INNOVATION AND DIGITAL SOCIAL NETWORKS: MAPPING PUBLICATIONS USING CO-CITATION ANALYSIS

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Abstract

The present study aims to verify and analyze the leading academic publications related to innovation topics and digital social networks. The research methodology is the co-citation analysis followed by the development of a co-citation map that includes approaches, types of networks and levels of aggregation by these themes. Therefore, this study can promote a better understanding of how the authors studying innovation and digital social networks relate. The research was conducted at Web Of Science and the total of 694 articles, the years 2015 to 2019 were selected. Of these, 26,570 were the references cited by the analyzed papers and the average citations per item were 9.78. Three main clusters were identified with the references of the articles analyzed. These clusters reflects the themes Organizational Knowledge; Social and Relations and Innovation; and Creativity and Social Networks. Future studies on innovation and social networks can use the result of this article to support your choice of authors.

Keywords: Digital social network, Innovation, Co-citation Analysis, Social Media

Resumo

O presente estudo tem como objetivo verificar e analisar as publicações acadêmicas relacionados aos tópicos de inovação e redes sociais digitais. A metodologia de pesquisa é a análise de co-citação seguida pelo desenvolvimento de um mapa de co-citação que inclui as abordagens, tipos de redes e níveis de agregação destes temas. Portanto, este estudo pode promover uma melhor compreensão sobre como os autores que estudam inovação e redes sociais digitais podem se relacionar. A pesquisa foi conduzida na Web Of Science e o total de 694 artigos, nos anos 2015 até 2019 foram selecionados. Com isto, 26,570 referências citadas nos artigos foram analisadas e a média de citação por item foi de 9.78. Três clusters principais foram identificados com a análise das referências dos artigos. Esses clusters refletem os temas Conhecimento Organizacional; Social e Relações e Inovação; e Criatividade e Redes Sociais. Estudos futuros sobre inovação e redes sociais podem usar o resultado deste artigo para embasar sua escolha de autores.

Palavras-chave: Redes sociais digitais, Inovação, Análise de Co-citação, Redes sociais

1 Introduction

Social networks exist everywhere, formed by actors (typically individuals) groups, and companies, which share the same values and goals (Mascia et al. 2015; Ciribeli and Paiva 2011). Social media is commonly misinterpreting as social networks. Although they can be both in the digital universe, social media are the means that a social network can communicate, interconnected through social ties or links (Ciribeli and Paiva 2011). However, the connections produced by social media are called digital social networks, represented by actors and their relationships (Recuero 2009).

Historically, digital social networks present an essential role in innovation, creativity, and development of new ideas and concepts (Mascia et al. 2015). At the same time, social media can provide a quick expansion of social networks, in the ways that individuals have access to contents that were not attainable before (Richey et al. 2016).

In order for individuals to be able to develop new ideas and concepts, they must have the ability to use information and communication technologies. In this perspective, it is noticed that digital literacy consists of the ability to make judgments about contents available on the Internet, as well as juxtaposing the different knowledge, from different sources and formats, to produce reliable information, as well as know how to search and maintain the constant research of updated information (Martin 2008; Gilster 1997). Thus, if a social actor has critical communication capacity, he knows how to use information and communication technologies without support for innovations (Martin 2008). Through the continuous process of internalization of conceptual, attitudinal and abilities necessary for understanding and integrate with the informational universe (Martin 2008; Gilster 1997). In this way, it is understood that it is through the levels of digital literacy that digital knowledge is glimpsed in the process of development of creativity and technological innovations (Gilster 1997).

Besides that, social media platforms can provide resources that facilitate innovation, because of the possibility of creating fast connections and the development of new ideas (Richey et al. 2016; Harris et al. 2012). That occurs because digital social networks can provide an atmosphere where the actors can seek suggestions, ideas, opinions, and other actors. In recent years, many studies have been conducted to recognize aspects of innovation on digital social networks

in several areas and disciplines. Some studies analyze the connections on social media that are crucial to the innovation process (Richey et al. 2016), explore the use of social networks for the development of open innovation (Hitchen et al. 2017), identify ways that relations online can provide benefits for companies (Tsimonis and Dimitriadis 2014), investigate the ability to use information provided by social media as a source of information (Mascia et al. 2015), and examine relationships between drivers of customers co-creation innovation on social media context (Sarmah et al. 2018). These studies make clear the diversity present in this research field.

