CONTENT ANALYSIS OF PUBLICATIONS ON KNOWLEDGE NETWORKS

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ABSTRACT: In the last few years there has been a growing interest especially in knowledge networks as they are also relevant for clusters. Owing to the increasing number of articles, it is important to explore and analyze this reality. Thus, the main purpose of this study is to be a first useful exploratory investigation about knowledge networks to know the main techniques and parameters used by scholars. In order to achieve this aim a content analysis from 2001 to 2014 of publications on knowledge networks in the main journals examined by researchers. A 45 articles database was obtained; in which it has been studies the general data, research methodology, sample characteristics and scope of application.

KEYWORDS: Knowledge Network, Knowledge, Network, Innovation, Cluster, Competitiveness.

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Introduction

To begin with, networks can be defined as a finite set or sets of actors and the relation or relations defined on them. The presence of relational information is a critical and defining feature of a social network (Wasserman & Faust, 2008). It is relevant to remark the importance of the study of these networks as they are highly related to clusters. Clusters are normally understood as social networks that are made of different actors that interact closely with each other and it is a powerful tool to measure social capital potentialities.

Then, in order to work on networks, we can find the Social Network Analysis (SNA) which can be defined as the study of the relationships between a defined set of elements such as: individuals, groups, organizations, countries and even events (Molina, 2001). It is based on the relationship between nodes. These nodes can have different attributes like age, weight, industry or income. The nodes in the network are the people and groups while the links show relationships or flows between the nodes.

However, in the last few years there has been a growing interest especially in knowledge networks as they are also relevant for clusters. Hence, the notion of "knowledge networks" appears to cover a variety of organization-related social structures that have a common reason of being in knowledge sharing. The concept refers to rather loosely coupled networks of employees who cross intra – or inter – organizational boundaries and interact to learn from each other by exchanging information and experiences.

Knowledge networks are now recognized as a crucial element underlying the economic success and competitiveness of regions (Asheim, Isaksen, Nauwelaers, and TÖdtilng 2003; Bathelt, Malmberg, and Maskell 2004; Cooke, Heidenreich, and Braczyk 2004; Rutten and Boekema 2007). Typically, it is argued that the existence of established spatially proximate knowledge networks is one of the key reasons why a number of the most successful localities and regions thought the world have become o remained more competitive than those that have not adopted a network approach (Huggins 2000, Knoben and Oerlemans 2006, Lawson and Lorenz 1999, Owen-Smith and Powell 2004, Storper 1997).

As there are several studies about knowledge networks, the main purpose of this study is to be a first useful exploratory investigation about knowledge networks to know the main techniques and parameters used by scholars to explore the use of the concept in

business and management and to offer the reader a main idea of the concept of knowledge networks and its implications.

To start, the study begins with a conceptual section, in which the concept of knowledge networks is defined. In order to make it more clearly for the reader as it may seem a bit confusing at the beginning, this section is divided into other subsections. First, a conceptual framework of what networks is business and management are and, also, its characteristics. Second, it is explained the Social Network Analysis; a type of network analysis. Thirdly, a subsection related to knowledge network where it is explained the concept, its characteristics and some typologies of knowledge networks. To end, it is explained how knowledge networks are related to innovation in companies.

Subsequently, the study will analyze 45 papers published in the journals with high impact factor according to the Journal Citation Report; all these articles were searched in the ISI WEB OF KNOWLEDGE database; where an almost 14 year – period (2001 – 2014) has been taking into account, by means of content analysis technique. Later on, the data will be codified in order to be easier to work with it when using statistics to make descriptive analysis.

Hence, to sum up, this project is structured as follows: first, introduces the concept of knowledge networks in order to be able to generate a global definition of it; next, it presents the methodology used to perform the content analysis; later, the main data and results are outlined and, finally, the general conclusions of the study, its limitations and future lines of the study are presented.

1. What are knowledge networks?

In this part of this academic study, a review of the concept of "knowledge networks" will be established, based, in part, on the different researches which have been used for the study. To begin, it starts with a review of the concept of networks; followed by another one related to the concept of social network analysis. Furthermore, in the next point, we will explain the knowledge in the business area and the concept of knowledge networks based in the information found. Finally, to end, it will appear a little review of how knowledge networks are related to innovation.
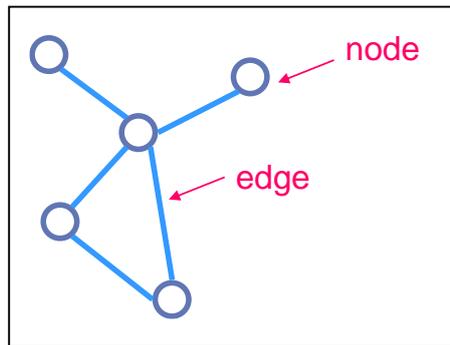
1.1. Networks

First of all, we can define networks as a finite set or sets of actors and the relation or relations defined on them. The presence of relational information is a critical and defining feature of a social network (Wasserman & Faust, 2008).

Illustration 1. Network - Graphical Analysis
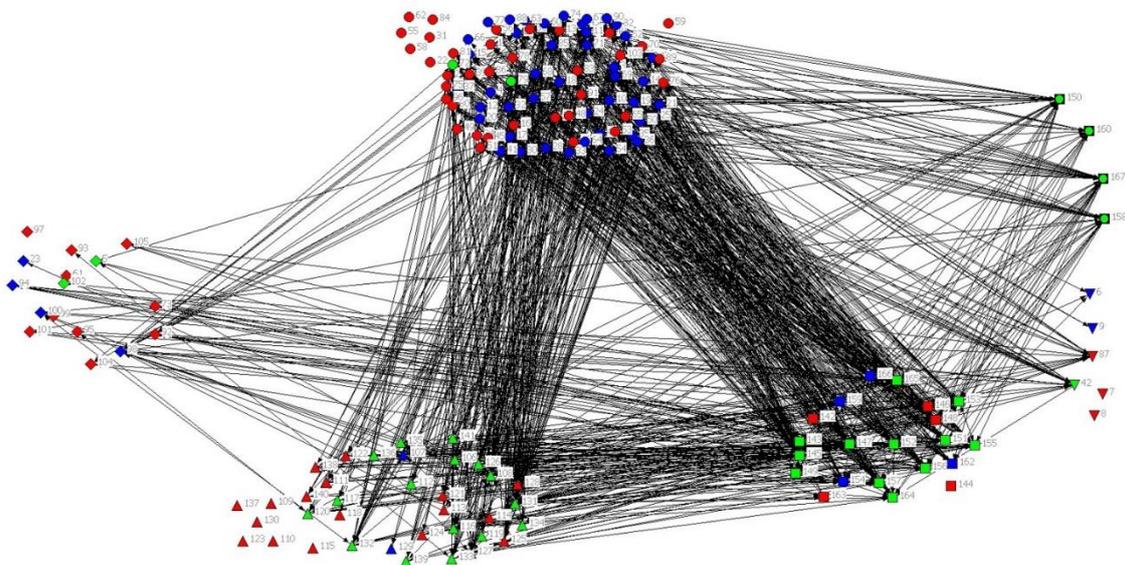
To continue, in order to understand it, a network can be compared to a graph; where the vertices match with the edges or arcs and are studied by the mathematics. Then, the nodes match the links and are studied by the computer science. Later, the sites are related to bonds and are studied by physics. Finally, the actors are related to ties and relations which are studied by the sociology.

Illustration 2. Network = Graph

node

edge

Additionally, it is relevant to remark the importance of the study of these networks as they are highly related to clusters. Clusters are normally understood as social networks that are made of different actors that interact closely with each other. On top of that we have to point the several advantages that has the study of this concept. To begin, it helps to identify structural properties. Secondly, it enables individual and group analysis. Then, we have to say that it is appropriate to identify key actors as well as non relevant actors. Besides, it allows the existence of a large number of indicators that permits a wider range of theoretical propositions. Finally, it is a powerful tool to measure social capital potentialities.

1.2. Social Network Analysis (SNA)

Social Network Analysis (SNA) can be defined as the study of the relationships between a defined set of elements such as: individuals, groups, organizations, countries and even events (Molina, 2001). It is based on the relationship between nodes. These nodes can have different attributes like age, weight, industry or income. The nodes in the network are the people and groups while the links show relationships or flows between the nodes. After having defined the concept of Social Network Analysis, it is time to point its basic properties:

1. Size: it represents the number of possible and potentials links between its actors.
2. Density: it gives us an idea about the level of utilization of the whole connectivity potential in a given network. Its formula is: number of links present/ number of links possible.
3. Geodesic distance: is the number of relations in the shortest possible path from one actor to another (Robert A. Hanneman and Riddle 2005).

4. <u>Diameter</u>: this indicator provides information on what is the largest geodesic distance in the network. It measures the steps that are necessary to go from one extreme to another.

In order to understand networks and their participants, we evaluate the location of actors in the network. Measuring the network location is finding the centrality of a node. These measures give us insight into the various roles and grouping in a network like who are the connectors, leaders, bridges, and isolates or where are the clusters and who is in them. Then, in order to better understand the following classification it is important to say that two nodes are connected if they regularly talk to each other, or interacts in some way.

So, to start we are going to explain what **degree centrality** is. Social network researchers measure network activity for a node by using the concept of degrees which can be defined as the number of direct connections a node has. However, what really matters is where those connections lead to and how they connect the otherwise unconnected. Therefore, the one that has the most direct connections in the network; this means the most active node in the network; is known as the "connector" or the "hub", it connects only those who are already connected to each other. Here, we can describe two types. The first one named **indegree** and the other one, **outdegree**; so, the indegree are the number of links that get into a node and the outdegree are the number of links that get out of a node.

Subsequently, we can find the **betweenness centrality** where the node has few direct connections, fewer than the average in the network. Although, it is one of the best locations as it is between two important constituencies. It plays a "broker" role in the network. This location plays a powerful role in the network; nevertheless, it is a single point of failure. A node with high betweenness has great influence over what flows and does not in the network.

Besides, we are going to explain the **closeness centrality** where the nodes have the shortest paths to all others, they are closes to everyone else. They are in an excellent position to monitor the information flow in the network, they have the best visibility into what is happening in the network.

