OPEN INNOVATION: A BIBLIOMETRIC STUDY

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ABSTRACT

"Open Innovation" activities are of crucial importance in the Research and Development (R&D) department, especially for survival among enterprises in the competitive nature. There has been an increasing interest in "Open Innovation". However, the rate of interest has yet to be measured by publications trends. This study aims to demonstrate the trends of "Open Innovation" from 2012 to 2017 and highlight the key-phrases for the selected topic. In this bibliometric study, a total of 3,567 publications were investigated in the SCOPUS database using SciVal platform. The concept of "Open Innovation" has received considerable attentions since 2003, and the highly cited paper was published by Chesbrough. The top 50 key-phrases by relevancy indicated the importance of "Open Innovation" and other emerging research areas, giving a guideline for future research.

Keywords: Bibliometrics; Open innovation; Citations analysis; Top cited papers; Research trends

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INTRODUCTION

Innovation plays a central role in the economic development both regionally and nationally (Nader Ale Ebrahim, Ahmed, & Taha, 2008; Haga, 2005). Research and development (R&D) activities are rigorous especially among industrial players. In order to face the competitive nature, enterprises are obliged to produce more rapidly, effectively and efficiently in development of new product (Nader Ale Ebrahim, Ahmed, & Taha, 2009). Although enterprises have invested heavily in the R&D departments to sustain growth and drive innovation, this model has eroded by the end of 20th century due to a number of factors (H. Chesbrough & Crowther, 2006; H. W. Chesbrough, 2003). The main factor was the dramatic rise in number and mobility of knowledge workers, making it difficult for enterprises to control and retain their proprietary ideas and expertise (H. W. Chesbrough, 2003). As such, the "Open Innovation" model emerged, whereby enterprises recognize that not all good idea will come within the organization, and not all good ideas created within the organizations can be successfully marketed internally (H. Chesbrough & Crowther, 2006). This model has been widely used among industries since the past decade (H. Chesbrough & Crowther, 2006).

Figure 1 illustrates the differences between the closed and open innovation model based on H. W. Chesbrough (2003)'s definitions. In the "Open Innovation" model, an enterprise commercializes both its own ideas as well as innovations from other firms, and seek away to bring its in-house idea to market by developing pathway outside its current businesses (H. W. Chesbrough, 2003).
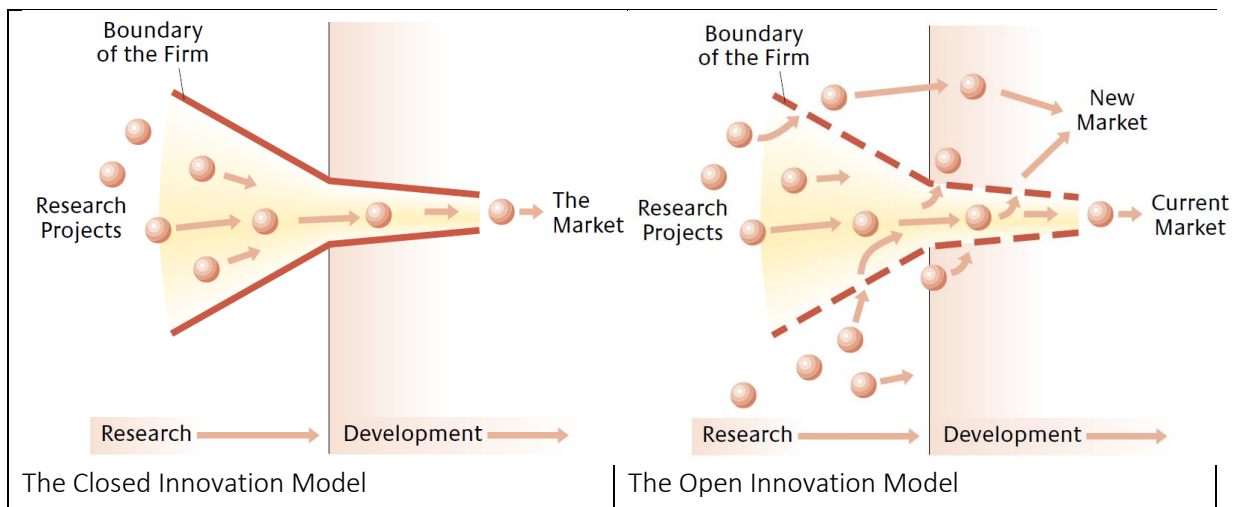

Figure 1 The closed and open innovation model [source: (H. W. Chesbrough, 2003) pages 36 & 37]

