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SCIENTIFIC PRODUCTION OF INNOVATION IN BRAZIL: A NETWORK ANALYSIS

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ABSTRACT

The use of social networks in the analysis of scientific literature allows the observation of interdisciplinary aspects arising from the collaboration of researchers and provide the analysis and structuring of a given field of knowledge. This study falls within the scope of research aimed at understanding the social networks in the field of scientific innovation in the area, aiming to quantify the exchange of information for the construction of knowledge. The study aims to identify the formation of social networks in the production of scientific innovation in the period 2006-2012 the Qualis CAPES journals of high impact (A1, A2, B1 and B2) of Brazil. The research is considered descriptive, with the quantitative method and documentary character. It was found 678 authors, representing the "nodes" that together produced 1.607 relations between them, called "ties" of 459.006 possible bond, indicating a social network composed of weak ties, fragmented, with the existence of 133 and low subgroups density. The intermediaries authors, considered the most important in a social network, for through them an actor interacts between non-adjacent actors, was formed by researchers VACCARO G. L. R. and BITENCOURT M. P., connecting a network of other researchers 9, the highest possible.

Keywords: networks, innovation, scientific production.

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1 INTRODUCTION

Innovation is part of the constant accumulation of knowledge and continuous technological training. Its importance was evidenced in the studies of Schumpeter (1911), who introduced the concept of innovation in economic analysis and described it as a great driving force for development. The social networks impact both the diffusion of innovations and the propagation of the information and the knowledge that allows the development of innovations (WATTS; 1998; SCOTT, 2000; OTTE; ROUSSEAU, 2002; HANNEMAN; RIDDLE, 2005; LIU et al., 2005).

Researches that analyze the scientific production on innovation in the academic scope have arisen to verify how the quality and the scientific production of this area are. At the national level one can cite the works of Bignetti (2006), Bignetti, Cappra and Thomas (2008), Muylder et al. (2008), Machado, Gomes and Giotto (2008), Gomes, Machado and Giotto (2009) and Ropelatto, Silveira and Machado (2010). Among the authors who used the analysis of social networks in their studies, the highlight is the work of Wasserman and Fast (1994), Scott (2000), Bulgacov and Verdu (2001), Newman (2001), Moody (2004) , Barabasi (2005), Guimera et al. (2005), Liu et al., (2005), Larivière, Gingras and Archambault (2006), Rossoni, Hocayen-da-Silva and Ferreira Júnior (2008).

This study is part of the research that aims to understand social networks in the field of scientific production in the area of innovation, aiming to quantify the exchange of information and the construction of knowledge. Scientific knowledge is socially constructed, being influenced by the pairs that structure the network of relations between institutions, aiming not only to describe such relationships, but also to understand how such structure affects the production of knowledge (ROSSONI; HOCAYEN-DA-SILVA; FERREIRA Júnior, 2008).

The research question that guides this study is: what are the social networks formed from the scientific production on the innovation of high impact Brazilian journals, listed in the Coordination of Improvement of Higher Education Personnel (CAPES) classified as Qualis A1, A2, B1 and B2? To answer this research question the study aims to identify the formation of social networks in the scientific production of innovation in the period 2006-2012 in the high impact (A1, A2, B1 and B2) periodicals of Brazil.

In order to reach the proposed goal, we sought to collect the articles published in the journals considered of high impact between the years 2006 and 2012; identify which universities work in this network; identify the type of research used in the methodology of related articles; and analyze the formation of social networks in these journals.

This study is structured with four more sections, besides this introduction. In the second, as a theoretical reference, the following stand out: the theory of networks (MILGRAM, 1967; KNOKE, KUKINSKI, 1982, BURT, 1992, NOHRIA, 1992; WASSERMAN; FAUST, 1994; UZZI, 1997; WATTS, STROGATZ, 1998; In this paper, we present the results of the literature of innovation (SCHUMACHER, 1911, 1982, VAN DE VEN, POOLE, VAN DE VEN et al., 1999, HAMEL, 2006). The third is the section devoted to the methodology of the research. In the fourth, we analyze the data. Finally, the fifth section is intended for final considerations and suggestions for further research.

2 THEORETICAL REFERENCE

In this stage will be presented the theories of Networks and Innovation.

2.1 Network Theory

The study of networks can range from computer science to sociology. Social networks create connections between people in their daily lives (RAPOPORT, HORVATH, 1961), professional contacts, business deals (PODOLNY, PAGE, 1998, LAZZARINI, 2007), academic relations (PRICE, 1965, REDNER 1998, GUIMARÃES et al., 2009). The network strengthens relations as well as contributes to the improvement, maturation or even innovation of scientific knowledge, which, according to Kuhn (1978) and Popper (1972), is socially constructed. Social networks directly influence how researchers think and formulate their ideas (LIU et al., 2005).

The present study uses social networks derived from sociology and anthropology with a focus on the relationships between researchers in the area of innovation, and can be called Social Network Analysis (SNA), Its definition is given as sets of contacts that connect several actors, in which such contacts can be of different types, present different contents, as well as several structural properties (NELSON, 1984). Alternatively, as a finite set of actors and the relations that occur between them (Wasserman and Faust, 1994).

Networks "are systems composed of 'nodes' and connections between them, which in the social sciences are represented by social subjects (individuals, groups, organizations, etc.) connected by some relation" (SILVA et al. 1977). The analysis of social networks is based on the premise that the relations between social actors can be described by a graph (LIU et al., 2005). The formation of social networks consists of: actor, nodes, relational bond (strong or weak links), dyad, triad, group and centrality (WASSERMAN, FAUST, 1994; LIU et al., 2005).

The actors represent the "nodes" (HANNEMAN; RIDDLE, 2005). The linkage of one or more specific types of interdependence is considered the links (BERKOWITZ, 1982). These ties can be characterized as: strong ties, corresponding to a social network formed by a dense network of relationships, or weak ties, which are those made outside a cohesive circle of relationship (WASSERMAN AND FAUST, 1994).

The bond between two actors in a unit of analysis is considered a dyad, and the triads are present in the links between three or more actors. The groups have their origin in relations that have measurable links, characterized by a finite set of actors defined by conceptual, theoretical or empirical criteria. Already the centrality is to identify the most important actors in a social network. The more central these actors are in the social network, the more their importance becomes evident (WASSERMAN, FAUST, 1994).

One of the types of network that has a high degree of clustering and the low average distance between the nodes is the Small World (MILGRAM, 1967; WATSTRONG 1998). This network refers to the situation where an individual can access any other from their relationships: even though most people are not directly related to each other, they connect indirectly through a few intermediates (LAZZARINI, 2007). Watts and Strogatz (1998) suggest that this phenomenon occurs when actors in a sparse network are highly grouped but at the same time connected to actors outside their groups using a small number of intermediaries.

There are several ways of identifying the structure and relationships of a network, among which the following stand out: structural properties, with density and centrality measures; roles and positions, with cluster analysis; and statistical analysis of relationships, with tests of theoretical propositions about relational properties (WASSERMAN AND FAUST, 1994).

In the case of the structural properties, the density shows the proportion of the number of loops realized in a network about the total number of possibilities among the actors of the network (KNOKE; KUKLINSKI, 1982; SCOTT, 2000). Gnyawali and Madhavan (2001) highlight three characteristics of dense networks: a) facilitate the flow of resources, especially information; b) function as closed systems of confidence, generating more easily similar behaviors; c) facilitate the allocation of sanctions.