Illustration 3. Centrality Indicators

indegree   outdegree   betweenness   closeness
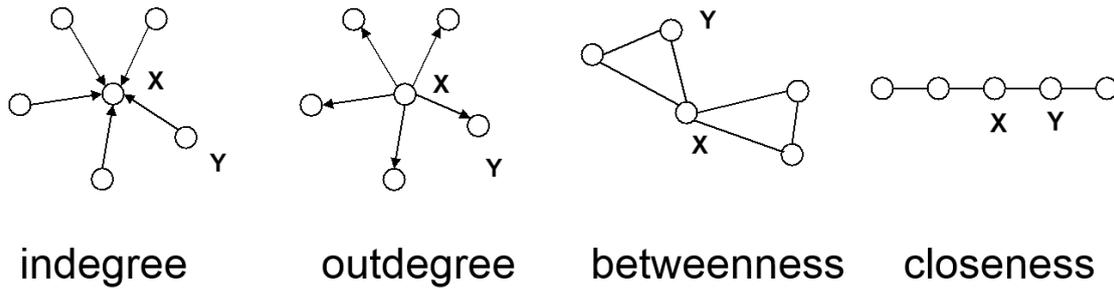
Another important aspect to explain in this theme is the **brokerage**. Any brokered exchange can be thought of as a relation involving three actors, two of whom are the actual parties to the transaction and one of whom is the intermediary or broker (Gould and Fernandez, 1989) and, moreover, brokerage represent an intransitive triple (Ibid: 97). Meanwhile, there is a classification of the forms of brokerage relations that is an exhaustive listing of types of two-step paths on which any actor may lie, and it is thus an exclusive and exhaustive partition of any actor j's total raw brokerage score t_j (Ibid: 101). After that stage, scholars have identified five types of roles, according to the direction of the ties and the groups actors belong to. In a situation where *a* sends a tie to *b* who sends a tie to *c* and there are no ties between *a* and *c*, the four possible brokerage roles of *b* are:

- Coordinator: *a, b* and *c* belong to the same group
- Gatekeeper: *a* and *b* belong to the same group, while *c* belongs to a different one.
- Representative: *b* and *c* belong to the same group, while *a* belongs to a different one.
- Liason: all the actors belong to different groups.

Illustration 4. Brokerage
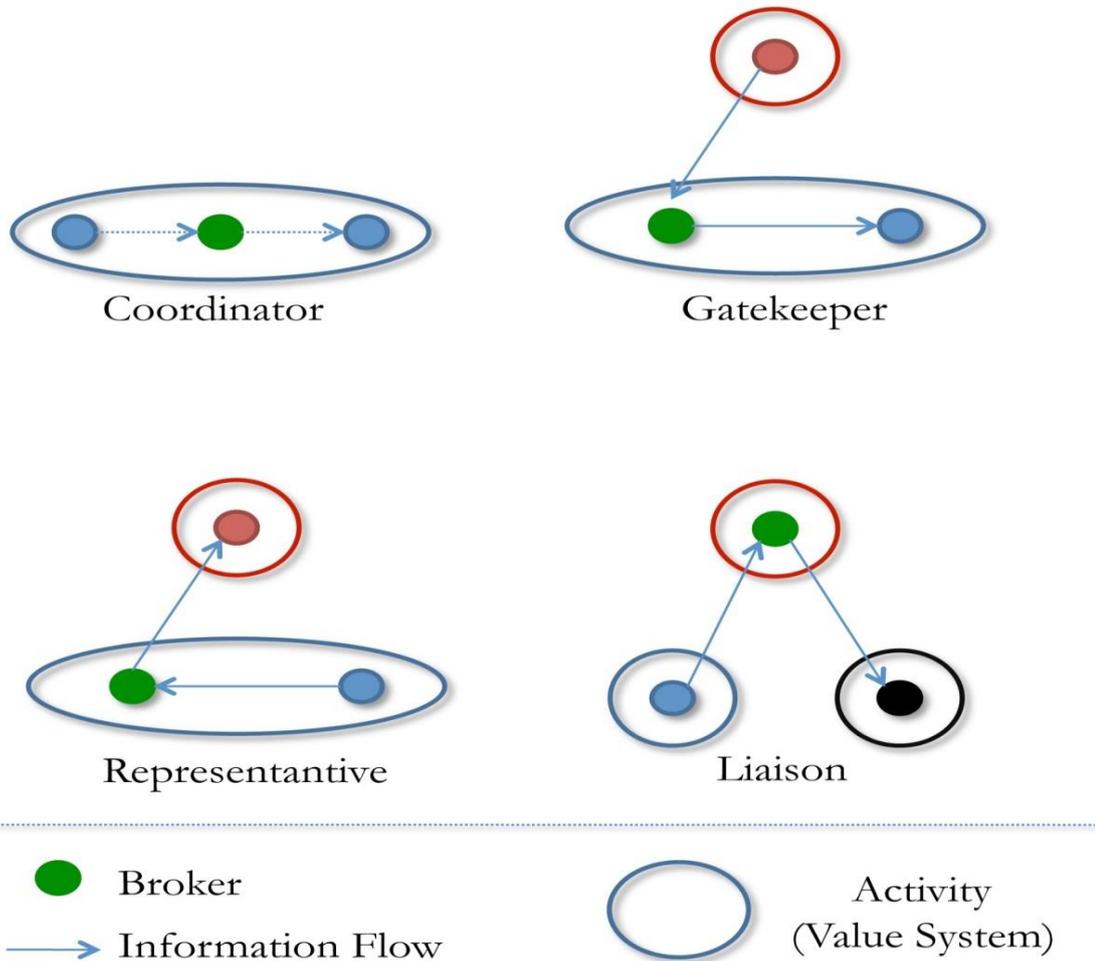
To end with Social Network Analysis, it is relevant to explain another classification related to the degree, centrality and knowledge. Firstly, a node can be "absorber" if I (indegree) divided O (outdegree) is bigger than 1; we can say that the firm is a net absorber of knowledge. Secondly, it can also be a "source"; if I divided O is minor than 1, the firm is a net source of knowledge. Thirdly, we can find the "mutual exchange"; if I divided O is about 1, the firm engages in the mutual exchange of knowledge. Finally, a node can be "isolate"; firms with In an Out centralities approximating to 0.

Illustration 5. Classification related to the degree, centrality and knowledge

ABSORBER

SOURCE

MUTUAL EXCHANGE

ISOLATE
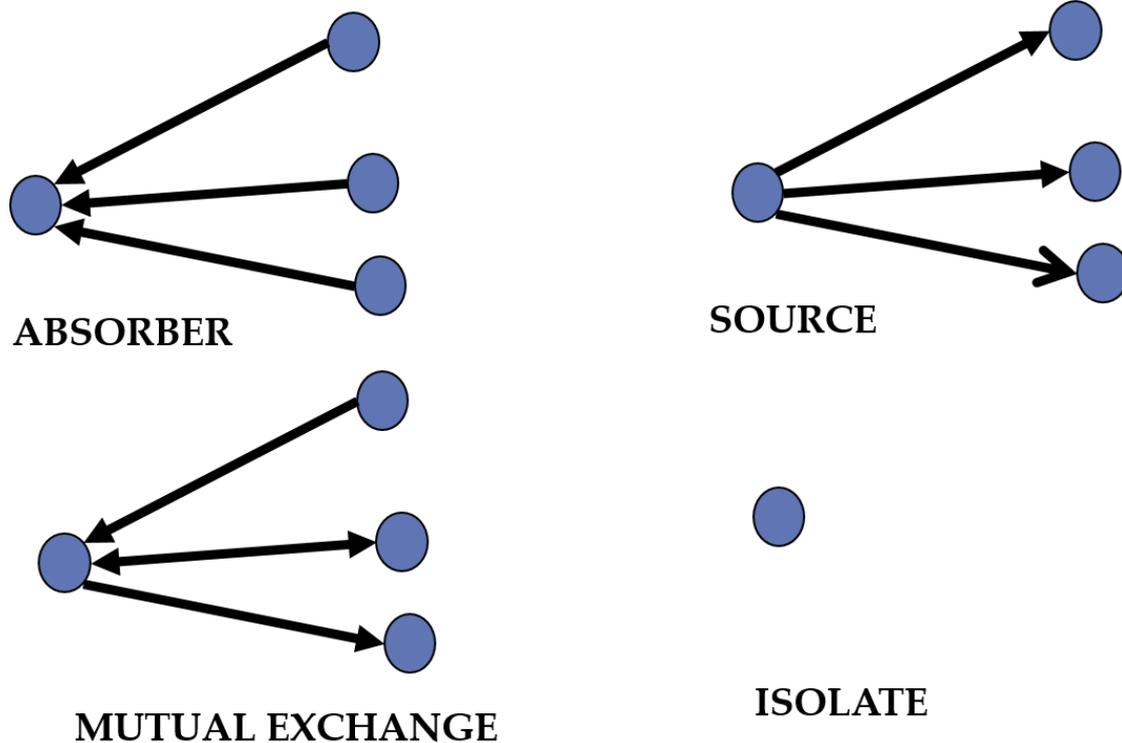
1.3. The concept of knowledge networks and its relevance in business

The concept of knowledge networks has attracted much interest over the years. It comes from the area of knowledge management but as more and more firms are trusting on their knowledge bases; knowledge networks have become a very visible reality.

To start, we define knowledge management as the process of systematic organizing and managing knowledge processes, such as identifying knowledge gaps, acquiring and developing knowledge, storing, distributing and sharing knowledge and applying knowledge (Verburg and Andriessen, 2011). The management of knowledge processes has become crucial in improving the performance of organizations. Knowledge provides the basis for improvements and innovations in companies.

To continue, knowledge networks can be found within one corporation, spanning many business units, but they can also be inter-organizational, comprising members of

different companies. So, we can find them in informal groups of experienced and inexperienced traditional workers and globally distributed groups of expert knowledge professionals. However, they have much in common as they are all emergent, autonomous and self-organizing networks, whose primary purpose involves knowledge sharing, knowledge creation and learning. Knowledge circulates and flows through networks that consists of agents sharing cognitive capabilities and trust, but no necessarily the same location; or what is to say that networks do not require permanent co-location for interactive learning to take place (Torre and Rallet, 2005).

Once we have introduced the concept of knowledge networks and other relative aspects, now we are going to identify the key characteristics of knowledge networks. We will consider and further explain five:

a. Interaction, connection and identity:

McDermott (1999) uses the degree of connection and identity among members as the key dimension to distinguish between three types of knowledge networks: user groups, networks and CoPs (communities of practice). User groups are a collection of individuals who are all interested in certain types of information but with hardly any interaction and a weak indentity. Networks are: groups of people sharing a common interest, exchange questions and solutions, but have limited sense of common identity and rarely meet as a network. To end, CoPs are groups of people sharing a common identity, history and purpose, which is often directed at developing best practices. Although social network theory was initiated in a quite different context, in its analysis of knowledge networks it focuses on similar characteristics, such as density of links, tie strength, intensity and frequency of interaction (Bogenrieder and Nooteboom, 2004; Wasko et al., 2004). We will analyze its differences later on.

b. Contract value and purpose:

The issue of contract value is related to what Andriessen et al. (2004) call purpose. On the basis of various case studies they concluded that all knowledge networks exist for knowledge sharing, but that this knowledge sharing appears to serve several purposes. These different purposes can be arranged on a dimensions of individual versus organization orientation:

a. Solving immediate individual problems, for example through sending of and responding to "who can help me on this problem "emails in networks of professionals.

b. Individual learning and building a wider perspective on the practice the group is working in.

c. Developing best practices, manuals, and guidelines for the organization.

d. Developing innovative solutions and new processes for the organization.

c. <u>Formalization and composition:</u>

The aspect of formalization is also addressed by Botkin (1999) who stresses the aspect of visibility. He distinguishes between CoPs – with high visibility- and knowledge communities – with low visibility. Brown and Duguid (2001) show that effective knowledge sharing and creation can also take place in large, loosely coupled groups. This occurs where large groups have a common practice, such as in scientific associations.