Consequently, a bibliometric analysis can provide insights into the growth of literature and the flow of knowledge within this specific field by mapping the citation network and the understanding of how innovation occurs in digital social networks. This study aims to present a map of co-citation that represents approaches, types of networks and aggregation levels related to aspects of innovation and digital social networks. The objetive of this study is to analyze the principal perspectives involving innovation a social networks.

Besides, this objective is developed through co-citation analysis, which is a type of similarity-based network, in other words, a technique to analyze the similarity and frequency that indicate when two authors are cited together by one group of recent studies (Yang and Ding 2012; Qiu, et al. 2014). Thus, the results of this study can provide a better understanding of authors' networks and contribute to the understanding of innovation and social networks.

2 Theoretical Framework

Social networks are composed of a set of autonomous participants (also called actors), who unite ideas, resources encompassing shared values and interests (Marteleto 2001). It can be considered one of the strategies of the society for the sharing of information and knowledge through the relations between the actors that integrate them (Tomaél et al. 2005). In a social network, each one of the individuals has its cultural function and identity, as well as the relationships with the other members of the network, which are presented in a cohesive way (Tomaél et al. 2005). According to Capra (2002), social functions and processes in the information age (in which we live) are organized more and more around networks.

There are several ways to access social networks. They can occur through personal contact, the telephone or, as is currently highlighted, via the internet (Ciribeli and Paiva 2011). The success of the use of this mean is through the freedom of expression, reality, and reliability of the contents that are shared there, except for personal safety precautions (Ciribeli and Paiva 2011).

Social networks must also be differentiated from the digital means that support them. Social media is one of the digital means by which communities connect. In social media, individuals talk about personal issues, although there is also a legion of consumers exchanging views on products and services (Ciribeli and Paiva 2011). Most of this information is shared on a voluntary basis, which generates trust with other network friends. In addition to the information exchanged by friends, there are those that are provided to companies and relate to the user's personal experience (Ciribeli and Paiva 2011; Richey et al. 2016). Tsimonis and Dimitriadis (2014) highlight that companies seek social media for benefits and valuable results. These involve mainly improving the relationship with the consumer, engagement, implementation of marketing actions and brand power (Tsimonis, and Dimitriadis 2014).

It is the companies understanding that the use of social media can help strengthen the brand and gain more customers (Ciribeli and Paiva 2011). However, the way in which the company generates information and develops an innovation is still a challenge (Richey et al. 2016). In an era of intense competition, technological complexity, and institutional instability, companies are willing to pursue competitive advantage through innovation (Mascia et al. 2015). The fact that social networks are made up of individuals is necessary, and they also play an essential role in the innovation process (Martin 2008).

These innovations can be represented in different ways, the Oslo Manual (OCDE/EUROSTAT, 2005) classifies as a product, process, marketing innovation, among others. The changes brought about by innovation processes can be defined in two axes: incremental innovation and radical innovation (Tidd et al. 2008).

Together, innovation and social networks are previously analyzed. Valente (1996), emphasized that social network was the pattern of friendship, communication, advice and support of the members of the social system. When used by companies, these elements are correlated to the innovativeness (Valente 1996).

Van Der Valk and Gijbers (2010) analyzed the use of social networks in innovation studies and appoint three research themes related to innovations: networks of collaboration; communication networks; and networks of technology. Perry-Smith and Mannucci (2017), affirms that social networks can be used as a lens through understand the effect of social context on creativity.

Gubbins and Dooley (2014) emphasized that a distance across a social network enables the organization to challenge their existing models and assumptions and generate new knowledge, the basis for creativity that offers potential for future innovation. The digital social network represents a revolution that can develop open innovation that is changing in companies (Degen 2009).

These studies demonstrate the importance of social networks in the development of innovations. Nevertheless, the search to identify whether these themes are still being studied and whether there is an academic domain over the main authors and theoretical field has induced this study to use the co-citation method, explained in the next section.