Centrality, in turn, shapes itself as a property of the actors, which measures how central they are in a network. It allows assessing the degree to which a specific actor is able directly or indirectly to access others in the network, and can be characterized as: a) degree centrality, which consists of the number of ties that an actor has with others in a network; as it takes into account only adjacent relationships, such a measure reveals only the local centrality of the actors; b) proximity centrality, which is based on the proximity or distance of an actor in relation to others in a network; the measure of closeness of an actor is obtained by summing the geodetic distances between all the other actors; c) betweenness centrality, in which the interaction between nonadjacent actors may depend on other actors, who may potentially have some control over the interactions between two nonadjacent actors. Thus, an actor is an intermediary that connects with several others that do not connect directly (SCOTT, 2000; WASSERMAN AND FAUST, 1994).

The relation between actors or groups can be called clusters, cliques, clans, components, colors or even cycles, and it is possible to be identified when the bonds between the actors of a group identify cohesive subgroups that can be formalized exposing their many different properties. This subgroup can be thought of as a set of actors in which everyone chooses all as peers in their connections, formed by three or more network actors (SCOTT, 2000; WASSERMAN AND FAUST, 1994).

The subgroups can be based on the reachability and proximity of individuals, and are formalized by the n-clique concept, which is considered the geodesic distance between the points. The cohesive subgroups require a small distance between nodes, in which the greatest geodesic distance between two nodes is less than or equal to n, being the maximum path in which one-click members may be connected (WASSERMAN, FAUST, 1994; SCOTT, 2000).

Finally, statistical analysis methods, which make it possible to evaluate the networks both at the local level (dyads and triads) and at the global level. Three are the purposes for using statistical tools defended by Hanneman and Riddle (2005): 1) to compare two relations in the same set of actors; 2) explain the impact of attributes on relationships and vice versa; 3) explain the relationships among the actors in the network.

From a pioneering study by Newman (2001), in the field of scientific production, the author identified that authors who enter the network tend to preferentially enter from the most connected authors. Some recent studies on social networks, such as Martins (2009), showed that in the field of operations management the vast majority of publications had a co-authoring structure, and the average number of co-authorships between these researchers increased, indicating that the authors tended to relate more now than in the past, but the volume of ties effectively constructed between the authors did not follow the increase of possible links in the network, which led to a greater fragmentation of the network.

Rossoni and Guarido Filho (2009) have published articles published in the area of administration and related, of the graduate programs in administration, and found a main component coherent with the structural characterization of the small worlds type, in which groupings of graduate programs they presented themselves as well-defined neighborhoods which, in turn, were not isolated from other groups, but interconnected by few intermediaries. In the same line, Guimarães et al. (2009), investigated the formation of social networks among researchers of postgraduate programs, evidencing that the researched network is little dense, with sparse and, in most cases, weak programs.

Analyzing specific areas, Martins et al. (2010) raised the network of researchers in the area of operations management in Brazil and verified the existence of a fragmented and dense network, and the presence of some close and cohesive groups that give stability to the field (small worlds networks). They also emphasized that the effect of non-redundant ties is moderated by the researcher's centrality and the effect on productivity is higher among researchers with a greater degree of centrality. Mendes-da-Silva, Onusic and Giglio (2013) studied the structural properties of networks of relations among researchers in the area of finance in Brazil. Through Social Network Analysis they verified that: the Brazilian environment is characterized by small worlds; few researchers can maintain regularity in production; and the greater centrality of the researchers in the network, implies in a greater volume of articles published by them.

2.2 Innovation Networks

The world is experiencing the era of innovation (BART, 2004). The importance of the topic in the last years is evidenced by many authors who have been studying the subject, making its concept more extensive and complex (SCHUMPETER, 1911, 1982, VAN DE VEN ET AL., 1989; DAMANPOUR, 1991, ROTHWELL, 1994, HAMWELL, 2006). Despite the numerous studies, there is no consensus about its definition (WAN, ONG, LEE, 2005). According to Barbieri (1997), depending on the area of study, the term "innovation" has different meanings.

Innovation generates competitive advantage for organizations, creating value for those who use it, being a factor of differentiation in the elaboration of possible strategies (SCHUMPETER, 1911, 1982). It can be understood as the adoption of an already existing idea, but it is new to the organization that is adopting it, including new products, services, technologies, processes, procedures, systems or social arrangements (PENNINGS, 1998; AFUAH, 2003). Damanpour (1991) complements incorporating into the context new behaviors, a new structure or administrative system, and a new plan or program related to the members of the organization, when linked to management, work to transform input into output.

In addition to an idea, innovation is a practice or material good that is perceived as new and of relevant application (ZALMAN, DUNCAN, HOLBEK, 1973), and may be based on the use of new technological or market knowledge to offer products or new services to customers. In this case, it is considered a new product when its cost can be lowered, its attributes are improved, or even when they are non-existent in the market (AFUAH, 2003).

Researchers from the Minnesota Innovation Research Program (MIRP), through the Minnesota Innovation Survey (MIS), defined innovation as a process of developing and deploying a novelty, including new processes or the development of new ideas, such as a new technology, product, organizational process or new arrangements (VAN DE VEN et al., 1989).

Analyzing the presented definitions, it is possible to group them in a concept like the one used by the company 3M, in which the innovation represents an algebraic equation: idea + action = result (GUNDLING, 1999).

Regardless of the concepts presented, it is possible to observe that the innovation process does not arise in isolation. It is necessary that the actor joins a network to generate and favor it. Lemos (1999, p.135) argues that networking is the "most appropriate organizational format for promoting intensive learning for knowledge generation and innovation".

Thus, in addition to the internal environment, organizations can also benefit from the innovations generated by universities and research centers, although this relationship is stronger with large and small technology-based companies, while others benefit from the appropriation of new knowledge (ARBIX and NEGRI, 2009). Gardner (1999) corroborates the importance of the academic environment, especially of universities and foundations, which contribute as a link between government and the private sector.

Interaction is essential for the generation of innovation. Lemos (1999) states that the organization does not innovate alone; it needs sources of information and knowledge that may be inside or outside the organization. Therefore, innovation is an interactive process that occurs with the contribution of various agents (economic and social).

Social networks are important resources for innovation, because they maintain channels and information flow in which trust and respect between actors bring them closer together and lead them to share information that affects the knowledge held by them, modifying or expanding it (TOMAÉL; ALCARÁ; DI CHIARA, 2005).

According to Silva et al. (2006), the use of social networks in the analysis of scientific production allows the observation of interdisciplinary aspects resulting from the collaboration of researchers, besides providing the analysis and structuring of a given field of knowledge, contributing to the two existing theoretical currents: one that considers the aspects of innovation from the economic perspective of the firm, and another that approaches the innovation process as an economic paradigm, with a greater linkage of its effects on the social and economic environment (CONCEIÇÃO, 2000)

Pereira and Reinert (2013) affirm that social networks are fundamental both in the formation and evolution of the company, providing resources and information that help in the creation and development of innovation. Participating in innovation networks, according to Monteiro, Sacomano Neto and Giuliani (2013) results in greater competitiveness and organizational capacity to adapt to the environment. Due to being built with the client, innovation networks favor the fluidity of the information and, consequently, the adjustment of the marketing strategies to the needs of the target public, attending them in a more specific way.