Where practice is common, communication can be global. Scientists from all over the world can share knowledge, even without knowing each other. Brown and Duguid (2001) prefer to call these groups networks of practice (NoPs), since most members will never interact or know each other personally.

d. <u>Boundary, connectivity and identity</u>:

Some knowledge networks consist of members working relatively close together with mainly face to face meetings. Other knowledge networks, however, are geographically widely distributed and interaction is mainly facilitated electronically, or through a combination of two modes of interaction.

e. <u>Development stages</u>:

To end, development stages of knowledge networks may in some cases be considered as separate types. In the literature, two types of stage models are found, namely life cycle models – from birth to death - and evolution models – from low to high level of maturity.

Gongla and Rizzuto (2001), however, present an evolution model including several stages. Their model describes how knowledge networks transform, becoming more capable at each stage. The first two stages in their model describe the development of a network and the definition of its existence. During these stages access to one another as community members and to individual learning are key functions of the network. At the third, so-called "active stage", members work together to solve business problems and to exploit business opportunities. They make the community's shared knowledge available to external groups. At the fourth "adaptive stage", a community has moved to a level where it senses and responds to external conditions. At this stage, the community innovates, creating significant new business objects, new solutions, new offerings, new methods and new processes.

In Gongla and Rizzuto's view, knowledge networks can mature or dissolve at any one of these stages beyond the initial formation level. It does not appear to be fruitful to regard the stages in a life cycle model as separate types of networks, but certain stages in evolutionary models may be considered as such, the purposes of the network change radically.

To conclude, the notion of "knowledge networks" appears to cover a variety of organization-related social structures that have a common reason of being in knowledge sharing. The concept refers to rather loosely coupled networks of employees who cross intra – or inter – organizational boundaries and interact to learn from each other by exchanging information and experiences. However, these social structures may differ in the objectives of their knowledge sharing in their structure, their composition and distribution, and in the way they interact and communicate.

Once all these aspects have been explained, we can pass to the next point. With this in mind, we are ready to describe the different types of knowledge networks that have been stated according to Verburg and Andriessen (2011).

To begin, we have the **informal networks** which are group of employees with a common area of interest, often closely related to their work (practice), having substantial interaction, a common history and culture involving shared concepts, ideas, stories, etc. The main purpose of people in these networks is to learn from each other; the transfer of this shared knowledge to the company is of less importance. This type of knowledge networks is generally not very formalized, although some may receive support when they

have proven their value. These communities grow spontaneously, are either small or have a small core and larger circle of peripheral members. So, after some studies, scholars have stated that a very active coordinator or core group and adequate ICT support are generally required to ensure success of such networks.

Next, we found the **question and answer networks**. These are knowledge networks with low to intermediate proximity and low levels of institutionalization. These networks consist of employees who exchange, over a company intranet, questions like who can help me with… and answers concerning the solution of certain practical problems. Although the size of such networks may be quite large (sometime many hundreds of members), they still display some form of group identity, based in commonality in function and organization. Question and answer networks have limited purposes and seem to thrive without many success conditions, except minimal commitment of those involved as members and good email connections.

Apart from these, there are also the **strategic networks** which are institutionalized groups of experts whose activities are focused on organizational learning. These groups are highly supported with resources and have a strong "contract value". Or what is the same, participants are expected, implicitly or explicitly, to perform for the company, to develop best practices or even innovative solutions. These networks generally consist of limited number of experts, without a periphery of "lurkers", since membership is generally not open. In some cases, these groups may cross the border between knowledge networks (learning oriented groups) and work groups or task forces (product oriented groups). Like most knowledge networks found in large companies, members of the strategic networks tend to be organizationally and geographically widely distributed. Some of them, however, have much interaction in face-to-face meetings. Moreover, this type of networks require intensive preparation, member selection, support and coordination to be effective.

Finally, added to that, we find the **online strategic networks**. This is a small group of the networks studied here is relatively highly institutionalized yet shows low levels of proximity among its members. These networks have similar institutionalization as the strategic networks described above but low proximity, particularly because of their exclusive communication via electronic means (means Internet or Intranets). This setting makes interaction, coordination, and cohesion forming within the network quite difficult. Such networks seem to be rare that's why they have been named this way.

To conclude, the four types presented here are ideal types, in the sense that in actual practice one may find networks with characteristics of more than one type or networks that oscillate between types. The concept of basic types of networks does not necessarily imply that such networks are stable. On the contrary, knowledge networks may have shifting membership and also shifting purposes. Another way in which knowledge networks thrive and change is through the emergence of subgroups.

As we have said before knowledge intensive organizations are dependent on transferring and sharing knowledge, experiences and insights among employees. Two ways of dealing with this issue are found in organizations, codification and interaction. The first approach leans heavily on knowledge systems and procedures to store and exchange documents. The second approach relies more on interpersonal exchange of knowledge and highlights the role of knowledge intermediaries and knowledge sharing networks. Both can be considered elements in a knowledge-based perspective on firms which highlights the organizational routines and experiences on which individuals draw to perform optimally and use the creative potential of human action (Tsoukas, 2002).

Incidentally, we must not forget then to define the concept of **knowledge bases** (Asheim and Gertler, 2005) which stresses that industries differ substantially with regard to their specific knowledge base, of which three are distinguished: analytical (science-based), synthetic (engineering based) and symbolic (creativity based). As for, the role of the agglomeration effects concerning the formation of knowledge networks cannot be generalized, but its importance depends on the specific knowledge base of the industries. Added to that, firms in a cluster are likely to be characterized by different knowledge bases. By knowledge base, we also understand the set of information inputs, knowledge and capabilities that inventor draw on when looking for innovative solutions (Dosi, 1988). Knowledge is seen as residing in firms' skilled knowledge workers, who embody tacit capabilities, and meanwhile, it is not merely the sum of each individual's knowledge, since it resides in the organizational memory of the company. The knowledge base in considered as a result a process of cumulative learning, which is inherently imperfect, complex and path-dependent (Dosi, 1997) and which delivers persistent heterogeneity between enterprises in the economic system.

Each single knowledge base implicates specific combinations of tacit and codified knowledge (Polanyi, 1966; Nonaka and Takeuchi, 1995), qualifications and skills that are

required by organizations as well as different innovations challenges and patterns of knowledge exchange, which in turn affect the sensitivity to geographical distance for interactive learning (Amin and Cohendent, 2004). Additionally, Asheim et al. (2011) state: "As this threefold distinction refers to ideal- types, most activities are in practice comprised of more than one knowledge base. The degree to which certain knowledge base dominates, however, varies and is contingent on the characteristics of firms and industries as well as between different type of activities, for instance research and production".

Innovation processes within industrial settings that draw on the **analytical knowledge base** strongly depend on scientific knowledge input. Knowledge creation is often based on deductive cognitive and rational processes, or on formal models that require abstraction skills. Examples with relevance to the biotechnology industry are laboratory-based research or scientific discourses. Basic and applied research as well as systematic product and process development belong to the core activities of firms. In order to turn knowledge into innovation successfully, firms often have their own R&D departments, but also rely profoundly on the research results of universities and other research organizations. Knowledge inputs and outputs involved in innovation processes always include combinations of tacit and codified components (Nonaka and Takeuchi, 1995; Johnson et al., 2002). For this case, face to face contacts are less important than they are for the synthetic case, because knowledge is more often codified, and therefore, easier to exchange between globally distributed actors (Asheim et al., 2007; Moodysson, 2008).

There are several reasons for the strong codified knowledge content to exist:

        a. Knowledge generation is often based on reviews of existing studies or on,
        b. The application of scientific principles and methods,
        c. Innovation processes are rather formally organized and
        d. Results tend to be documented in reports, electronic files or patent descriptions.

These activities require people with specific qualifications and capabilities such as analytical skills, abstraction, theory building and testing, and documentation. As a consequence, the core of the work force needs university education and/or research experience. The application of knowledge in such industries is often integrated in more

radical product or process innovations. These innovations build starting points for new start-ups and spin-offs on a regular basis (Asheim and Coenen, 2005; Asheim et al., 2007, 2011).

Product and process innovations within industries that draw on the **synthetic knowledge base** take place mainly through the application or (new) combination of existing knowledge with the aim to solve a specific problem that comes up in the interaction with clients and suppliers. Knowledge formation is characterized as a more inductive process. Characteristics activities are, to mention some examples, system design, prototyping, fine tuning, testing, and practical work in general. Many of these activities are visible within the automotive industry. R&D intensity is in general lower than the first type. Overall, the accentuation within R&D refers more to the "D-part" in the form of product or process development. If research is a matter of interest, it is mainly applied research, even within industry-university relationships. Although collaboration with universities and other research organizations can play a significant roles for firms' innovation processed, interactive learning is often dominated by industry-industry links. Knowledge embodied in a particular technical solution or engineering work is at least partially codified.

However, due to the fact that knowledge often arises from experience gained at the workplace, and through learning by doing, using and interacting, tacit knowledge is typically more important than in the analytical knowledge base (Nonaka and Takeuchi, 1995; Johnson et al. 2002). The strong tacit nature of knowledge almost always requires being at the same time at the same place in order to share this knowledge (Audretsch, 1998). So, the synthetic type shows a relatively stronger sensitivity towards spatial proximity between innovation partners. Professional and polytechnic schools as well as on-the-job trainings are of particular importance to provide an adequate educational background facilitating concrete know-how, craft and practical skills. The knowledge creation process as well as the application process is dominated by the modifications of existing products and processes with the aim of achieving higher efficiency and reliability of new solutions, or to raise the practical utility and user friendliness of products from the customers' perspectives. Accordingly, innovation processes in such industries have a mainly incremental nature. They mostly take place in existing firms, whereas spin-offs are relatively less frequent (Asheim and Coenen, 2005; Asheim et al., 2007, 2011).

Finally, to sum up, the geographical patterns of knowledge networking have often been explained by pointing at agglomeration effects, in general, or the specific regional context in particular, such as the concentration of applied research institutes, universities and polytechnics. However, it is necessary to consider also the characteristics of the knowledge base in the dominating industry of a cluster to explain the characteristics of knowledge networking. Then, the concept of knowledge base is useful to analyse, compare and explain knowledge exchange processes in different industries. With the help of the knowledge base concept differences between clusters and industries in a spatial context can be explained concerning knowledge creation, innovation processes, knowledge exchange partners, knowledge content and particularly spatial proximity. Firms try to connect or mix dissimilar vs. comparable knowledge assets throughout their knowledge networks. The position of an industry within the triangle of three knowledge bases changes through time. Other impact factors may be important to explain the structure and functioning of knowledge networking. These include firm attributes, such as size, age, owner structure within specific industry-region-combinations, the position of the firm or industry in a life-cycle, the necessity to find specialized knowledge and correspondingly the scarcity of potential collaborators as a push-factor to look for sources outside the regional/national system of innovation and the influence of supportive infrastructure.