Bibliometric is "the study of the quantitative aspects in production, dissemination, and usage of published information" (Jamali, Md Zain, Samsudin, & Ale Ebrahim, 2015; Moed & Glänzel, 2004, p. 343) and is used for publication and citation evaluation in almost all nations and fields of study (Ergul, Ardahan, Temel, & Yildirim, 2010). The idea on quantitative analysis of scholarly output was introduced by Garfield in 1955, and subsequently the concepts of citation and highly cited paper in 1972 came about. Results from a bibliometric analysis may shed some light on factors that strengthen the contributions of a study in the area, thus guiding scholars towards producing more impactful studies (Akhavan, Ale Ebrahim, Fetrati, & Pezeshkan, 2016). Number of papers published and citations received represent two of

the most important indicators for an impactful contribution in such evaluations (Hirsch, 2007; Patterson & Harris, 2009).

Recent bibliometric studies included research productivity (Zyoud, Al-Jabi, & Sweileh, 2015), intellectual link between two different fields (Schulz & Nicolai, 2015), financial growth (Gholizadeh et al., 2014), top cited publications (Rakhshandehroo, Yusof, Ale Ebrahim, Sharghi, & Arabi, 2015), higher education evaluation in a country (Godoy, Zunino, & Mateos, 2015; Kim, Horta, & Jung, 2015), keywords selections effect on citations (Nagaratnam, Ale Ebrahim, & Habibullah, 2016), effect of social media on research impact (Nader Ale Ebrahim et al., 2013; Bong & Ale Ebrahim, 2017b; Haustein, Costas, & Larivière, 2015), international collaborations (Kazakis, 2015; Zhai, Yan, Shibchurn, & Song, 2014), authorship rate (Chow, Ha, & Filippi, 2015), open access effect (Borrego, 2015), impact of article page count and number of authors on citations (Ahmed, Mastura, Ghafar, Muhammad, & Ale Ebrahim, 2016), assessing the impact of funding environments (Zoller, Zimmerling, & Boutellier, 2014), self-citation classification (Yu, Yu, & Wang, 2014), database differences (Aghaei Chadegani et al., 2013; Winter, Zadpoor, & Dodou, 2014), increasing visibility and enhancing impact of research (Nader Ale Ebrahim et al., 2014; Bong & Ale Ebrahim, 2017a) and many more. Scientists and universities around the world are concerned about the number of publications and citations (Farhadi et al., 2013).

As such, our bibliometric analysis on 'Open Innovation" literature will further reveal information about authorship, types of document, keywords and publication trends. Bibliometric data can be extracted from publication databases such as SCOPUS, Web of Science (Thomson Reuter) or even Google Scholar, depending on the limits and objective of the study.

In this paper, the trends of "Open Innovation" were analyzed from 2012 to 2017 to explore further on the key-phrases. Several bibliometric studies have been done on the "Open Innovation" (OI) topic. Randhawa, Wilden, and Hohberger (2016) investigated 321 journal articles in their bibliometric review of open innovation to find the key concepts underpinning OI. In another bibliometric study, the first decade of "Open Innovation" research publications were

investigated based on a topic search on Web of Science database (Kovács, Van Looy, & Cassiman, 2015). The third article (De Paulo, Carvalho, Costa, Lopes, & Galina, 2017) also uncovered 1,925 publications from year 2000 to 2014 in the Web of Science database. The last bibliometric paper (Seguí-Mas, Signes-Pérez, Sarrión-Viñes, & Vidal, 2016) was written in Spanish language and had investigated the relationship between "Open Innovation" and absorptive capacity. To the best of our knowledge, this current study is more comprehensive in comparison with respect of:

1- The number of scholarly outputs is 3,567 publications at the initial stage and 2,406 at the advanced level of investigation;

2- The SCOPUS database which covers over two times of the journal indexed by Web of Science (Aghaei Chadegani et al., 2013) has been selected;

3- A comprehensive publications year from 1996 to 20 June 2017

METHODOLOGY

SciVal platform was used to run article topic search with the keyword "Open Innovation". SciVal, a product which was developed under the Elsevier Research Intelligence, offers a quick and easy access to the research performance of 8,500 research institutions and 220 nations worldwide (Elsevier, 2017).

It enables visualization of SCOPUS database for "Open Innovation". Data was retrieved on 20 June 2017 from University of Malaya access point. The topic search focuses key-phrase within the title, abstract, and author keywords.

As one of the main database, SCOPUS presents the biggest abstract and citation dataset collection with quality web sources (Aghaei Chadegani et al., 2013).