3 Method

The author's co-citation analysis (ACA) was used in this study, it is a bibliometric technique that concedes the understanding and grouping of the current dominant academic thinking and is used to map the theoretical field involving the themes of innovation and digital social networks. ACA assumes that the bibliographic references of a study represent the influences, theoretical and empirical foundations of a study (Ramos-Rodriguez and Ruiz-Navarro 2004).

This method assumes that the documents cited together embarrass the same type of intellectual affinity (Holman et al. 2018). The co-cited documents are presented on a network map that demonstrates the relationship of ideas across the field (Holman et al. 2018).

The selection of articles was made through the Web of Science database in September 2020. The article search strategy included topic (keyword, title and abstract) with the terms "innovation" and "social networks", using quotation marks to look for the exact expression. Only

journals articles in English were selected and the conference papers, books, chapters of book and reviews were excluded.

Since there is a concern about changes over time, in the first search carried out, the years were not specified, therefore, from the first studies that encompassed the two terms to the most current, they were used as a way to identify whether there was a growth in publications. It was identified that since 2011 there has been a steady growth in published articles. Therefore, the selection for this study covered the last five full years of publication. This means that since the publications of 2020 are not fully finalized, the years 2015 to 2019 were selected for this study.

The total of 875 articles was initially identified. However, many of these articles were not in the field of social studies. Therefore, a selection was made for the following study areas on Web Of Science: Business Economics, Computer Science, Science Technology, Engineering, Information Science, Public Administration, Social Science, Educational Research, Communication, Development, Telecommunications, Mathematics, Operations, Areas Studies, Philosophy of Science, Social Work, Social Issues, International Relations And Cultural Studies, by doing so, all articles related to psychology, medicine and ecology where eliminated. The total of 694 documentes were identified as eligible for the analysis.

To the initial data statistics Excell software was used to map the principal authors, journals and articles. The software VOSviewer was used to map co-citation patterns and clusters. Recent exemple of uses VOSviewer in co-citation analysis can be found in Leung et al. (2017), Hota et al. (2019) Meng et al. (2020) and Ding (2020). In this study, the author's co-citation analysis (ACA) was applied, which means that the authors cited in 694 were related to map the intellectual affinity between them.

4 Results

This section will first present the initial analysis of the data, which shows the main documents, authors, journals. Then, the co-citation analysis of the authors will discuss the clusters identified by the proximity of their use together.

4.1 Citation Analysis

The Initial Data Statistics is evidenced to present where is the researchers that most influence research field that studies innovation and social networks. Table 1 shows the geographical locations of the organization of the ten authors that contribute most to the literature of innovation and social networks. There were 64 different countries found, indicating that these topics were considered important worldwide, although the United States, England, and China holds the most significant amount of articles and citations in this research field.

It was verified that the 371 journals contributed to the publication of the 694 articles. The ten journals with more articles on the subject, together add 117 articles. The results are presented in Table 1.

Table 1 - Top Ten Cited Journals

JOURNAL	DOCUMENTS	% of 875
SUSTAINABILITY	33	4,775%
RESEARCH POLICY	16	2,305%
JOURNAL OF KNOWLEDGE MANAGEMENT	12	1,729%
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	11	1,585%
SMALL BUSINESS ECONOMICS	9	1,297%
STRATEGIC MANAGEMENT JOURNAL	8	1,153%
JOURNAL OF BUSINESS RESEARCH	7	1,009%
JOURNAL OF PRODUCT INNOVATION MANAGE-MENT	7	1,009%
ORGANIZATION SCIENCE	7	1,009%
SCIENTOMETRICS	7	1,009%

Source: Research data

When analyzing Table 1, it is possible to verify that even the ten journals with the most publications add up to only 16.88% of the total articles. This means that there is no standardization among the journals used.

Citation analysis is used to examine the degree to which peers are connected among the 694 authors of the identified articles, this sum includes only the principal authors. About 84% of these articles have been cited at least one time. Table 2 describes the ten articles most cited over the five years collected, as expected the articles of the first years obtained more citations.