1.4. How knowledge networks are related to innovation.

Knowledge networks are now recognized as a crucial element underlying the economic success and competitiveness of regions (Asheim, Isaksen, Nauwelaers, and TÖdtilng 2003; Bathelt, Malmberg, and Maskell 2004; Cooke, Heidenreich, and Braczyk 2004; Rutten and Boekema 2007). Typically, it is argued that the existence of established spatially proximate knowledge networks is one of the key reasons why a number of the most successful localities and regions thought the world have become o remained more competitive than those that have not adopted a network approach (Huggins 2000, Knoben and Oerlemans 2006, Lawson and Lorenz 1999, Owen-Smith and Powell 2004, Storper 1997). Generally, the development of leading advanced regional economies is considered to involve the flow of knowledge through a highly networked regional business culture rich in "untraded interdependencies" (Castells and Hall 1994, Cooke, Heidenreich and Braczyk 2004, Porter 1998, Rutten and Boekema 2007, Saxenian 1994, Storper 1995). It is argued that networks within these leading regional economies are able to mobilize and fully develop the human capital residing within knowledge-based firms, in particular small and medium sized enterprises, through external networks

providing feedback loops, ensuring the continuation of high levels of innovation (Bresnahan and Gambardella 2004, Crescenzi 2005, Garnsey and Lawton Smith 1998, Goman 2000). The important role of external knowledge has led to the innovation process being conceived as a systemic process resulting from both formal and informal networking with other knowledge actors such as universities, R&D labs and other firms (Chesbrough 2003, Cooke, Heidenreich and Braczyk 2004, Seely Brown and Duguid, 2001).

Drucker (1989) provides us with a useful definition of knowledge, viewing it as information that changes something or somebody, either by becoming grounds for action or by making an individual or an institution capable of different or more effective action. Knowledge, unlike simple information, is about action and is a function of a particular stance (Nonaka and Takeuchi 1995). Of course, knowledge takes many different forms, with one of the most familiar typologies suggesting that knowledge is either explicit/codified or tacit. Generally, explicit knowledge refers to information that can be easily communicated among individuals , whereas tacit knowledge like skills, competence and talents; is more difficult to directly communicate to someone else in a verbal or other symbolic form (Huggins and Izushi 2007, Nonaka and Takeuchi 1995). Codified knowledge is usually considered to be relatively less sensitive to space than tacit knowledge, with tacit knowledge flow bounded within specific spatial contexts (Bathelt, Malmberg and Maskell 2004). Moreover, knowledge is often described as a public good, where use by one actor does not preclude it use by others. However, as Oliver (1997) argues, in reality it is no longer possible to think of knowledge as a truly public good that can be easily reproduced and diffused, but at best a quasi-public good where reproduction and diffusion cannot be taken for granted.

To continue, the potential problem for firms is that knowledge may flow more easily out of it rather than move productively within it (Seely Brown and Duguid 2001). As a rule, network scholars claim that innovation, be it undertaken internally or externally, is a complex process, which may require knowledge flow between firms and other actors (Lichtenthaler 2005, Meagher and Rogers 2004). Increasingly, this process is viewed as a systemic undertaking; i.e., firms no longer innovate in isolation but through a complex set of interactions with external actors (Chesbrough 2003). Therefore, external knowledge networks are potentially an important aspect of the innovation process. It is through these pipelines that firms procure knowledge that they do not, or cannot, generate internally based on their own capabilities. These external knowledge networks

are often manifested in the form of strategic alliances between firms in the form of formalized collaboration and joint ventures, and other "contracted" relationships resulting in frequent and repeated interaction. Firms gain competitive advantages from alliances by accessing the resources of its alliances partners. This means that the competitive advantage a firm is potentially able to gain is dependent upon the resources profiles of its partners (Grant and Baden-Fuller 2004, Ireland, Hitt and Vaidyanath 2002, Stuart 2000). Converse to alliances, contact networks consist of non-formalized interaction and relationships between firms and other actors. The structure of these networks is often more dynamic, as firms continually update and change their contacts. Contacts networks may involve acquaintances that individuals within a firm possess, as well as membership of informal networks such as chamber of commerce, trade associations, business clubs and the like.

Nonetheless, as firms become increasingly familiar with each other's knowledge, negative network may emerge, locking firms into the network and stifling the creation of new knowledge and innovation (Adler and Kwon 2002; Arthur 1989; Labianca and Brass 2006). In order to continue to play a role in the innovation process, knowledge networks are often required to evolve taking new members and configurations to meet changing needs (Hite and Hesterly, 2001; Lechner and Dowling, 2003). For example, networks originally conceived on an informal contact basis may evolve into more formalized alliances whereby there are contractual agreements between network members (Almeida, Dokko, and Rosenkopf 2003).

In general, it is argued that strong ties promote the transfer of complex knowledge and weak ties the transfer of simple knowledge (Sorenson, Rivkin and Fleming, 2006). Strong ties, therefore, are considered to require the type of face-to-face interaction facilitated by the regional proximity of networks actors (Bathelt, Malmberg and Maskell, 2004; Cowan, Jonard and Özman, 2003). Spatially proximate knowledge networks are considered a key factor underlying the success of the most advanced and successful regional economics. Watts, Wood and Wardle (2003) find that many firms in close proximity do no necessary share face-to-face interaction through their either social or business contacts, reducing the scope for knowledge networks. A regional innovation system is characterized by interaction among firms and institutions from both the public and private sector, such as firms, universities, public and private research laboratories and providers, and business support technology transfer agencies. Innovation activity is also positively

correlated with collaboration activity with other firms and institutions such as universities and research institutes (Patrucco, 2003).

To continue, the view of regions as key drivers of innovation is very strong and well established in economic geography. It builds on the fact that geographical proximity facilitates knowledge sharing and, thus, interactive learning and innovation. In doing so, it assumes that knowledge does not spill over large distances: district firms can benefit from knowledge externalities that are "in the air", but that are not available to firms located outside the district. In addition, this body of literature stresses that all firms in the district can benefit from those knowledge spillovers, because they belong to the same cultural environment (Malmberg and Maskell, 2003). Knowledge circulate and flows through networks that consist of agents sharing cognitive capabilities and trust, not necessarily the same location. What is the same, networks do not require permanent co-location for interactive learning to take place (Torre and Rallet, 2005).

Moreover, geographical awareness –being connected to extra local knowledge networks- is a precondition for districts firms to survive. Too much reliance on local knowledge sources may be harmful for interactive learning and innovation: when district firms become too much inward looking, their learning ability may be weakened to such an extent that they lose their innovative capacity and are unable to respond to new developments. This problem of lock-in may be solved or avoided by establishing non-local networks, providing access to the outside world (Camagni, 1991; Asheim and Isaksen, 2002).

In sum, knowledge creation and innovation may take place within the boundaries of a firm, within a network and within the confines of a district. So, district firms are expected to perform better when they have a higher absorptive capacity or a stronger knowledge base, when they are better connected and when they participate in local networks.

2. Research methodology

Content analysis is a scientific, objective, systematic, quantitative and generalizable description of communications content (Kassarjian, 1977). This method allows classifying textual material, reducing it to more relevant, manageable bits of data; because of this, a large number of social scientists will find the technique indispensable (Weber, R.P., 1990). Maybe, the most distinctive characteristic that differentiates content analysis from other, more qualitative or interpretive message analysis is the attempt to meet the standards of the scientific method (Bird, 1998; Klee, 1997).

Publications that have been reviewed such as articles constitute a great source of material to analyze and evaluate the concept "knowledge networks" along the years. In order to achieve that goal, in this study it has been used a technique named Content analysis. This type of technique allows the researchers to evaluate the development of this kind of networks as well as other concepts related to it.

In order to start with the analysis, it has been considered a long period, a 14 year-period; from 2001 to the 2014. This period of study considered is due to the changing context of current business where information is highly important and, so, knowledge networks have increased their importance. Moreover, this time span is common in methodological reviews (e.g. Scandadura & Williams, 2000; Piekkari et al., 2010; M.T. Martinez Fernandez et al., 2012). To analyze with trustworthiness the tendency of researches evolution, a wide temporal field has to be taking into account.

The resulting sample contained 45 academic articles, and it just considered academic articles because, normally, a great number of relevant doctoral thesis or other sorts of publications are, at the end, published as academic articles in academic journals. It has been analyzed a high number of articles because of the importance of studying a high quantity of these to be capable to draw a conclusion with a minimum of creditability and validity.

All the academic articles are enclosed in the two main journals related to management, which are included in the well-known database "Web of Science", due to its prestige and with the aim of delimiting the sample. In particular, it has been chosen the social science edition because the topic that occupies us is clearly related to this area of study. "Web of Science" offers access through Internet to the indexes in ISI Citation Indexes. ISI WEB OF KNOWLEDGE is an academic citation indexing and search service, which is provided

by Thomson Reuters. This database covers the sciences, social sciences, arts and humanities It includes information about high quality multidisciplinary investigation published in world-wide leader journals related to different areas. It is a bibliographical database so the registers contain information such as titles, authors, keywords, abstracts and so on. Regarding to the Social Sciences Citation Index, it contains 2.169 journals.

Once established these preliminary requirements, the first step in the research was to find the articles that could contribute with useful information to the study. The researches were researched in the following journals:

- ACADEMIC MANAGEMENT JOURNAL: The Academy of Management Journal is peer-reviewed academic journal covering all aspects of management. It is published by the Academy of Management and was established in 1958 as the Journal of the Academy of Management, obtaining its current name in 1963. According to the Journal Citation Reports, the journal has a 2012 impact factor of 5.919, ranking it third out of 172 journals in the category "Management" and third out of 116 journals in the category "Business". In 2012 the journal was listed as one of the top 10 offenders in a practice called "coercive citation", wherein publishers manipulate their impact factors to artificially boost their academic reputation. It is also on the Financial Times list of 45 journals used to rank business schools and is one of the four general management journals that the University of Texas Dallas uses to rank the research productivity of universities. Furthermore, AMJ is the flagship empirical journal in management, and has been indispensable reading for management scholars for more than five decades. AMJ articles test, extend, or build theory and contribute to management practice using a variety of empirical methods (e.g., quantitative, qualitative, field, laboratory, meta-analytic, and combination). AMJ articles are regularly cited in the major business media, including The New York Times, The Economist, The Wall Street Journal, The Washington Post, Business Week, and Fortune. It is published six times a year in February, April, June, August, October, and December.

- STRATEGIC MANAGEMENT JOURNAL: The journal publishes original material concerned with all aspects of strategic management. It is devoted to the improvement and further development of the theory and practice of strategic management and it is designed to appeal to both practising managers and

academics. Papers acceptable to an editorial board acting as referees are published. The journal also publishes communications in the form of research notes or comments from readers on published papers or current issues. Editorial comments and invited papers on practices and developments in strategic management appear from time to time as warranted by new developments. Overall SMJ provides a communication forum for advancing strategic management theory and practice. Such major topics as strategic resource allocation; organization structure; leadership; entrepreneurship and organizational purpose; methods and techniques for evaluating and understanding competitive technological social and political environments; planning processes; and strategic decision processes are included in the journal. The Strategic Management Journal seeks to publish the highest quality research with questions, evidence and conclusions that are relevant to strategic management and engaging to strategic management scholars. We receive manuscripts with a diverse mix of topics, framings, and methods, and our acceptances reflect this diversity. More specifically, the Strategic Management Journal seeks to publish papers that develop and/or test theory, explore interesting phenomena, and evaluate the many methodologies used in our field. We welcome a diverse range of researcher methods and are open to papers that rely on statistical inference, qualitative studies, conceptual models, computational models and various kinds of mathematical models.