RESULTS AND DISCUSSION

Figure 2 shows the trend of publications on "Open Innovation" from 1996 to date (20 June 2017). There were 3,567 scholarly output retrieved on "Open Innovation" for the selected period.
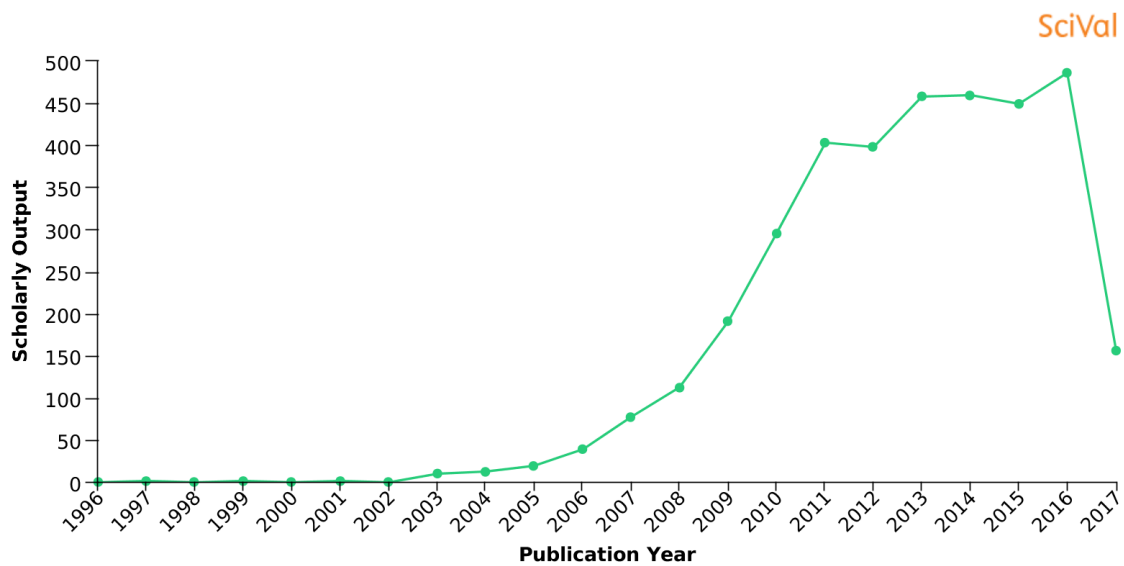
Figure 2 Trend of publications on "Open Innovation"

"Open Innovation" was not much popular from 1996 to 2002, with only three papers published under this title. However, the number of publication on "Open Innovation" increased tremendously from 10 publications in 2003 to 486 publications in 2016.

The first publication which directly refers to "Open Innovation" started in the year 2003. Of all publications, "The era of open innovation" (H. W. Chesbrough, 2003) is the highly cited paper (1,045 citations to date). This particular paper also ranked as the top cited paper.

The second paper in the rank received 561 times citation, published by H. Chesbrough and Crowther (2006). Since 67.47% (2,406) of the total publications on "Open Innovation" were published within the period of 2012-2017, we decided to concentrate on the recent publication trends. For the last five years, 2,406 papers were published, receiving over 100,677 views, 8,427 citations, 518 international collaborations, and 1.25 score for Field-Weighted Citation Impact (FWCI).

The FWCI is a measure of citation impact that normalizes for differences in citation activity by subject field, article type, and publication year (Jang & Kim, 2014). The world's average is indexed at 1.00, such that values above 1.00 indicate above average citation impact. More specifically, a citation impact of 1.25 means 25% above the average citations for "Open Innovation" in the same filed.

Figure 3 shows the top 50 key-phrases by relevance based on 2,406 "Open Innovation" publications in the past five years. The "Open Innovation" phrases is in the heart of most repeated keywords, with a 20.5% growth over the period of 2012-2017. The trends of publications and the top 50 key-phrases are solid proofs of the importance of "Open Innovation" in scholarly publications.

The red color phrases indicated growing popularity in the past five years among publications, while the blue color phrases are less favored. Therefore, "Service Innovation" has declined almost 50.0% over the period of 2012-2017. There is a positive shift from blue color phrases (like "Service Innovation") in Figure 3 towards the red color phrases such as "Open Innovation", a sign that researchers should place more emphasis for the red color phrases in future.

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Figure 3 Top 50 key phrases in "Open Innovation" by relevance in the past five years (analysis based on 2,406 publication).