3 METHODOLOGICAL PROCEDURES

This study is a descriptive, quantitative and documentary research. Descriptive research is done by observing, recording, analyzing and correlating the facts or phenomena without manipulating them (CERVO; BERVIAN, 2002). This research also has a quantitative approach, in which the statistical techniques of network analysis in the treatment of collected data were applied. The documentary research was used in the bibliometric and sociometric study. Martins and Theóphilo (2007) emphasize that the documentary research surveys edited material, like books and periodicals, among others. In turn, bibliometric surveys, according to Macias-Chapula (1998, p. 134), comprise "the study of the quantitative aspects

of the production, dissemination and use of recorded information". As far as sociometric research is concerned, they turn to the exploration of the matrix of relationships that come from social actors (GALASKIEWCZ; WASSERMAN, 1994).

The research population comprised 116 high impact Brazilian journals, classified by the CAPES Qualis system. Qualis is a set of procedures used to stratify the quality of the intellectual production of graduate programs. It assesses the quality of the articles and other types of production, from the quality analysis of the dissemination vehicles, that is, scientific journals and procedures of conferences. The classification of periodicals and events is carried out by the evaluation areas and undergoes an annual updating process. These vehicles are classified into strata indicative of quality – A1, the highest; A2; B1; B2; B3; B4; B5; C – with zero weight (CAPES, 2011).

For the research, the Brazilian journals classified as A1, A2, B1 and B2,, from the area of administration, accounting and tourism, were adopted, since it is understood that the theme "innovation" may be present in several lines of research, besides administration. However, it was pointed out that we sought to identify the word "innovation" for organizations, so that health articles were excluded, in which the theme was approached in a context of clinical discovery. The other journals, B3, B4, B5 and C, and the international journals, due to the delimitation of this study, were not contemplated. Of the 116 periodicals collected, 45 had some article related to the theme "innovation", totaling 378 published articles.

The word "innovation" was searched for in the title, abstract, and keywords. However, all abstracts were analyzed to determine if the word "innovation" was inserted in the organizational context. The survey was carried out in 2013. In addition to the authors, the institutions to which they belong. In the case of a researcher working in two universities simultaneously, it was considered the first mentioned.

It was also sought to identify the approach adopted in the articles, which is classified as qualitative and quantitative as well as the two approaches together, that is, Quanti-Quali.

As for the procedures used in the quantitative analysis of the data, the descriptive statistics for the survey of the scientific production on innovation were used, through the periodicals classified as A1, A2, B1 and B2, available in Capes's report (2008). Moreover, in the analysis of the social networks established between the authors and their respective institutions, the software UNICET® version 6.0 was used. According to Hanneman and Riddle (2005), there are two reasons for the use of statistical methods in network analysis. The first, in the case of large networks, is the possibility of describing and understanding patterns of behavior both of the network as a whole and of its immersed actors. The second reason is the possibility of understanding the evolution process of networks in time, from the probability of actions of the actors.

Every method has limitations. According to Vergara (2000: 59), "it is healthy to anticipate the criticisms that the reader can make to work, explaining what limitations the method is chosen offers, but justify it as the most appropriate for the investigation ". The cross section, not being a historical series and the outdated record of some periodicals, is part of this context.

4 DATA PRESENTATION AND ANALYSIS

This section is structured according to the objectives of the study and according to the variables measured. The purpose of this study was not to raise the number of articles published by journals, but rather the authors who had publications on the theme "innovation" in the high impact journals of the Qualis Capes system (A1, A2, B1 and B2) what network is established through them. However, as a result of the research approach used by the authors, the number of articles published in the period 2006-2012 was also raised, as shown in Table 1.

Table 1: Approach adopted

Journal	No. Articles	%
Qualitative	294	78%
Quantitative	75	20%
Quanti-Quali.	09	2%
TOTAL	**378**	**100%**

Source: Research data.

Regarding the adopted approach, qualitative studies predominated, with a total of 294 articles, representing 78% of the total surveyed. Quantitative studies represented 20% of the total, with 75 publications. Moreover, only 2% or 9 articles were classified as quantitative and qualitative, configuring the innovation network that is formed by the authors who develop these researches.

Innovation is an interactive process that occurs with the contribution of various agents (economic and social). Social networks are important resources for innovation, since they bring authors closer together, leading them to share information that focuses on the knowledge they hold (TOMAÉL; ALCARÁ; DI CHIARA, 2005). In this context, the social network of innovation, represented here in Figure 1, also called Social Network Analysis (SNA), which presents the relationships between the actors as well as the isolated components of the network, is composed of 678 authors, called "actors" who represent the "nodes" (HANNEMAN; RIDDLE, 2005). These actors produced 1,607 relations among themselves. This interdependence is called "ties" (Berkowitz, 1982).