After looking for the articles, the following step was establishing different lines of study, always with the words "business" and "management" in the topic of the search. Then there were included the words "knowledge networks" as keyword search, in order to find these articles that could provide definitions and information about these concepts. It was included the word "innovation" because of the importance of the relation between all these concepts and, also, due to the fact that there is a lot of articles that connect these concepts. Having done the search with this guideline, the words "knowledge networks" were looked up as part of the abstract and the title. Finally, it was done the same search with "knowledge" as keyword and then as abstract and title, but this time without the word "networks" and vice versa. In all the selection process, only the articles that had to do with the study object were accepted, rejecting the ones that had no relation.

After this step, it was obtained a database made up of 45 articles, which are listed in the Appendix. In Table 1 it can be seen, in ascending order, the journals that were used to

find the academic articles and the number of articles per journal that were found. This order corresponds to an impact factor; this concept can be defined as the number of times that an article has been quoted in other journals. This is published in the Journal Citation Report in the ISI Web of Knowledge that has been explained before; it is published each year and we have taken into account the one in year 2013. So, the first is the Academic of Management Journal, which has an impact factor of 4,974 and has obtained a 5th position of 172 in the ranking of management and a 3rd position in the ranking of business. The second one is the Strategic Management Journal with an impact factor of 2,993, about its position in the ranking we haven't found any information.

Table 1. Journal Citation Report Impact Factor and articles per journal

Journal Title	Impact Factor	Number of articles
Academy of Management Journal	4,974	28
Strategic Management Journal	2,993	17

At this moment of the study, it was analyzed each article in depth; doing a data analysis, where it was collected the information in a Word worksheet in a table; with the following information:

- o Journal title
- o Article title
- o Year of publication
- o Volume
- o Number
- o Page
- o Authors
- o How the keyword appeared, just knowledge, just network or both together as one only concept.
- o Main aim of the article
- o Type of work: theoretical or empirical
- o Methodology, if empirical
- o Conclusions of the articles

- o Observations

This information was codified and dealt with in a quantitative manner to produce the results that will be commented in the Analysis of Results part. After that, all the information was analyzed using statistics in order to get some results. To end, the final objective is to get information to get to several conclusions about the topic.

3. Analysis of Data and Results

From the data collected from the review, this paper will focus on the analysis of the different factors which will be drawn from the Analysis part. The order will correspond to the introduction of the data; moreover, these have been separated in several parts, to simplify and facilitate its interpretation.

The different parts are: general data, research methodology and sample characteristics of analyzed work. The content analysis made about the articles integrated in the database has allowed to achieve relevant results that are presented below.

3.1. General Data

In this part, the years taken into account to make the analysis, the journals that content the relevant articles to the research, the number of authors that are normally used to develop the researches and its gender will be studied. Finally, we are going to establish a table that relates the journals to the years in order to know which ones are used in which years.

To begin, we are going to talk about the age of the articles. As we can see in Table 2, our sample is made of 45 articles published between 2001 and 2014 each of these years has been given a number related to its antiquity, using as reference current year (2015). Then, 2001 has been given number 14 as it was published 14 years ago and, after that, multiplied by the number of the articles of that year. Finally, the average was calculated. Besides, it can be seen that the average is 5'2. This means that the average of the articles is five years old; so, the great majority of the articles were published in 2010. On the top of that, it is important to remember that the current year has not been taken into account due to the proximity of it to this project; and, also that the period used is 14 years long, which is a big distance from the first one to the last one. However, the average is relatively close to the present; this number could be related to the fact that the studies about "knowledge networks" as a whole have increased exponentially.

Table 2. Descriptive statistics of years

	N	Minimum	Maximum	Average
Years	45	1	14	5'2

To continue, under these lines we can see the Figure 1 that shows the evolution of the analysis of the articles over the years. It can be stated that the years with the biggest number of researches are 2014 and 2013, both, with 9 studied articles. Additionally, it is seen that in 2010 the number of researches is dramatically reduced to only 3; although in 2011, the number increases up to 5 articles. Nonetheless, there is an inflexion point in 2007 where no articles are taken into account to this project. Subsequently, in year 2004 we see that a higher number of articles, if compared to the others close, are used: 4.

As a result of what we have just said before and what we can see in the graphic, we can affirm that the tendency in academic papers related to "knowledge networks" increases over the years. Then, it is proper to state at this point that the concept that concerns us has got more and more relevance in the academic and business area. If the tendency continues, it will possible to achieve the same level as the last year used in the research, or even increase it.

Figure 1. Evolution of the timeline of the articles
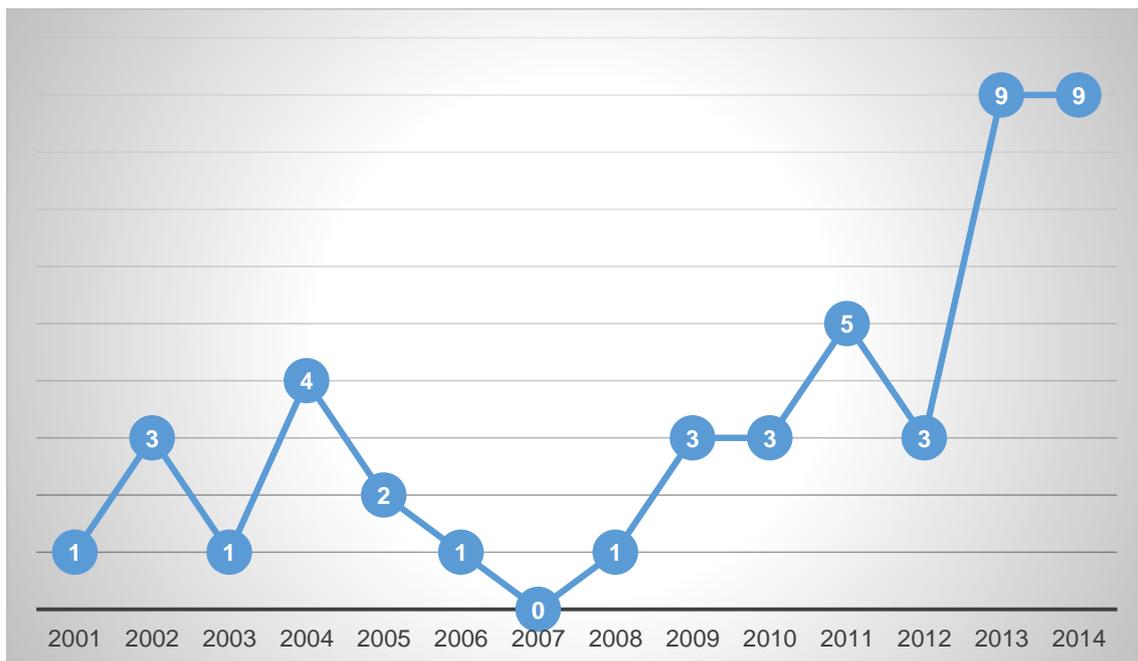
Afterwards, the Figure 2,which can be seen under this paragraph, shows the major sources for content analysis, that have been already seen in Table 1 in the 3rd part of this paper: Research Methodology. They are, in the 1st position, the *Academy of*

Management Journal, where 28 article have been used in this project; then, in the 2nd position, we have the *Strategic Management Journal*, with 17 papers analyzed.

Figure 2. Frequency of Journals
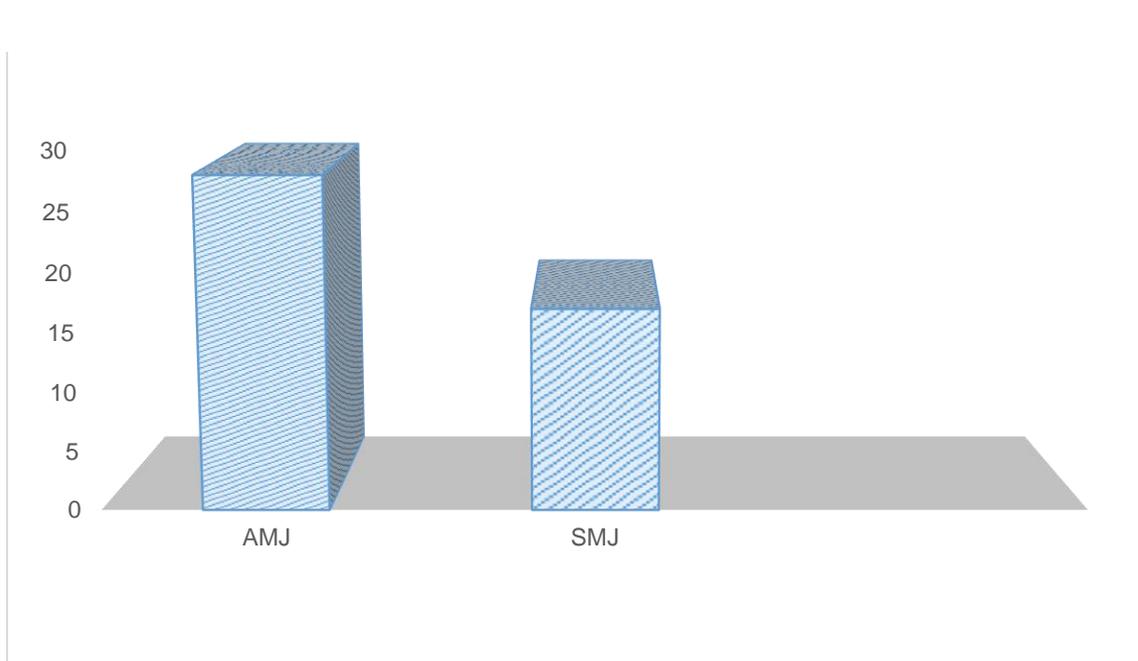
Furthermore, even though a high number of journals haven't been taken into account in order to construct the sample; the journals used represented a huge influence in the academic world related to business and management. If we look at the impact factor of them, we see that they have high numbers and, consequently, high position in the important rankings. Therefore, it can be stated that the study is valid to establish reasonable conclusions.

Once years and journals have been analyzed, a relation between these variables can be stated. It can be considered, if we refer to Table 3, that there is an important journal per year depending on the number of researches. Then, because of that, we can affirm that in 2001 there were examined only one journal, Academy of Management Journal, as it is the most relevant regarding to its impact factor. In 2002 and 2003, the situation explained before takes place again, this time with 3 articles and 1, respectively.

In 2004, there are two analyzed journal, Academy of Management Journal and Strategic Management Journal. In this case, the most important is, again, the Academy of Management Journal represents the 75%. Strategic Management Journal represents,

then, the 15% left. Referring to the next year, 2005, all the articles used belong to the Academy of Management Journal. However, in 2006, it can be observed that the Strategic Management Journal has the 100% of the articles used. Later, in 2007, no article has been taken into account to be used in the project; so, we might refer to this year as an inflexion point for the concept as, apparently, it wasn't as important as other aspects in this area.