Table 2 - Top Ten Most Cited Articles

AUTHORS	YEAR	CITATIONS	MEAN BY YEAR	2015	2016	2017	2018	2019
Aplin et al	2015	267	44.50	27	45	48	62	54
Perry-Smith et al	2017	153	38,25	0	0	10	28	53
Guan et al	2016	100	20,00	0	3	16	16	32
Rai et al	2015	100	16,67	2	5	18	18	31
Tortoriello et al	2015	97	16,17	0	6	19	24	25
Huggings et al	2015	89	14,83	3	9	20	15	23
Spigel et al	2018	86	28,67	0	0	0	11	40
Xu et al	2015	83	13,83	15	33	15	13	4
Centola et al	2015	79	28,67	6	11	17	22	17
Martinez-Conesa	2015	78	13,83	0	0	9	20	22

Source: Research data

The most cited article presented in Table 2, which refers to the study by Aplin et al (2015), studies the cultural norms that happen when behaviors are transmitted through social networks. For this, the authors carry out an experimental study that compares the behavior of birds. Although this article does not appear to have been eliminated by the area filter, the category it is in is categorized in the areas 'Science and Technology' and uses bibliography of the analyzed areas. Therefore, it is kept in the analysis and the other articles were revised.

The top ten contributing authors outline in Table 3. It can be seen that the author with the most significant number of articles represents only 0.865% of the 694 articles identified.

Table 3 - Top Ten Most Cited Authors

AUTHOR	DOCUMENTS	% of 866
GUAN JC	6	0,865%
PALACIOS-MARQUES D	5	0,720%
DOLFSMA W	4	0,576%
MOLINA-MORALES FX	4	0,576%
SODA G	4	0,576%
TORTORIELLO M	4	0,576%
XIONG H	4	0,576%
ANDREI AG	3	0,432%
GELDES C	3	0,432%
GLOOR PA	3	0,432%

Source: Research data

The Table 3 demonstrates that the theme is diverse and there is not only one studies group, but it is diffuse among different authorship.

The total amount of citations was 6.785 and the average citations per item were 9.78, with the *h*-index rating of 34. It can also be identified in Figure 1 that the citations of the 694 articles have increased over the years, which indicates the relevance of the themes.
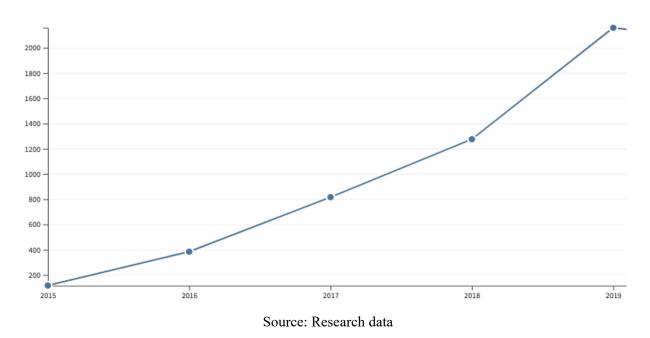
Figure 1 – Citations Per Year

Source: Research data

This preliminary step in the use of the VOSviewer software makes it possible to understand the database through the most relevant authors, most cited documents, journals in which these topics are published, and especially the advancement of publications over the years.

4.2 Co-citation Analysis

Co-citation analysis process includes the identification of all references of the articles, calculating the similarity between the pairs of the references articles, calculating the clusters of the reference documents and assigning the articles investigated to the clusters based on their references (Boyack and Klavans 2010). VOSviewer is used together to analyze the co-citation of these reference articles, and it was used because it has its clustering technique (Waltman et al. 2010). The clustering technique was used to partition cluster in groups by association strength. It

was used the default parameters 2 to attraction and 1 to repulsion, the minimum size of the cluster was four cited references, and the minimum number of citations of a cited reference was 20. The total of 26.570 references cited was presented.

