Fornell & Larcker, 1981 (30)	**Katz & Shapiro, 1985 (49)**
Ceccagnoli et al., 2012 (29)	**Katz & Shapiro, 1994 (39)**
Gawer & Cusumano, 2013 (25)	**Rysman, 2009 (37)**
Adner & Kapoor, 2010 (24)	Anderson, 2005 (26)
Cennamo & Santalo, 2013 (22)	**Hagiu, 2006 (26)**
Parker et al., 2016 (22)	**Clements & Ohashi, 2005 (25)**
Zhu & Iansiti, 2012 (20)	**Armstrong & Wright, 2007 (23)**
Barney, 1991 (19)	**Weyl, 2010 (22)**
Ghazawneh & Henfridsson, 2013 (18)	Evans, 2003 (20)
Thomas, 2014 (18)	**Corts & Lederman, 2009 (18)**
Boudreau, 2009 (17)	Nair, 2004 (18)
Podsakoff et al., 2003 (17)	Rysman, 2004 (18)
Yoo et al., 2010 (16)	Caillaud & Jullien, 2001 (15)
March, 1991 (15)	**Hagiu, 2009 (15)**
Shapiro, 1999 (15)	**Kaiser & Wright, 2006 (15)**
Wareham et al., 2014 (15)	
Cluster 3 – Different types of innovation on the platform (390)	Cluster 4 - Product platform (442)
Gawer & Cusumano, 2002 (57)	**Meyer & Lehnerd, 1997 (50)**
Gawer & Cusumano, 2008 (33)	Eisenhardt, 1989 (43)
Eisenmann et al., 2011 (31)	**Robertson & Ulrich, 1998 (42)**
Gawer & Henderson, 2007 (30)	Ulrich, 1995 (32)
West, 2003 (27)	**Baldwin & Woodard, 2009 (28)**
Bresnahan&Greenstein, 1999 (25)	Baldwin & Clark, 2000 (27)
Chesbrough et al., 2006 (26)	**Henderson & Clark, 1990 (26)**
Evans, 2006 (23)	Miles et al., 1994 (24)
Economides & Katsamakas, 2006 (21)	Krishnan & Ulrich, 2001 (23)
Iansiti & Levien, 2004 (21)	**Cusumano & Gawer, 2002 (22)**
Shapiro et al., 1998 (19)	Meyer, 1993 (21)
Von Hippel, 2005 (18)	**Sawhney, 1998 (21)**
Eisenmann et al., 2009 (17)	**Gawer, 2009 (17)**
Farrel& Saloner, 1985(17)	Sanchez & Mahoney, 1996 (17)
Katz & Shapiro, 1986 (17)	Schilling, 2000 (17)
Teece, 1986 (16)	Baldwin & Clark, 1997 (16)
Jacobides et al., 2006 (15)	Meyer et al., 1997 (16)

2) Map of most cited authors

With the minimum 40 citations, the sample was declined to a new sample which contains 40 authors, and has 3078 citations in total. This study portrayed the map of the 40 authors consisting of four clusters by co-citation analysis of authors (See "Fig. 3").

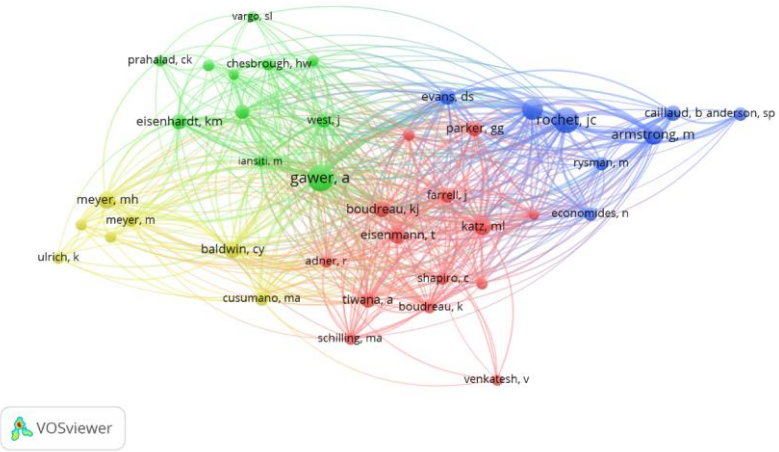

Fig. 3. Co-citation of cited authors.

Cluster 1 contains authors from strategic management (e.g. Ron Ander, Kevin Boudreau, Annabelle Gawer), economics (e.g. Joseph von R Farrell), political economy (e.g. Michael Katz), technology standards and modularity (e.g. Melissa Schilling), platform ecosystems (Amrit Tiwana).

Cluster 2 encompasses authors from technological innovation (e.g. David Teece), open innovation (e.g. Eric von Hippel, Henry Chesbrough), strategic management (e.g. Joel West), which drew on other theory and method, such as the competitive advantage theory (e.g. Michael Porter) and case study method (e.g. Kathleen Eisenhardt).