To continue, in 2008 the 100% is represented by the Academy of Management Journal, once again. In 2009, the leading tendency of the Academy of Management Journal starts to disappear as the Strategic Management Journal takes the 66%. This tendency increases in 2010 where the 100% is represented by the Strategic Management Journal. This means that, in 2010, it is a prominent journal. In the following year it maintains its leadership but only represents the 60% while the Academy of Management Journal takes now the 40%. The same happens in 2012, but with less articles; the percentages remain the same.

Suddenly, the number of articles highly increases in 2013 and 2014, because of the consciousness of the academics referring to "knowledge networks". In 2013, we see that the Academy of Management Journal recovers and the 55% of the articles used come from this journal, whereas the 45% left comes from the Strategic Management Journal. It can be stated that they almost represent the same percentage so its relevance is more or less the same but with a leadership from the Academy of Management Journal. Finally, in 2014, we see clearly the tendency of the past years. Academy of Management Journal represents 77% while the Strategic Management Journal only represents the 22%.

Table 3. Journals used related to years

|	20 01	20 02	20 03	20 04	20 05	20 06	20 07	20 08	20 09	20 10	20 11	20 12	20 13	20 14	TOT AL
A M J	1	3	1	3	2	0	0	1	1	0	2	1	5	7	**28**
S M J	0	0	0	1	0	1	0	0	2	3	3	2	4	2	**17**
	1	3	1	4	2	1	0	1	3	3	5	3	9	9	**45**

To conclude with the first part of the analysis of results, we are going to talk about the Authors of these articles. Table 4 presents that the minimum of authors' per research is one and the maximum is five. Moreover, the average is 1.77, so it can be said that, normally, the researchers are carried out by one researches but it approximates to two, so, a considerable number or articles is written by two authors, too.

Table 4. Descriptive statistics of Authors

|	N	Minimum	Maximum	Average
Authors	45	1	5	1,77

In addition, Figure 3 illustrates the fact explained before. We see that 48% of the articles are written by just one author. Then, a 38% are elaborated by two authors. Consequently, we may affirm that almost all of the articles (86%) are developed by one or two authors. Only a small part that represents the 8% is done by three researchers and the rest by four or five; which represents a 4% and a 2%, respectively.

Figure 3. Percentage of Authors
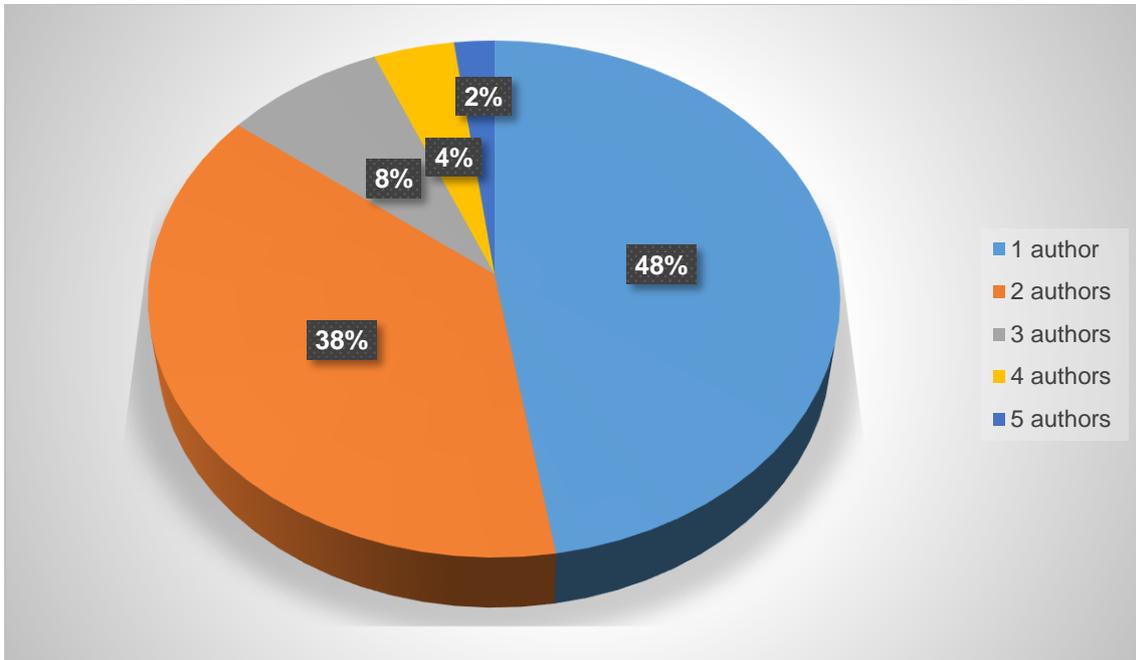
Then, it is important to remark the fact that the 71, 25% of the articles are written by men, whereas a 28,75% of them are elaborated by women. The percentage of men represents almost the third part of the total, which is a high number. Then, we can assess that generally most of the scholars that write or investigate about the concept "knowledge network" are men. These figures are represented in Figure 4.

Figure 4. Percentage of the authors' gender
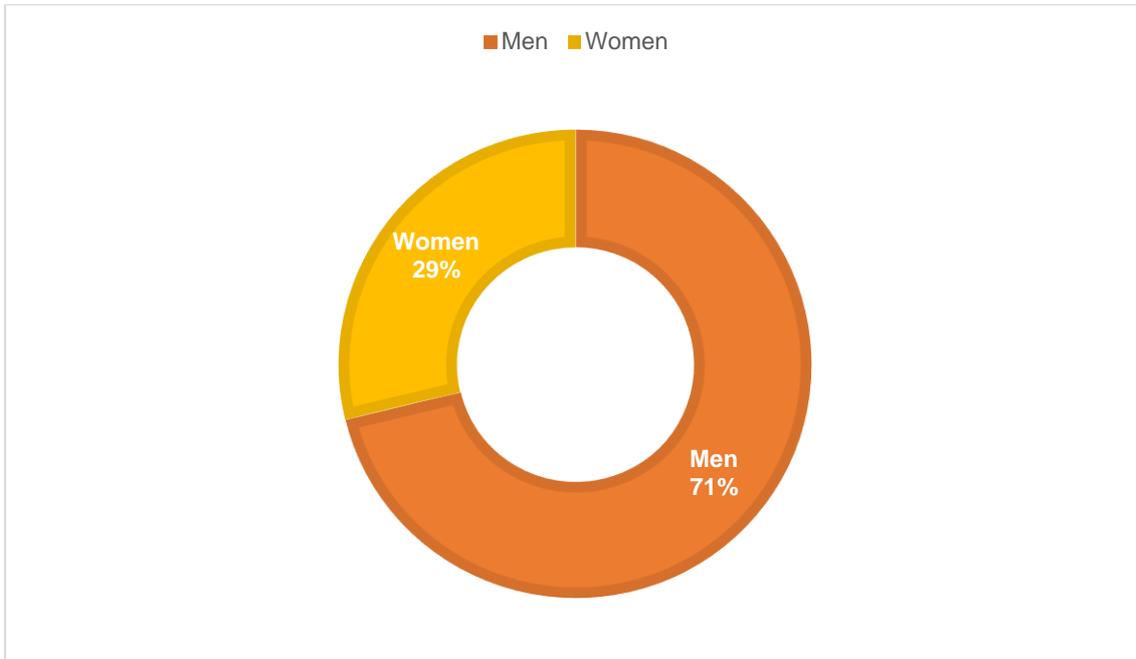
3.2. Analysis of Research Methodology

Referring to this part of the analysis of results, we are going to analyze the following subjects: the type of work most used by the authors Then, it will be explained if the concepts used when looking for the articles; this means "knowledge", "networks" or/and "knowledge networks". To continue, the type of temporal field used and the type of information as well as the relation between them will be analyzed.

To begin, Table 5 outlines the number of articles in relation to the type of work. As is clear from the table below, we can affirm that there is a great majority of authors who prefer empirical studies, in particular, there are 33 papers which use empirical studies, corresponding to the 73,3 per cent. The remainder, 26,6% are conceptual studies. This high difference might be due to the fact, that normally, if the research shows empirically the results, it has higher credibility for those who seek to know if it is recommendable or not to use these in their own researches for their companies or academicals studies.

Table 5. Frequency of Type of Work

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Theoretical	12	26,6	26,6	26,6
Empirical	33	73,3	73,3	73,3
Total	45	100	100	

To continue, as can be seen in Figure 5; which shows the percentage of the appearance of the different keywords used in the research of the several academic papers chosen for the elaboration of this project, this keywords are "knowledge", "networks" and "knowledge networks"; the most repeated keyword has been "networks", represented by a 42,3% of the total. Then, the next item most repeated is "knowledge", that represents the 38,4%. Finally, "knowledge networks" only depicts a 19,2% of the whole sample. From this we deduce that "knowledge networks", as a unique concept, has been lightly studied if compared with the other keywords; in this way we might say that it is a reality which doesn't have an academic studied background. Furthermore, on the other hand, it is clear that "knowledge" and "networks" as individual concept have been much more studied. Here, we can say that "networks" could be because of its importance regarding to clusters for companies and "knowledge" because of its relevance in every field in companies and so on.

**Figure 5. Percentage of the appareance of the keywords**
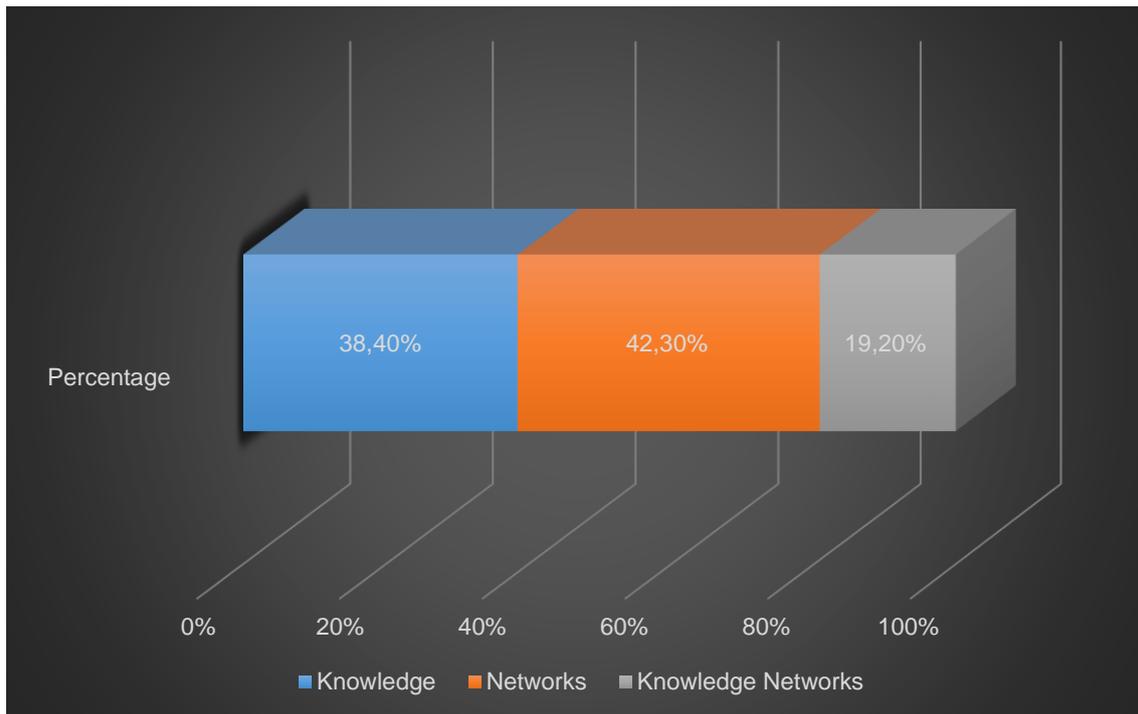
Afterwards, consider Figure 6, which illustrates the great difference between the options referred to the temporal field. It has been found that the most used temporal technique is the transversal technique representing the 58%. This is a high percentage of the papers which allow the study to conclude that the researchers are more inclined to think that the transversal technique is better.