Colors, labels, and circles are represented in the map generated by VOSviewer, the size of the circle represents its importance. The results of the co-citation analysis of this study are shown in Figure 2. The articles used on this co-citation map are presented on Appendix.
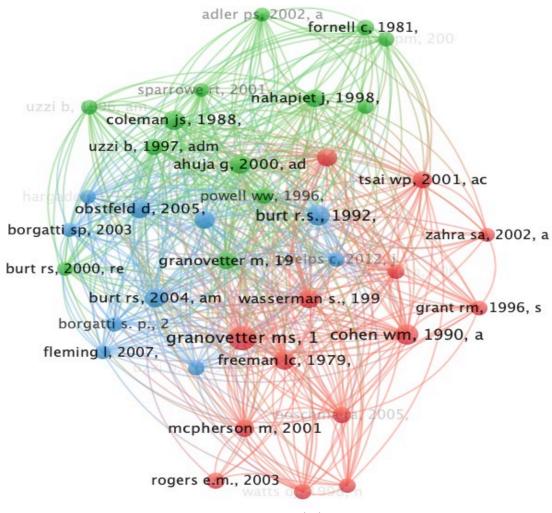
Figure 2 - Map of Co-citations Reference Authors

Source: Research data

As can be seen in Figure 3, three clusters emerged. With this, it is possible to affirm co-citation three significant clusters relate to the 26.570 references identified. An approximate interpretation of the vision is as follows.

Although three clusters have been identified, they are very close on the co-citation map, each one has its particularity that will be presented below. The first author and year of the publication of each clusters found are shown in Table 4.

Table 4 - Group itens by Cluster

CLUSTER 1 – ORANGE	CLUSTER 2 - GREEN	CLUSTER 3 – BLUE
Barabasi al, 1999	Adler ps, 2002	Borgatti s. p., 2002
Boschma ra, 2005	Ahuja g, 2000	Borgatti sp, 2003
Cohen wm, 1990	Burt rs, 2000	Burt r.s., 1992
Freeman lc, 1979	Coleman js, 1988	Burt rs, 2004
Granovetter ms, 1973	Fornell c, 1981	Fleming l, 2007
Grant rm, 1996	Granovetter m, 1985	Hargadon a, 1997
Hansen mt, 1999	Hoang h, 2003	Obstfeld d, 2005
Mcpherson m, 2001	Nahapiet j, 1998	Phelps c, 2012
Rogers e.m., 2003	Podsakoff pm, 2003	Reagans r, 2003
Schilling ma, 2007	Powell ww, 1996	Uzzi b, 2005
Tsai wp, 2001	Sparrowe rt, 2001	
Wasserman s., 1994	Uzzi b, 1996	
Watts dj, 1998	Uzzi b, 1997	
Zahra sa, 2002		

Source: Research data

In the first cluster, on the map identified with the orange color, could be called Organizational Knowledge. The articles that compose it are classic in the literature of social networks and focus on the diffusion of innovation (Rogers 2003), knowledge transfer in intraorganizational networks (Tsai 2001), absorptive capacity (Zahra and George 2002; Cohen and Levinthal 1990).

The green cluster, could be named as Social and Relations. There are articles that permeate the field of social capital (Adler and Kwon 2002; Burt 2000; Coleman 1988; Nahapiet and Ghoshal 1998), the process that social relationships affects economic actions in companies (Uzzi 1996; Uzzi 1997; Granovetter 1985), network-based in business research (Hoang and Antoncic

2003; Powell et al 1996; Sparrowe et al 2001), collaboration networks (Ahuja 2000) and two about methods in social sciences (Fornell and Larcker 1981; Podsakoff et al. 2003).

Whereas, the blue cluster could be called as Innovation, Creativity and Social Networks. This is because there are specific articles on product innovation (Hargadon and Sutton 1997), generative creativity (Fleming et al 2007); structure holes and good ideas (Burt 1992; Burt 2004), social networks and knowledge (Phelps et al. 2012; Reagans and Mcevily 2003; Obstfeld 2005; Borgatti 2002; Borgatti 2003) and collaboration and creativity (Uzzi 2005).

5 Final Considerations and Directions for Future Research

This paper presents an analysis of the grouping of articles referenced in the last five competed years of publications referring to the themes of innovation and social networks. There have been a growing amount of studies on these themes, although, there is scope for research aimed at quantitatively analyzing the growth of the field.