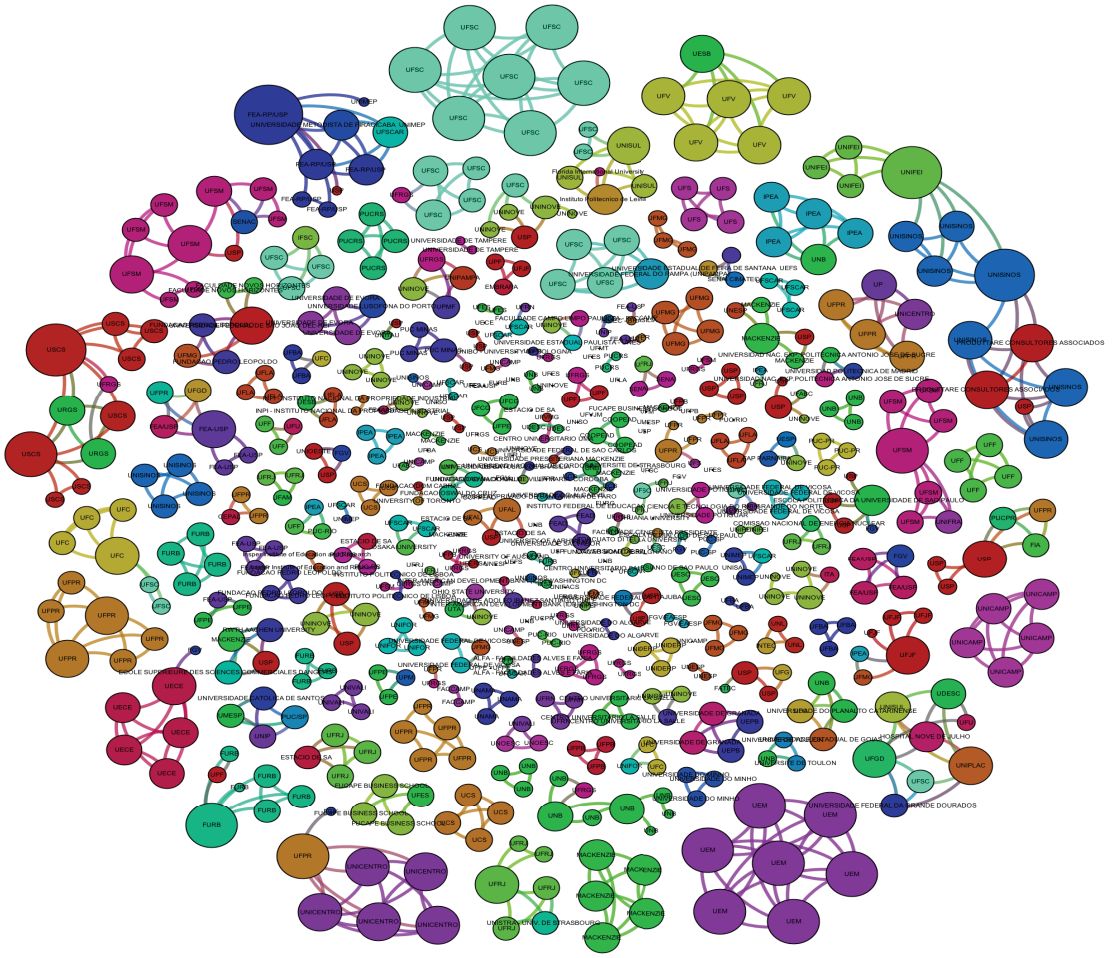


Figure 1. Social network analysis of innovation.
Source: Research data.

Figure 1 shows the links between the "nodes" composed of the various actors that are part of this network. Of the 678 authors belonging to the innovation network, most of them are connected. The contributions of network production are to strengthen both the relations and the contribution to the improvement, maturation, or even the innovation of scientific knowledge, which are socially constructed (KUHN, 1978; POPPER, 1972).

Through the analysis of the social network of innovation, shown in Figure 1, it is possible to perceive a fragmented network. Its density was calculated as 0.0035 or 0.35%, indicating a low density network. Density shows the proportion of the number of ties realized about the total number of possibilities among the actors in the network (KNOKE; KUKLINSKI, 1982; SCOTT, 2000). In this study, 1,607 ties were made in 459,006 possible loops. Thus, this network is formed by weak ties, that is, ties made outside a cohesive circle of relationship (WASSERMAN AND FAUST, 1994).

A similar result was found in the study developed by Guimarães et al. (2009), in which the social networks among researchers of graduate programs have proved to be very dense, with sparse and, in most cases, weak programs. The authors also point out that a network of graduate programs can be an ideal condition to increase the volume and quality of Brazilian scientific production. In the same way, when analyzing the network of researchers in the area of operations management

in Brazil, Martins et al. (2010) verified the existence of a fragmented network, not dense and composed of some close and cohesive groups that confer stability to the field (small worlds networks).

A denser network in principle means faster dissemination of information, in which knowledge travels with greater agility and fluidity to those connected to it, contributing to the expansion, diversification and innovations of intellectual capital. Also, dense networks facilitate the flow of resources, especially information. They function as closed systems of trust, generating similar behaviors, and promote the attribution of sanctions (GNYAWALI and MADHAVAN, 2001).

To identify the structure and relationships of this social network of innovation, the measures of density, the degree of centrality, the centrality of proximity, the centrality of intermediation and analysis of clusters were analyzed. Other indicators can be used for the analysis of a network, however by delimitation of the study we opted for those described.

4.1 Degree of Centrality

The centrality of a network allows identifying the position in which an actor is about the others in the network (HANNEMAN; RIDDLE, 2005). In the same way, it allows us to assess the degree to which a specific actor is able, directly or indirectly, to access other actors in the network. Table 2 presents the Centrality Degree, which consists of the number of ties that an actor has with other actors in a network. The 10 actors with the highest number of loops were separated.

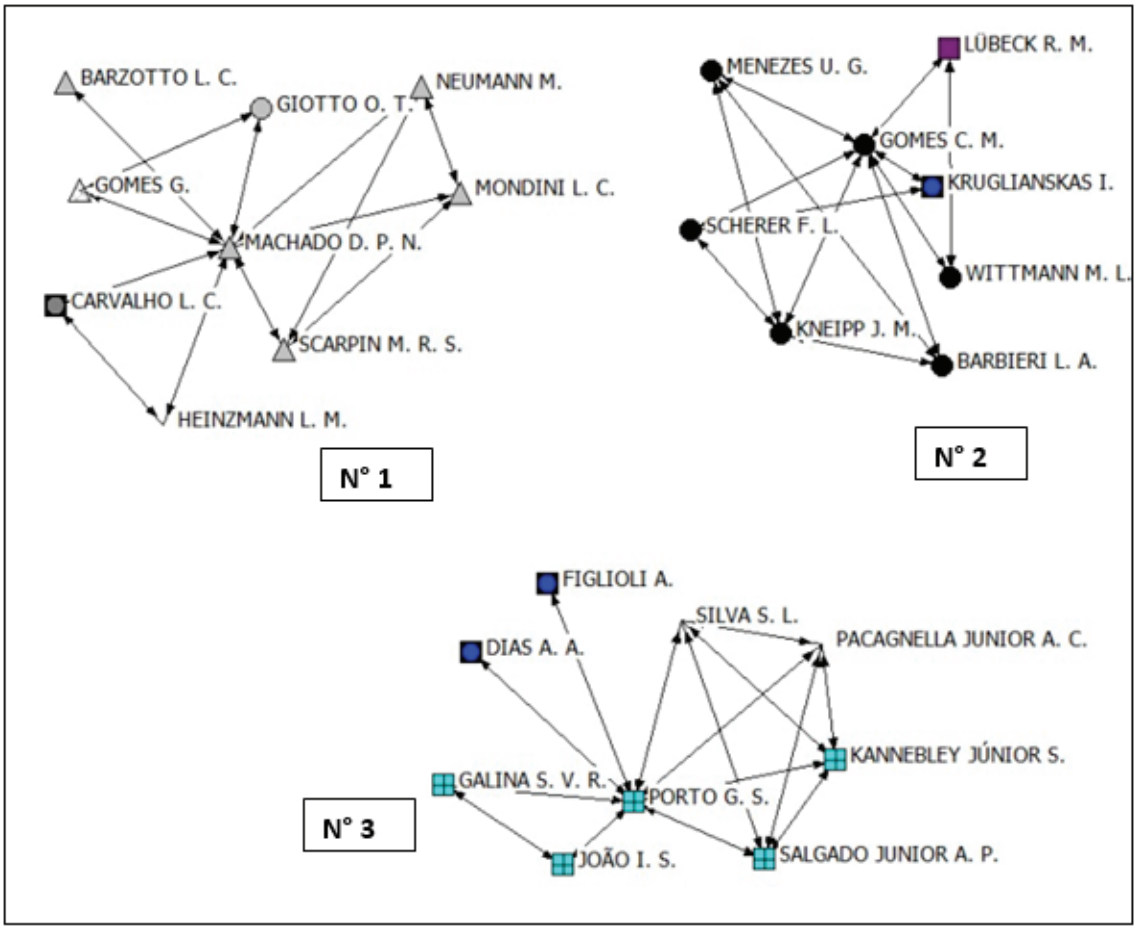
Table 2: Centrality Degree

Ranking	Main Authors	*Degree*
1	GOMES C. M.	10.000
2	MACHADO D. P. N.	10.000
3	PORTO G. S.	10.000
4	PEREIRA R. S.	9.000
5	BINOTTO E.	9.000
6	VACCARO G. L. R.	7.000
7	SIQUEIRA E. S.	7.000
8	BITENCOURT M. P.	7.000
9	ESTEVES G.	7.000
10	KNEIPP J. M.	7.000

Source: Research data.