Table 1 shows the top 10 institutions based on the number of scholarly outputs and Field-Weighted Citation Impact (FWCI). We found that research impact is not based on the number of publications alone, but other factors as well. For instance, Technische Universitat Munchen published the highest number of publications (36 papers) on "Open Innovation" in the past five years as compared to other institutions. However, its Field-Weighted Citation Impact (FWCI) is merely 1.84. By contrast, University of Bath received the highest FWCI of 5.85 with just 7 publications during the same time frame. Therefore, these results suggested that researchers and institutions should not emphasize just the quantity for its outreach validity to get more attention and impact, but the quality of publications too.

Table 1 Top 10 intuitions based on number of publications on the "Open Innovation" and FWCI (2012-2017)

No.	Top 10 institution based on the number of publications	No. of Publications (FWCI)	Top 10 institution based on Field-Weighted Citation Impact	FWCI (No. of Publications)
1	Technische Universitat Munchen	36 (1.84)	University of Bath	5.85 (7)
2	Aalto University	33 (1.74)	Imperial College London	5.73 (12)
3	Lappeenranta University of Technology	32 (1.75)	Universidad Complutense	5.11 (7)
4	Politecnico di Milano	25 (2.15)	Hasselt University	5.06 (15)
5	University of Erlangen-Nuremberg	25 (1.23)	University of Twente	4.99 (8)
6	Delft University of Technology	24 (1.14)	ETH Zurich	4.92 (10)
7	Chalmers University of Technology	21 (1.02)	Universita di Palermo	4.8 (8)
8	National University of Singapore	20 (3.75)	Maastricht University	4.28 (9)
9	Wageningen University & Research	20 (1.95)	ESADE Business School	4.13 (15)
10	Universita di Salerno	19 (1.25)	Copenhagen Business School	4.05 (16)

FWCI = Field-Weighted Citation Impact.

The distribution of top 10 countries based on the number of publications in "Open Innovation" and its relevant Field-Weighted Citation Impact (FWCI) were presented **in Figure 4.** The USA (332) was the most productive country with largest number of publications regardless of international collaborators' participation, followed by Germany (275), United Kingdom (236), Italy (229), Spain (149), China (129), Sweden (125), Finland (101), Netherlands (101), and France (99). Yet, the highest FWCI goes to Argentina (8.23), with only two publications.
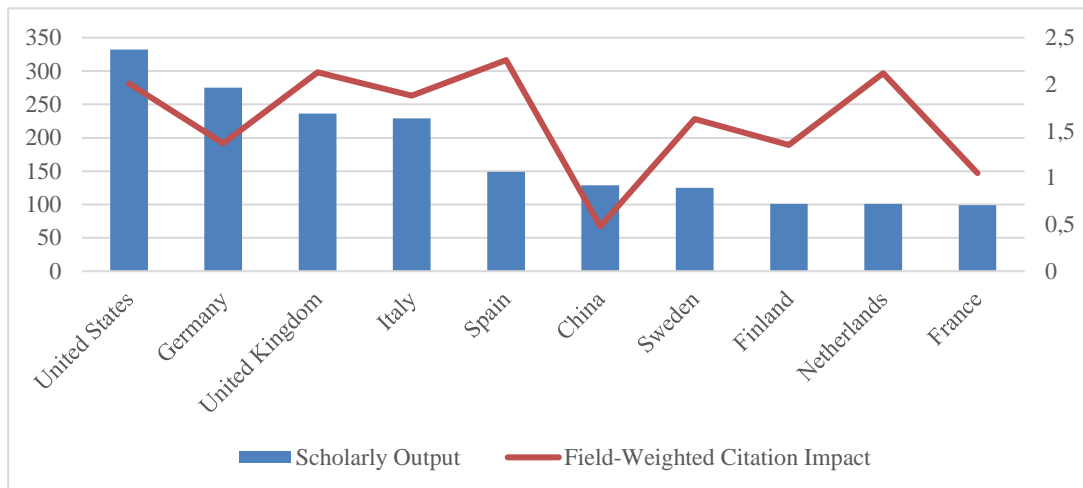

Figure 4 Top 10 countries based on the number of publications in "Open Innovation" and its relevant FWCI (2012-2017).