Cluster 3 includes two-sided markets (e.g. Mark Armstrong, Jean-Charles Rochet), pricing theory (e.g. Bernard Caillaud, Andrei Hagiu), networks (e.g. Nicholas Economides), most of whom study on economic quantity relationships by constructing economic mathematical model.

Cluster 4 has the least authors with the lowest number of citations in total (469). Nevertheless, this cluster also includes studies from various fields, like modularity (e.g. Carliss Baldwin), leadership (e.g. Michael Cusumano), product platform (e.g. Marc Meyer, David Robertson).

3) Map of most cited journals

By employing the threshold at 120 citations, we got a set of 36 journals that are used for co-citation analysis of cited journals, and finally gained a network consists of management, economics, marketing and information system four clusters (See "Fig. 4").

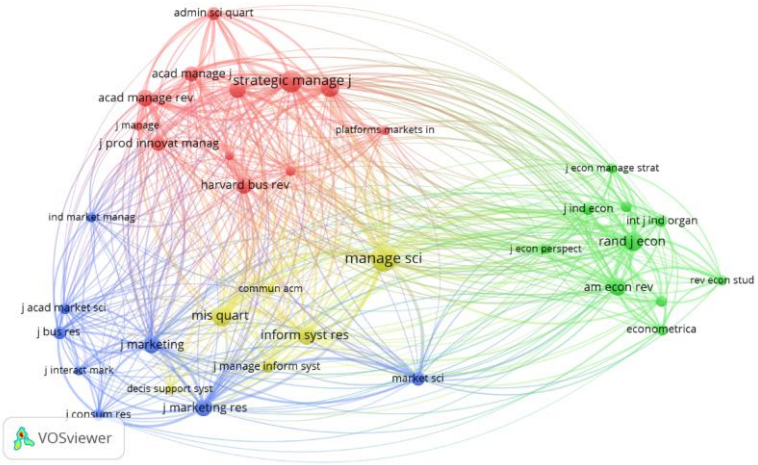

Fig. 4. Co-citation of cited journals.

The management cluster contains journals concentrating on strategic management (*Strategic Management Journal*), management practice (*Harvard Business Review*) and theoretic and empirical researchers on management (*Journal of Management, Academy of Management Review, Academy of Management Journal*).

The economics cluster basically includes journals that accept microeconomics which focus on the organization level (*RAND Journal of Economics, Journal of Economics & Management Strategy*), econometrics (*Econometrica*) and industrial economics focusing on the industry level (*International Journal of Industrial Organization*).

The marketing cluster encompasses journals that focus on consumer behavior (*Journal of Consumer Research*), marketing research practice and marketing theory (*Journal of Marketing Research*) and electronic, interactive and direct marketing environments (*Journal of Interactive Marketing*).

The information system cluster is an emerging field which is more relevant with platform research that other clusters. This cluster involves journals which publish study on platform (Information System Research), information technology (*Decision Support Systems*) and ecosystem (*MIS Quarterly*).

IV. Conclusion

This study achieves some insights from the literature review and summarizes the existing studies. By employing the performance analysis which obtained on WoS, this study identified the most cited articles, the most important authors, the most impact journals, the most influential institutions and the most outstanding countries in the field of platform. This study identified the most cited publications by counting the number of citations. The first most cited article "Platform competition in two-sided markets", which was written by Rochet and Tirole. As with the most important authors, this study uses two indicators to identify: Hagiu is the most productive author who published nine articles, while Kogut is the most influential author with the highest average citation per publication.

The journal that published the most articles is Information Systems Research, which suggests that this journal is more interesting in the platform topic. The journal with the highest citation per publication is Organization Science, which represent the most impact status in the platform research field. The countries that published most are the United States, the United Kingdom and France, and

the countries with the highest average citation per publication are France, Sweden and Netherlands.

By scientific maps method, this study illustrates the map of cited references in the platform field, in which four clusters are confirmed. Co-citation analysis of author identified four invisible cliques, among which Annabelle Gawer is the most influential authors who published a series of articles in the platform field, such as platform leadership, industry platform, technological platform, platform entry mode and other relevant topics. The result of journal co-citation analysis highlighted the theory and research on platform was still fragmently distributed in different disciplines, which called for comprehensive and interdisciplinary researches are necessary in the future.

Through bibliometric analyses, this study is helpful for portraying a comprehensive framework of platform research, and enabling future scholars to focus their own studies effectively. However, we have to acknowledge that this study also has limitations. First, the sample in our study is captured in only one database. Although WoS encompass various journals, it could not cover the whole journals on the platform topic. Second, this work uses two types of publications (articles and reviews). Future study can extend data collection to other types of publications, which may provide more insights and latest findings in the platform field. Finally, although the bibliometric analysis by employing specialized software is objective, the following interpretation of the results is somewhat subjective.

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