It is possible to observe from Table 2 that the actors GOMES C. M., MACHADO D. P., PORTO G. S., PEREIRA R. S., BINOTTO E., VACCARO G. L., SIQUEIRA E. S., BITENCOURT M. P., ESTEVES G. and KNEIPP J. M. are the authors with the most ties. However, since it takes into account only the adjacent relationships, this measure reveals only the local centrality of the actors (SCOTT, 2000). As shown in Figure 2.

Figure 2. Degree centrality of the innovation network.



Legenda:

△	FURB	▽	UFMT	■	USP	SILVA S. L.	UFSCar
○	UPF	●	UFSM	▦	FEA-RP/USP	PACAGNELLA JR. A. C.	Unimep
■	FGV	■	Senac				

Source: Research data.

Analyzing Figure 2, it is possible to observe that the number of loops produced by each author is a determinant component for the analysis of a social network, because without them the formation of the network would not occur. Each isolated network (N.1, N.2 and N.3) represents a set of actors who share knowledge and develop teamwork, however restricted to their group, limiting knowledge among their peers, since most belong to the same university. This can generate a homogeneity, creating an obstacle to heterogeneous knowledge in the production of knowledge in the area of innovation. The importance of an actor in the network is not only due to the number of direct contacts he maintains, but also to the number of contacts he mediates (ROSSONI; GUARIDO FILHO, 2009).

Martins et al. (2010) emphasize that the effect of the ties is moderated by the researcher's centrality. The effect on productivity is higher among researchers with a greater degree of centrality. Mendes-da-Silva, Onusic and Giglio (2013) affirm that the Brazilian environment has the following characteristics: to be formed by small worlds; low regularity of production and higher volume of production of researchers with a greater degree of centrality.

It is worth mentioning that the links do not reveal the most relevant actors in a network, since it is possible to have an expressive number of links without connections with the rest of the network, indicating a limited production preference to a set of authors. Moreover, if there is low coupling between actors, the total amount of power in the network is also low, as there are few contacts among the actors for this power to be exercised (HANNEMAN, RIDDLE, 2005).

The networks of numbers 1, 2 and 3 are predominantly reclusive in their universities. Networks 2 and 3 have a convergence point manifested by the University of São Paulo (USP). In this item we tried to demonstrate the degree of centrality of the authors, but, as each one represents a specific college or university, it was possible to verify that even with a high degree of centrality among the actors in the social innovation network there is a small movement of cooperation between the college or university. This was evidenced in the study by Rossoni and Guarido Filho (2009), in which the authors identified a small world structural in the graduate programs in administration. Although internally, some universities stand out for their research groups, such as the Regional University of Blumenau (FURB), Federal University of Santa Maria (UFSM) and FEA-RP / USP.

4.2 Closeness

Proximity centrality is based on the proximity or distance of an actor relative to the other actors in a network. Table 3 presents the first 15 actors with the greatest centrality of proximity, but it can be seen that the average proximity remained the same for all, indicating that the geodesic distance between these actors in the social innovation network is the same.

Table 3: Closeness

Ranking	Authors	*Betweenness*
1	VACCARO G. L. R.	0,018
2	BITENCOURT M. P.	0,013
3	GOMES C. M.	0,011
4	PEREIRA R. S.	0,010
5	MACHADO D. P. N.	0,010
6	PORTO G. S.	0,009
7	BRESCIANI L. P.	0,007
8	VARGAS E. R.	0,006
9	GUIMARÃES T. A.	0,004
10	KNEIPP J. M.	0,004
11	GODOY L. P.	0,004

Source: Research data.

Table 4 shows that the actors VACCARO GLR, BITENCOURT MP, PORTO GS, GOMES CM, PEREIRA RS, MACHADO DPN, PORTO GS, BRESCIANI LP, VARGAS ER, GUIMARÃES TA, KNEIPP JM and GODOY LP, are the intermediate authors that most connect authors. It is also possible to verify the relevance of the authors VACCARO G. L. R. and BITENCOURT M. P., who are the main connectors of distinct groups, favoring the expansion of the social network of innovation.

4.3 Betweenness

The centrality of intermediation is based on how much an actor facilitates the flow of information in a network. Table 4 shows the first 11 actors with the greatest centrality of intermediation. This data is relatively small given the total size of the social innovation network, shown in Figure 1. But these actors are the connectors that favor access to any other in the network from their relationships; even though most are not directly related to each other, they connect indirectly through these few intermediaries. This phenomenon can also be called Small World (MILGRAM, 1967; WATTS; STROGATZ, 1998, LAZZARINI, 2007).

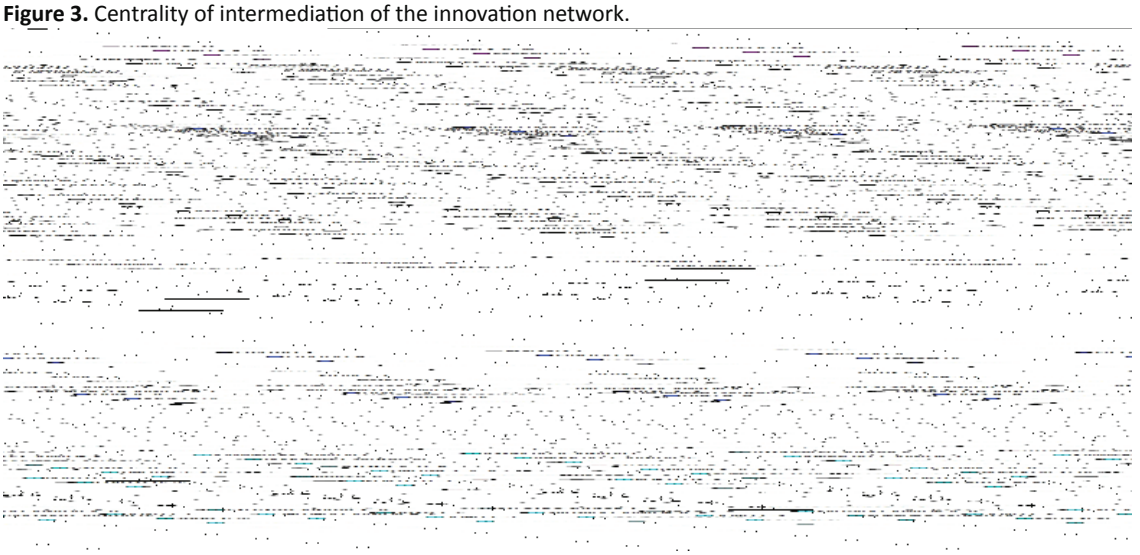
Tabela 4 – Betweenness

Rank	Main Authors	Betweenness
1	VACCARO G. L. R.	0,018
2	BITENCOURT M. P.	0,013
3	GOMES C. M.	0,011
4	PEREIRA R. S.	0,010
5	MACHADO D. P. N.	0,010
6	PORTO G. S.	0,009
7	BRESCIANI L. P.	0,007
8	VARGAS E. R.	0,006
9	GUIMARÃES T. A.	0,004
10	KNEIPP J. M.	0,004
11	GODOY L. P.	0,004

Source: Research data

Table 4 shows that the actors VACCARO GLR, BITENCOURT MP, PORTO GS, GOMES CM, PEREIRA RS, MACHADO DPN, PORTO GS, BRESCIANI LP, VARGAS ER, GUIMARÃES TA, KNEIPP JM and GODOY LP, are the intermediate authors that most connect authors. It is also possible to verify the relevance of the authors VACCARO G. L. R. and BITENCOURT M. P., who are the main connectors of distinct groups, favoring the expansion of the social network of innovation.