Figure 5 shows the top 10 journals with the highest number of publication on "Open Innovation" from 2012 to 2017. International Journal of Innovation Management leads in the field and published 40 papers. Recent publications (2,406) can be found in 977 SCOPUS sources, an average of 2.46 article per SCOPUS source. None of the journals can be considered as dominant in the field of "Open Innovation". The top ten journals published 293 (12.2%) articles, giving huge opportunities for new journals to concentrate on the topic of "Open Innovation".
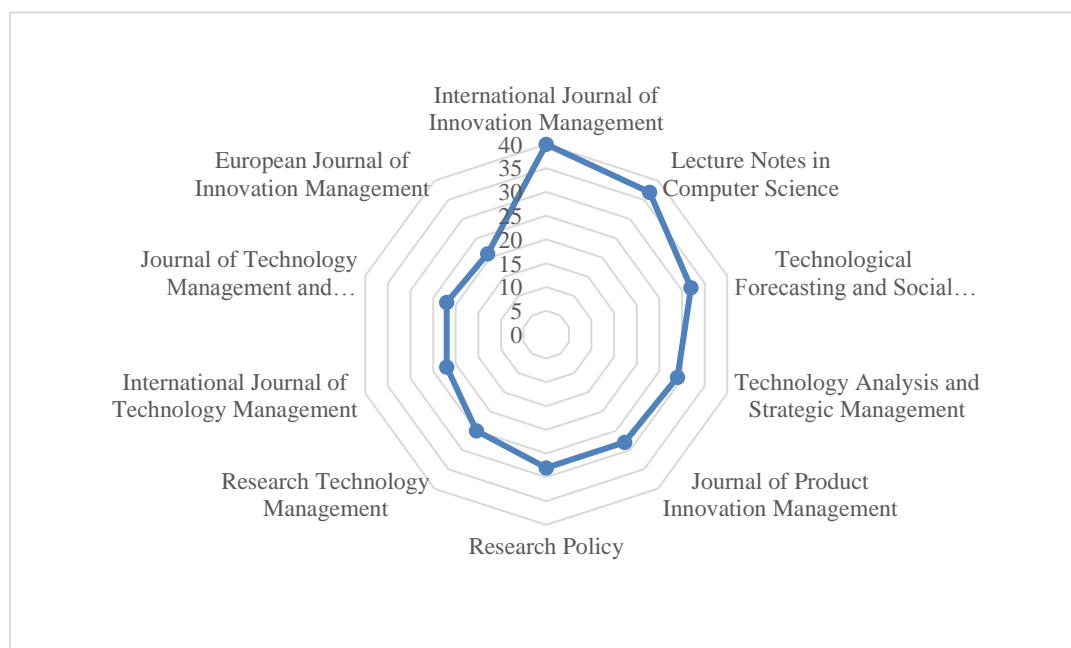

Figure 5 Top 10 journals with highest number of publication in "Open Innovation" from 2012 to 2017.

Besides that, the most productive authors from 2012 to 2017 were listed in Table 2. Vanhaverbeke, Wim received the highest citations for the last five years. The top 10 authors received a total of 602 citations, with a percentage of 7.14% of the accumulated citations within these years. An interesting aspect found in this study is that authors' citations rank are not equal to their number of publications rank. Such differences may be resulted from the publication year or other factor like paper availability (Nader Ale Ebrahim et al., 2013). Researchers should have strategies to increase their research visibility and impact both before and after publications (Bong & Ale Ebrahim, 2017a). In addition, the most common documents source types are journal papers (1,379 publications), followed by conference proceeding (620 publications) and book and book series (404 publications), while others are trade Publications.

Table 2 Top 10 most productive "Open Innovation" authors from 2012 to 2017.

Author	Number of publications	Number of citations	Publication rank	Citation rank
Lazzarotti, Valentina	18	52	1	2
Lindemann, Udo	18	19	1	7
Cammarano, Antonello	17	49	2	3
Caputo, Mauro	17	49	2	3
Lamberti, Emilia	17	49	2	3
Michelino, Francesca	17	49	2	3
Manzini, Raffaella	16	43	3	4
Vanhaverbeke, Wim	15	239	4	1
Pellegrini, Luisa	13	29	5	5
Moeslein, Kathrin M.	12	24	6	6

CONCLUSION

The main goal of the current study was to examine the trends of "Open Innovation" for the past 5 years and determine the key-phrases associated with the research topic. In this papers, we presented the various key-phrases, institutions, authors, journals, countries and sub fields for "Open Innovation" published research and indexed by SCOPUS. Results indicated that the interest in "Open Innovation" research increases steadily. The USA is leading the pack as expected compared to China which is at the 6th position among top 10 countries. Although the USA produced the highest number of publications, its FWCI is not of the top scores. Thus, we believe that both quality and quantity should be taken into consideration for impactful research. This bibliometric analysis uncovers the importance of "Open Innovation" area and its multi-disciplinary applications. The increasing number of publications and citations suggested that "Open Innovation" is gradually becoming a hot topic. In future, researchers should collect more bibliometric information from other scholarly databases such as Web of Science for a more in-depth analysis. On top of that, researchers may perform comparisons analysis of data acquired from multiple scholarly databases.

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