The following position is far away from the first one; moreover, this position belongs to those articles that do not specified the technique used. This situation may cause a problem, because it represents a 27%. Nonetheless, it can be seen as obvious that this percentage is the percentage belonging to the number of theoretical articles showed in Table 5, in whose type of work this variable is not specified.

To end with the analysis of the temporal field' usage, as shown in the Graphic 6, we can say that just a 15% of the whole use the longitudinal technique. This could be as a result of the fact that the changes happened quickly over the years, then it is better to use a technique that can specify straight away how knowledge networks develop and how it affects to the companies and the business world.

Figure 6. Percentage of Temporal Field
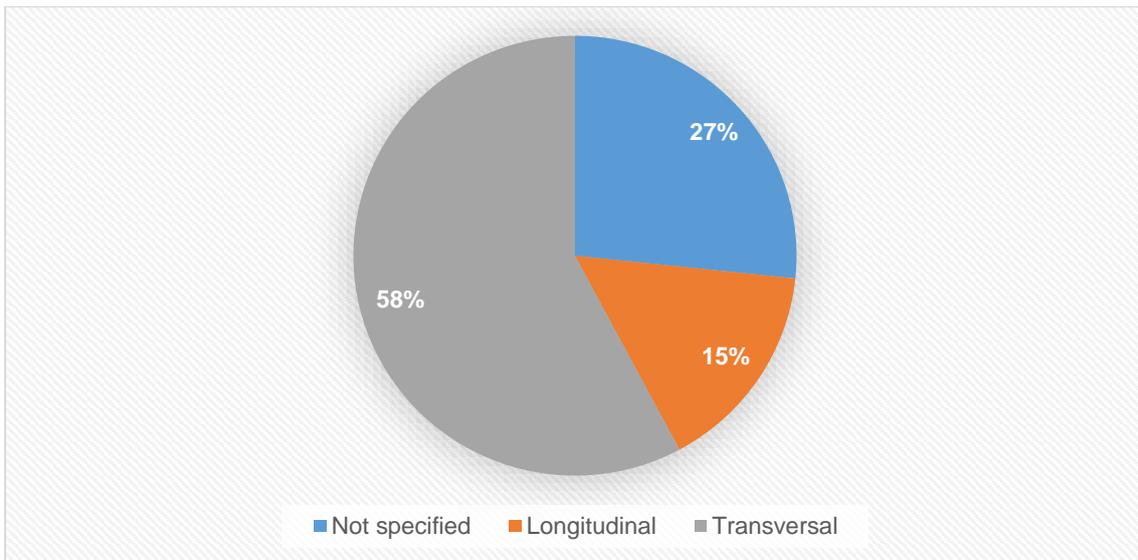
In the same way, the type of information used in the articles found has also been analyzed. Figure 7 indicates that a high number of articles use quantitative information, as it represents a 65% of the whole. Later, it shows that there are 27% of papers that have not followed any classification, but, referring to Table 5, we see that this percentage equals the one of the number of articles that appear in the named table before related to conceptual studies, which do not classify this kind of information. To finish, regarding to the empirical studies, we see that just an 8% use qualitative information.

Figure 7. Percentage of Type of Information
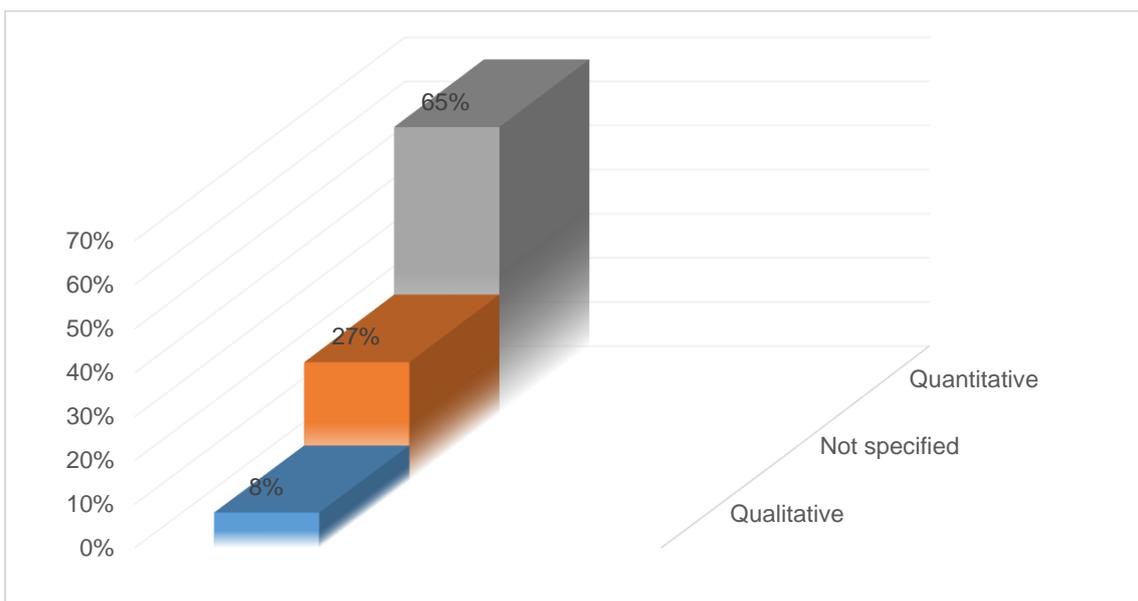
Once examined the type of information used, as well as the temporal field, a relation between both variable can be established. Table 6 summarizes how they are distributed. To start, we see that, when talking about quantitative information, 7 articles out of 30 are longitudinal; so, we conclude that all the articles that use the longitudinal temporal technique use quantitative information. Later, 23 articles also use quantitative information; bearing this in mind, we can state that the great majority of the articles that use transversal technique are developed used quantitative information.

**Table 6. Descriptive statistics of Temporal Field * Type of Information**

	Quantitative	Qualitative	Not specified	Total
Not specified	0	0	12	**12**
Longitudinal	7	0	0	**7**
Transversal	23	3	0	**26**
Total	**30**	**3**	**12**	**45**

4.3. Analysis of the scope of application and sample characteristics.

Added to what has already been seen, in this part of the study, we are going to study the different samples that have been used to analyze the concept of "knowledge network" to know the most used sample. In order to do this geographical field, industry or sector and the sample will be studied, this is known as the scope of application.

Firstly, Figure 8 indicates the relation between the number of articles and the geographical field, depending on if is a national or international field, considering a third category in which there can be found the articles that do not specify a geographical field. It can be seen that a high number of articles are analyzed in a international field, specifically 33, representing 73, 3%, which is quite more than the half of the whole.. Regarding to the national field, no articles have been developed in the national field. Then, the rest of the articles, 12 papers, do not specify the geographical field, corresponding to 26, 6%. Thus, we conclude that a great majority of the studies have been done in the international field.

Figure 8. Frequency of Geographical Field
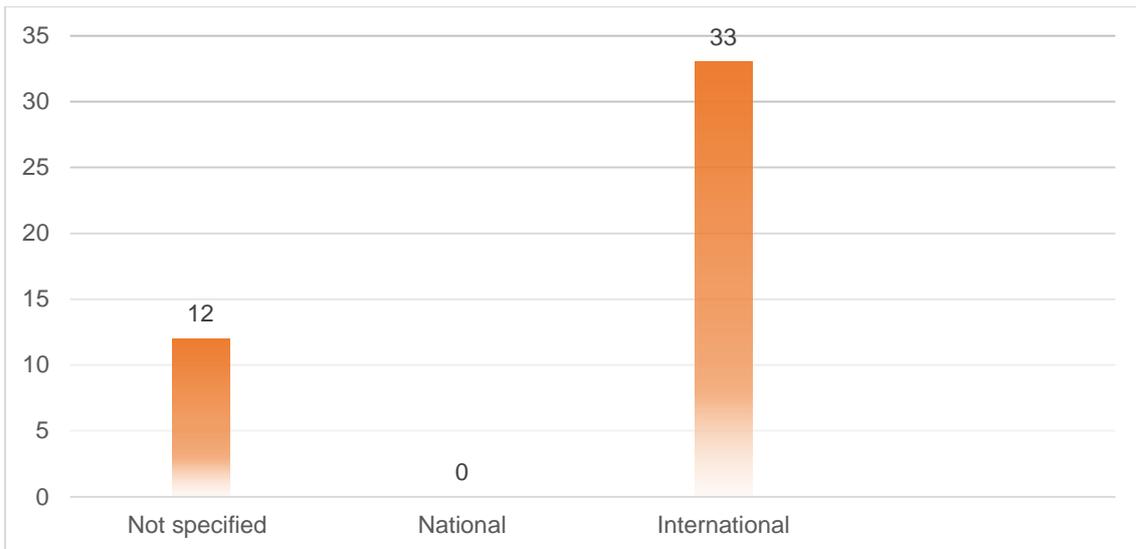
Added to that, we can say that after analyzing the papers the most repeated countries that have been studied are; China and USA, that represent the 58% of the total, followed by Europe which represents a 12%. Next, a variable named Others has been created and it contains the rest of the countries of the worlds like India, Australia, South America, Russia and so on. This variables represents 30%. All this data can be observed in Figure 9.