Figure 3. Centrality of intermediation of the innovation network.



Subtitle:

	UNIFEI
	UNISINOS
	Produttare Consultores Associados

Source: Research data.

The centrality of intermediation can be considered one of the most important indicators of a social network, because through it an actor interacts among non-adjacent actors (WASSERMAN, FAUST, 1994). An actor is an intermediary when connecting to several other actors who do not connect to him directly.

Figure 3 shows the intermediation of two authors VACCARO G. L. R. and BITENCOURT M. P. who together connect a network formed by other 9 (nine) researchers, the largest intermediation network possible. The network of actor VACCARO G. L. R. is composed almost in its entirety by actors of UNISINOS, and the network of BITENCOURT M. P., establishes its number of partnerships exclusively with UNIFEI.

It is important to emphasize that it is the authors and not the institutions that make up the networks, but being part of an organization that favors the construction of knowledge can encourage interinstitutional relations. The more bonds are created, the greater the possibility of building a dense intermediation network.

This intermediation results in essential interaction for innovation generation and the relationship between academia and companies, organizations also need sources of information and knowledge that may be inside or outside the company. As the organization does not innovate alone, this interaction with several agents (economic and social) facilitates its innovation process (LEMOS, 1999). In this study, it was observed, even if in a timid manner, that in about 2% of the articles this interaction occurred. In the survey of the institutions belonging to each author who had their articles published in the analyzed periodicals, in some cases it was possible to perceive the conjunction between colleges, universities and private companies, such as Produttare Consultores Associados, Senac, Embrapa among others.

4.4 Clusters Analysis

Of the 678 actors who formed the field of scientific production in innovation, 133 cliques or clusters of up to three authors were found (WASSERMAN, FAUST, 1994; SCOTT, 2000). The remaining clusters were composed of 64 subgroups with four authors, 39 subgroups with five authors, 26 subgroups with six authors, 13 subgroups with seven authors and, finally, eight subgroups with eight authors, the latter being the main group identified in Table 1.

	N-CLIQUES
	Max Distance (n-): 2
	Minimum Set Size: 8
	Atores: 678
	133-cliques found.
1	SILVA J. M. SILVA C. E. S. BATISTA G. D. M. BITENCOURT M. P. VACCARO G. L. R. SILVA D. O. CAMARGO L. F. R. POHLMANN C. R.
2	BITENCOURT M. P. VACCARO G. L. R. SILVA D. O. CAMARGO L. F. R. POHLMANN C. R. PELLEGRIN I. ZIMMER M. V. LACERDA D. P.
3	VENDEMIATTI M. SIQUEIRA E. S. FILARDI F. BINOTTO E. SIMIONI F. J HOFF D. N. NAKAYAMA M. K. CASAROTTO E. L.
4	GOMES C. M. KRUGLIANSKAS I. SCHERER F. L. MENEZES U. G. KNEIPP J. M. BARBIERI L. A. WITTMANN M. L. LÜBECK R. M.
5	GOMES C. M. KRUGLIANSKAS I. SCHERER F. L. MENEZES U. G. KNEIPP J. M. BARBIERI L. A. CARPES A. M. BEURON T. A.
6	PACAGNELLA JUNIOR A. C. PORTO G. S. SILVA S. L. KANNEBLEY JÚNIOR S. SALGADO JUNIOR A. P. FIGLIOLI A. DIAS A. A. JOÃO I. S. GALINA S. V. R.
7	MACHADO D. P. N. CARVALHO L. C. HEINZMANN L. M. BARZOTTO L. C. GOMES G. GIOTTO O. T. SCARPIN M. R. S. MONDINI L. C. NEUMANN M.
8	PEREIRA R. S. FRANCO I. D. ALMEIDA L. C. B. SANTOS I. C. OLIVEIRA S. M. HAYASHI JÚNIOR P. ARRUDA A. G. BRESCIANI L. P. SILVA T. N.

Table 1 – N-Clicks.
Source: Research data.

In any social network, some links keep the relationships closer. These relationships create subgroups, which are based on the reachability and proximity of individuals, and are formalized by the n-click concept (WASSERMAN, FAUST, 1994; SCOTT, 2000). In this study it is possible to observe that, even if this network presents itself fragmented, the existence of 133 subgroups indicates that the students in the area of innovation produced in the network, even if it is restricted to their peers. What is perceived in this analysis is the need to expand the social network of innovation, since innovation as presented in the theoretical framework needs connections, and the more connected a network is, the greater the flow of information circulating through it, favoring quality of the information presented in the published articles.

However, it is important to remember that only the bonds built do not consolidate a network. It is necessary that these ties have continuity and diversity in the scientific production, because if the number of ties does not keep up with the possible number in the network, greater fragmentation of the network may occur (MARTINS, 2009).

5 CONCLUSION

This study aimed to show which actors form social networks based on the scientific production on the innovation of high-impact Brazilian journals, listed in CAPES classified as Qualis A1, A2, B1 and B2.

In the analysis of social networks of innovation, 678 authors were found, representing the "nodes" that together produced 1,607 relations among themselves, called "ties", of 459,006 possible links, indicating a social network formed by weak, fragmented links with the existence of 133 subgroups and low density. As a matter of delimitation of the study, we opted to analyze the measures of density, the degree of centrality, the closeness, the centrality of intermediation and clusters analysis.

In the case of the degree of centrality, there was a set of actors who share knowledge and develop teamwork, however restricted to their group, limiting knowledge among their peers. However, it was possible to observe that, even with a high degree of centrality among the actors in the social innovation network, there is cooperation among colleges or universities. The closeness remained the same for the main actors of the network, indicating that information circulates more easily among these actors, allowing a greater flow of information. Some of the authors, such as VACCARO G. L. R., BITENCOURT M. P., PELLEGRIN I., LACERDA D. P. and ZIMMER M. V., also belong to the group that composes the centrality of intermediation.

Intermediate actors are the most important in a social network, because through them an actor interacts between non-adjacent actors. In this study, we highlight the authors VACCARO G. L. R. and BITENCOURT M. P., since they are the main connectors between two distinct social network groups that together connect a network formed by other nine researchers, the largest intermediation network possible. This network favors the expansion of the social innovation network, since authors participating in the intermediation centrality network share several different lines of thought, extending their knowledge beyond a restricted set of researchers, generating ideas about new topics to be researched, or contributing to ongoing studies. With this it is possible to say that the flow of information that circulates in the social network can generate innovations in the scientific production and benefit to a whole society.

The study showed that the social innovation network consists of 133 subgroups, working with at least three authors, but restricting their production to their peers, evidencing a need to expand the social innovation network, not only in established networks, but also in continuity and diversity among authors and colleges or universities. A denser network, in principle, means more rapid diffusion of information, since knowledge arrives with greater agility and fluidity to those connected to it, contributing to the amplification, variation and innovations of intellectual capital.