This is an initial effort to map literature on innovation and social networks. The findings indicate that there are studies on the topics are spread around the world and are analyzed by several authors. Three main clusters were identified in the co-citation analysis, that indicates that the majority of studies are related. The studies for each cluster were analyzed and the cluster was named for the predominance of themes. The names of the clusters are: Organizational Knowledge, Social and Relations and Innovation, Creativity and Social Networks. By understanding that each cluster has its own characteristic, this study aims to contribute so that future studies are oriented towards citing authors on related topics.

One limitation of this study is that a quantitative analysis delineates the findings. Therefore, future studies may develop a systematic review of the literature for a better understanding of the scenario in the literature on the subject. Also, the evidence found may not reflect the organization's scenario. With this, it is possible that empirical research on how social networks develop innovations based on the acquired knowledge can bring a better reflection on the themes.

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Appendix

Articles Used in Elaborating the Co-citation Map

CITED REFERENCE	CITATIONS	TOTAL LINK STRENGTH
Adler Ps, 2002, Acad Manage Rev, v27, p17, doi 10.2307/4134367	21	109
Ahuja G, 2000, Admin Sci Quart, v45, p425, doi 10.2307/2667105	47	363
Barabasi Al, 1999, Science, v286, p509, doi 10.1126/science.286.5439.509	23	69
Borgatti S. P., 2002, Ucinet Windows Softw	23	126
Borgatti S. P., 2003, J Manage, v29, p991, doi 10.1016/s0149-2063(03)00087-4	21	101
Boschma R.A, 2005, Reg Stud, v39, p61, doi 10.1080/0034340052000320887	31	120
Burt R.S., 1992, Structural Holes Soc	62	418
Burt R.S., 2000, Res Organ Behav, v22, p345, doi 10.1016/s0191-3085(00)22009-1	22	166
Burt R. S., 2004, Am J Sociol, v110, p349, doi 10.1086/421787	49	355
Cohen W. M., 1990, Admin Sci Quart, v35, p128, doi 10.2307/2393553	57	290
Coleman J. S., 1988, Am J Sociol, v94, ps95, doi 10.1086/228943	52	348
Fleming L, 2007, Admin Sci Quart, v52, p443, doi 10.2189/asqu.52.3.443	22	176
Fornell C, 1981, J Marketing Res, v18, p39, doi 10.2307/3151312	27	101
Freeman L. C., 1979, Soc Networks, v1, p215, doi 10.1016/0378-8733(78)90021-7	46	245
Granovetter M, 1985, Am J Sociol, v91, p481, doi 10.1086/228311	37	197
Granovetter M. S., 1973, Am J Sociol, v78, p1360, doi 10.1086/225469	98	463

(continued)

CITED REFERENCE	CITATIONS	TOTAL LINK STRENGTH
Grant R. M., 1996, Strategic Manage J, v17, p109, doi 10.1002/smj.4250171110	23	127
Hansen M. T., 1999, Admin Sci Quart, v44, p82, doi 10.2307/2667032	43	338
Hargadon A, 1997, Admin Sci Quart, v42, p716, doi 10.2307/2393655	20	156
Hoang H, 2003, J Bus Venturing, v18, p165, doi 10.1016/s0883-9026(02)00081-2	24	105
Mcpherson M, 2001, Annu Rev Sociol, v27, p415, doi 10.1146/annurev.soc.27.1.415	38	136
Nahapiet J, 1998, Acad Manage Rev, v23, p242, doi 10.2307/259373	40	280
Obstfeld D, 2005, Admin Sci Quart, v50, p100, doi 10.2189/asqu.2005.50.1.100	46	327
Phelps C, 2012, J Manage, v38, p1115, doi 10.1177/0149206311432640	26	187
Podsakoff P. M., 2003, J Appl Psychol, v88, p879, doi 10.1037/0021-9010.88.5.879	25	106
Powell W. W., 1996, Admin Sci Quart, v41, p116, doi 10.2307/2393988	29	202
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Source: Research data