It is hoped that this research will contribute to the theoretical field of social networks as well as alert researchers of private and governmental institutions of the importance of sharing knowledge. Innovation is a process of interactive, continuous and heterogeneous learning that occurs with the contribution of several agents in which each one brings with it its knowledge and its lens on a certain subject. Moreover, as reported by Popper (1972) and Kuhn (1978), scientific knowledge must be socially constructed. For future studies, it is suggested to extend the research also to the conferences, as well as to survey social networks of innovation in international journals.

REFERENCES

AFUAH, A. **Innovation management**: strategies, implementation and profits. New York: Oxford University Press, 2003.

ARBIX, G.; DE NEGRI, J. A. A Inovação no Centro da Agenda do desenvolvimento. **Brasil Pós-Crise:** Agenda para a próxima década. 2 ed. Campus-Elsevier, Rio de Janeiro, 2009.

BARABÁSI, A. Network theory-the emergence of the creative enterprise. **Science**, v. 308, n. 5722, p. 639-641, 2005.

BARBIERI, J. C. A contribuição da área produtiva no processo de inovação tecnologias. **RAE – Revista de Administração de Empresas**, v. 37, n. 1, p. 66-77, 1997.

BART, C. Innovation, mission statements and learning. **International Journal of Technology Management**, v. 27, n. 6, p. 544-561, 2004.

BERKOWITZ, S. D. **An introduction to structural analysis:** The network approach to social research. Toronto: Butterworth-Heinemann, 1982.

BIGNETTI, L. P. Gestão de tecnologia e inovação: uma análise de autores, vertentes teóricas e estratégias metodológicas predominantes em trabalhos apresentados nos encontros da ANPAD. In: XXX ENCONTRO ANUAL DA ANPAD, 2006, Salvador. **Anais...** Salvador: ANPAD, 2006.

BIGNETTI, L. P.; CAPPRA, C. M.; THOMAS, E. Estudos nacionais e internacionais sobre gestão da inovação: uma análise dos principais autores e das vertentes teóricas atuais. In: XXXII ENCONTRO ANUAL DA ANPAD, 2008, Rio de Janeiro. **Anais...** Rio de Janeiro: ANPAD, 2008.

BULGACOV, S.; VERDU, F. C. Redes de pesquisadores da área de administração: um estudo exploratório. **Revista de Administração Contemporânea**, v. 5, n. SPE, p. 163-182, 2001.

BURT, R. S. **Structural holes:** the social structures of competition. Cambridge: Harvard university press, 1992.

CERVO, A. L.; BERVIAN, A. **Metodologia científica**: para uso dos estudantes universitários. 3. ed. São Paulo: McGraw-Hill do Brasil, 1983.

CONCEIÇÃO, O. A. C. A centra lidade do conceito de inovação tecnológica no processo de mudança estrutural. **Ensaios FEE**, v. 21, n. 2, p. 58-76, 2000.

DAMANPOUR, F. Organizational innovation: A meta-analysis of effects of determinants and moderators. **Academy of management journal**, v. 34, n. 3, p. 555-590, 1991.

DOSI, G. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. **Research policy**, v. 11, n. 3, p. 147-162, 1982.

GALASKIEWICZ, J.; WASSERMAN, S. (Ed.). **Advances in social network analysis:** research in the social and behavioral sciences. London: Sage, 1994.

GARDNER, J. W. A liderança nas cidades. In: Hesselbein, F. & Cohen, P. M. (Org.). **De Líder para Líder.** São Paulo: Futura, 1999. p.361-367.

GNYAWALI, D. R.; MADHAVAN, R. Cooperative networks and competitive dynamics: a structural embeddedness perspective. **Academy of Management review**, v. 26, n. 3, p. 431-445, 2001.

GOMES, G.; MACHADO, D. D. P. N.; GIOTTO, O. T. Análise do conteúdo dos artigos de inovação publicados nos anais do ALTEC, SIMPOI e EnANPAD (2003-2007). In: SIMPÓSIO DE ADMINISTRAÇÃO DA PRODUÇÃO, LOGÍSTICA E OPERAÇÕES INTERNACIONAIS – SIMPOI, 2009, São Paulo. **Anais**... São Paulo: SIMPOI, 2009.

GUIMARÃES, T. A.; GOMES, A. O.; ODELIUS, C. C.; ZANCAN, C.; CORRADI, A. A. A rede de programas de pós-graduação em administração no Brasil: análise de relações acadêmicas e atributos de programas. **Revista de Administração Contemporânea**, v. 13, n. 4, p. 564-582, 2009.

GUIMERÀ, R.; UZZI, B.; SPIRO, J.; AMARAL, L. A. N. Team assembly mechanisms determine collaboration network structure and team performance. **Science**, v. 308, n. 5722, p. 697-702, 2005.

GUNDLING, E. **The 3M Way to innovation**: balancing people and profit. New York: Vintage Books, 1999.

HAMEL, G. O laboratório de inovação em gestão. **HSM Management**, v. 58, set./out. 2006.

HANNEMAN, R. A.; RIDDLE, M. **Introduction to social network methods**. University of California, Riverside. 2005.

KNOKE, D.; KUKLINSKI, J. H. (Ed.). **Network analysis**. Newsbury Sage, 1982.

KUHN, T. S. **A estrutura das revoluções científicas**. 2. ed. São Paulo: Perspectiva, 1978.

LARIVIÈRE, V.; GINGRAS, Y.; ARCHAMBAULT, E. Comparative analysis of networks of collaboration of Canadian researchers in the natural sciences, social sciences and the humanities. **Scientometrics**, v. 68, n. 3, p. 519-533, 2006.

LEMOS, C.; LASTRES, H. M. M.; ALBAGLI, S. Inovação na era do conhecimento. **Informação e globalização na era do conhecimento.** Rio de Janeiro: Campus, p. 122-144, 1999.

LAZZARINI, S. G. Mudar tudo para não mudar nada: análise da dinâmica de redes de proprietários no Brasil como mundos pequenos. **RAE-eletrônica**, v. 6, n. 1, 2007.

LIU, X.; BOLLEN, J.; NELSON, M. L.; SOMPEL, H. V. Co-authorship networks in the digital library research community. **Information processing & management**, v. 41, n. 6, p. 1462-1480, 2005.

MACHADO, D. D. P. N.; GOMES, G.; GIOTTO, O. O que se produz de conhecimento sobre inovação: uma breve análise das características dos artigos de inovação publicados nos anais do ENANPAD (1997-2007). In: SIMPÓSIO DE ADMINISTRAÇÃO DA PRODUÇÃO,

LOGÍSTICA E OPERAÇÕES INTERNACIONAIS – SIMPOI, 2008, São Paulo. **Anais**... São Paulo: SIMPOI, 2008.

MACIAS-CHAPULA, C. A. O papel da informetria e da cienciometria e sua perspectiva nacional e internacional. **Ciência da informação**, v. 27, n. 2, p.64-68, 1998.

MARTINS, G. A.; THEÓPHILO, C. R. **Metodologia da investigação científica para ciências sociais aplicadas.** São Paulo: Atlas, p. 53-82, 2007.

MARTINS, G. S. A construção do conhecimento científico no campo de gestão de operações no Brasil: uma análise sob a ótica de redes sociais do período 1997-2008. São Paulo, 2009. 179 p. Dissertação (Mestrado em Administração), Fundação Getúlio Vargas, São Paulo, 2009.

MARTINS, G. S.; ROSSONI, L.; CSILLAG, J. M.; MARTINS, M. E.; PEREIRA, S. C. F. Gestão de operações no Brasil: uma análise do campo científico a partir da rede social de pesquisadores. **RAE-eletrônica**, v. 9, n. 2, 2010**.**

MENDES-DA-SILVA, W.; ONUSIC, L. M.; GIGLIO, E. M. The finance research network in Brazil: a small world. **Revista de Administração Contemporânea**, v. 17, n. 6, p. 739-763, **2013**.

MILGRAM, S. The small world problem. **Psychology today**, v. 2, n. 1, p. 60-67, 1967.

MOODY, J. The structure of a social science collaboration network: Disciplinary cohesion from 1963 to 1999. **American sociological review**, v. 69, n. 2, p. 213-238, 2004.

MONTEIRO, T. A.; SACOMANO NETO, M.; GIULIANI, A. C. Redes de inovação e composto mercadológico: um estudo exploratório sobre o desenvolvimento de produtos. **Revista de Administração da UFSM**, v. 6, n. 4, p. 672-684, 2013.

MUYLDER, C. F.; ROCHA, A. M.; GONÇALVES, C. M.; SOUZA, R. B.; OLIVEIRA, W. T. Tema Inovação: uma análise bibliométrica no Evento da EnANPAD 2007. **Gestão & Tecnologia,** v. 8, n.1, p. 1-13, jan./jul. 2008.

NELSON, R. Uso da análise de redes sociais no estudo das estruturas organizacionais. **Revista de Administração de Empresas**, v. 24, n. 4, p. 150-157, out./dez. 1984.

NEWMAN, M. E. J. Scientific collaboration networks. I. Network construction and fundamental results. **Physical review E**, v. 64, n. 1, p. 1-8, 2001.

NEWMAN, M. E. J. The structure of scientific collaboration networks. **Proceedings of the National Academy of Sciences**, v. 98, n. 2, p. 404-409, 2001.

NOHRIA, N. Introduction: Is a network perspective a useful way of studying organizations. **Networks and organizations: Structure, form, and action**, v. 1, p. 22, 1992.

OTTE, E.; ROUSSEAU, R. Social network analysis: a powerful strategy, also for the information sciences. **Journal of information Science**, v. 28, n. 6, p. 441-453, 2002.

Pennings, J. M. (1998). **Innovations as precursors of organizational performance. In: Information technology and organizational transformation - innovation for the 21st century organization**. Edited by Robert d. Galliers & Walter R. J. Baets. New York: John Wiley & Sons.

PEREIRA, J. A.; REINERT, M.. A influência das redes sociais na inovação: um estudo de caso em uma incubada do Centro Incubador Tecnológico–CIT/FUNDETEC. **Revista Eletrônica de Ciência Administrativa - RECADM**, v. 12, n. 2, p. 140-155, 2013.

PODOLNY, J. M.; PAGE, K. L. Network forms of organization. **Annual review of sociology**, v. 24, n. 1, p. 57-76, 1998.

POPPER, K. R. **Conjecturas e refutações**. Brasília: UNB, 1972.

PRICE, D. J. S. Networks of scientific papers. **Science***,* v. 149, p. 510-515, 1965.

RAPOPORT, A.; HORVATH, W. J. A study of a large sociogram. **Behavioral Science**, v. 6, n. 4, p. 279-291, 1961.

REDNER, S. How popular is your paper? An empirical study of the citation distribution. **The European Physical Journal B-Condensed Matter and Complex Systems**, v. 4, n. 2, p. 131-134, 1998.

ROPELATO, M., SILVEIRA, A.; MACHADO, D. D. P. N. Inovação: análise da produção científica brasileira: 2006-2009. In: SIMPÓSIO DE ADMINISTRAÇÃO DA PRODUÇÃO,

LOGÍSTICA E OPERAÇÕES INTERNACIONAIS – SIMPOI, 2010, São Paulo. **Anais**... São Paulo: SIMPOI, 2010.

ROSSONI, L.; HOCAYEN-DA-SILVA, A. J.; FERREIRA JÚNIOR, I. Aspectos estruturais da cooperação entre pesquisadores no campo de administração pública e gestão social: análise das redes entre instituições no Brasil. **Revista de Administração Pública**, v. 42, n. 6, p. 1041 a 1067, 2009.

ROSSONI, L.; GUARIDO FILHO, E. R. Cooperação entre Programas de Pós Cooperação entre Programas de Pós-Graduação em Graduação em Administração no Brasil: Evidências Estruturais em Quatro Áreas Temáticas. **Revista de Administração Contemporânea**, v. 13, p. 366-390, 2009.

ROTHWELL, R. Towards the fifth-generation innovation process. **International marketing review**, v. 11, n. 1, p. 7-31, 1994.

SCHUMPETER, J. **Theorie der wirtschaftlichen Entwicklung**. Leipzig: Duncker und Humblot, 1911.

_____. **Teoria do desenvolvimento econômico: uma investigação sobre lucros, capital, crédito, juro e o ciclo econômico**. São Paulo: Abril Cultural, 1982.169 p.

SCOTT, J. **Social Network Analysis**: a handbook. 2 ed. London: Sage Publications, 2000.

SILVA, A. B. O.; MATHEUS, R. F.; PARREIRAS, F. S.; PARREIRAS, T. A. S. Análise de redes sociais como metodologia de apoio para a discussão da interdisciplinaridade na ciência da informação. **Ciência da Informação**, v. 35, n. 1, p. 72-93, 2006.

TIDD, J.; BESSANT, J.; PAVITT, K. **Managing innovation**: integrating technological, managerial organizational change. New York: John Wiley & Sons, 2005.

TOMAÉL, M. I.; ALCARÁ, A. R.; DI CHIARA, I. G. Das redes sociais à inovação. **Ciência da informação, Brasília**, v. 34, n. 2, p. 93-104, 2005.

UZZI, B. Social structure and competition in interfirm networks: The paradox of embeddedness. **Administrative science quarterly**, p. 35-67, 1997.

VAN DE VEN, A. H.; POOLE, M. S. Methods for studying innovation development in the Minnesota Innovation Research Program. **Organization Science**, v. 1, n. 3, p. 313-335, 1990.

VERGARA, S. C. **Projetos e relatórios de pesquisa em administração**. 3 ed. São Paulo: Atlas, 2000.

WAN, D.; ONG, C. H.; LEE, F. Determinants of firm innovation in Singapore. **Technovation**, v. 25, n. 3, p. 261-268, 2005.

WASSERMAN, S; FAUST, K. **Social network analysis: Methods and applications**. New York:

Cambridge university press, 1994.

WATTS, D. J.; STROGATZ, S. H. Collective dynamics of 'small-world'networks. **Nature**, v. 393, n. 6684, p. 440-442, 1998.

ZALTMAN, G.; DUNCAN, R.; HOLBEK, J. **Innovations and organizations.** New York: Wiley, 1973.