Figure 9. Percentage of the Countries used in the international geographical field
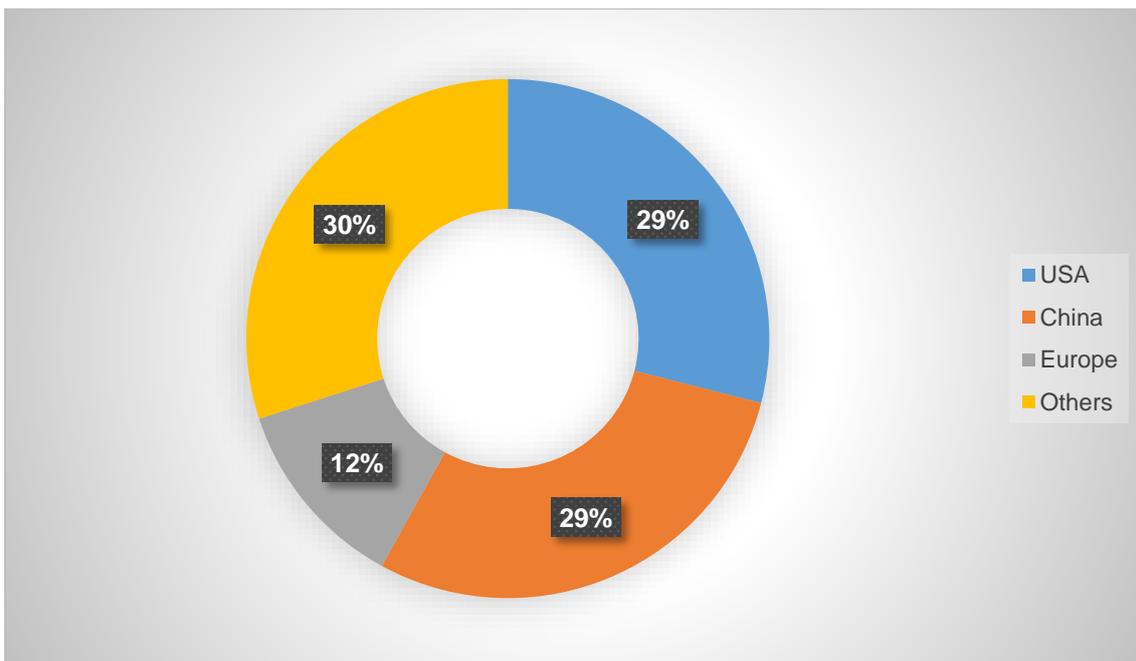
Secondly, it will be defined the different sectors that are the object of study in the researches. Those are Semiconductor, Biotechnology, Automotive, Patents, Technology, Pharmaceutical, Microprocessors, Petrochemical, Consulting, Data Solution, Executive Education, Furniture and Others. In Figure 10 it can be observed that the industry with the most number of articles is Others. As it includes different sectors not reflected in the Graphic, this could be the reason this sector has high number of articles, but, meanwhile, it does not establish which sectors are included, therefore it is not a good indicator. Next to it, is Semiconductor with 5 papers intended only for this sector. The rest of the researchers are focused on the rest of the sectors to a lesser degree, standing out, among them; Automotive and Pharmaceutical with 3 articles each one.

Figure 10. Frequency of Sectors
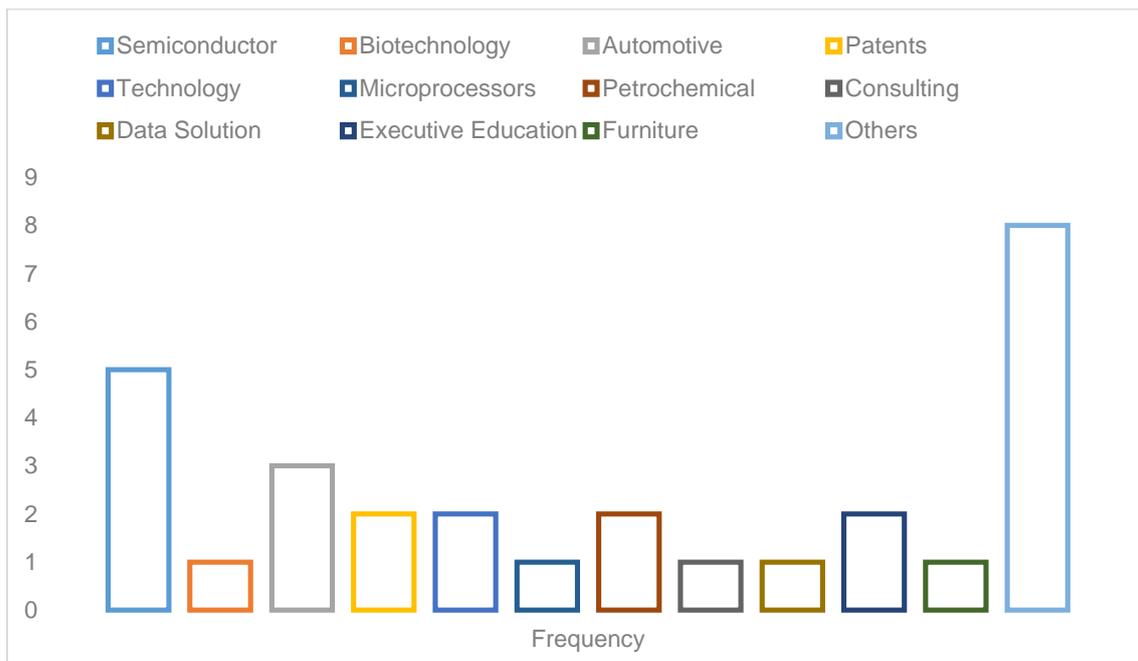
Thirdly, in Table 7 the minimum and maximum of the sample represented, as well as the average. On the one hand, we observe that the minimum is 0, because there are 12 theoretical papers and some of them do not specify the sample unit. On the other hand, the maximum of the samples is 2.052, a high number of sample units for the project, considering that the average of sample units is 46,04 samples.

Due to this, it can be said that compared with the minimum and the maximum of the sample unit, the average is closer to be limited. Moreover, it can be stated that researchers have a preferences for the use of an average of approximately 46 participants in the study of knowledge networks.

Table 7. Descriptive statistics of Number of sample unit

	N	Minimum	Maximum	Average
Nº UM	45	0	2052	46,04

Finally, to end with the analysis of results part, in Figure 11, it can be observed the number of samples per type of sample. In the different articles it has been used as sample Studies, Firms, Manufactures, Teams, Engineers, Consultants, Business Units, Employees, Middle Managers and Others which includes subsidiaries, ventures, readers, etc. The sample Others has been created due to the fact that the number of samples was too limited to create a new classification.

Thus, it can be stated that the most used sample is Firms, getting a number of 7 papers that represents the 30, 3%. To continue, and quite proximate is Others, with 8 articles and represents the 24, 2%. Then, the rest of samples are used in a limited number of articles, with Studies and Employees in front of the other classifications. It is important to remember that this particular study has been done using the empirical studies because they are the ones that use sample for their academic papers.

Figure 11. Frequency of Sample
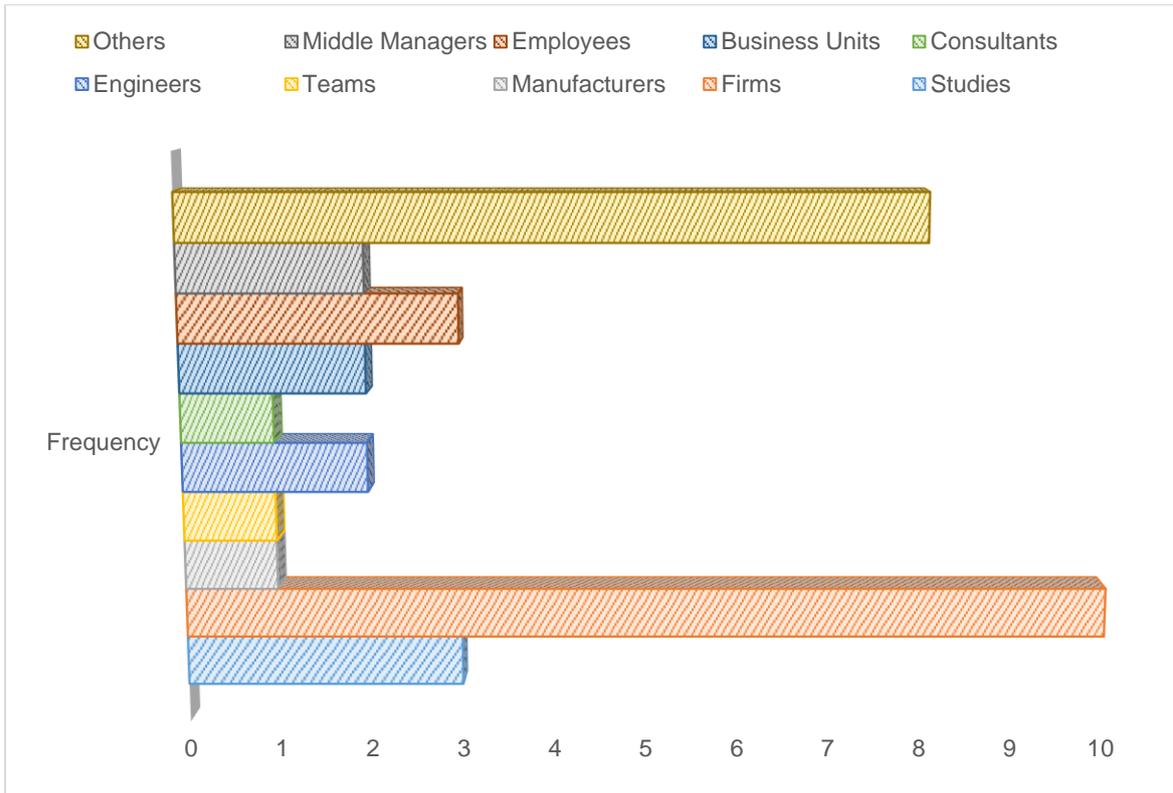
4. Discussion and conclusions

This project about knowledge networks has generated a large number of definitions and ideas related. Knowledge networks can be found within one corporation, spanning many business units, but they can also be inter-organizational, comprising members of different companies. So, we can find them in informal groups of experienced and inexperienced traditional workers and globally distributed groups of expert knowledge professionals. Furthermore, knowledge creation and innovation may take place within the boundaries of a firm, within a network and within the confines of a district. So, district firms are expected to perform better when they have a higher absorptive capacity or a stronger knowledge base, when they are better connected and when they participate in local networks.

With this project, the main aim was to provide an initial diagnosis about the state of the investigation related to the study of "knowledge network", how it is developing and so on. In this study, it has been done an analysis of knowledge networks in business over almost a 14 years – period (2001 to 2014).

Once the search in the well-known database ISI WEB OF KNOWLEDGE was finished, 45 articles were found in two different journals, having these one high impact factors that are published in the Journal Citation Report.

With these papers, the information obtained has been codified and dealt in a quantitative manner. Content analysis, an important method for facilitating many other types of analysis, has been used to elaborate the project. Consequently, the following conclusions can be highlighted.

a. Considerations about Researches Methodologies

Arisen from the analysis of the articles, some findings can be established which will be expounded in the same order than in the Analysis of Results part; hence: general data, research methodology and analysis of the scope of application and sample characteristics.

Content analysis of publications on KNOWLEDGE NETWORKS

Firstly, in terms of their general data, it can be confirmed that there is an exponential growth regarding to articles per year. The average is situated in 2009, but the papers have risen over the years, with a positive view of future.

Referring to the journals, it can be stated that the main journal is *Academy of Management Journal,* which is logical because it has a high impact factor and, in addition, it has obtained a 5th position of 172 in the ranking of management and a 3rd position in the ranking of business developed, as the impact factor, by the Journal Citation Report.

When talking about the authors, it can be stated that it exists a superior tendency to work individually in relation to team works. However, it is known that researches are better when two or more people bring together their knowledge. Thus, the second force in this topic are two authors. Regarding to their gender, the results show a supremacy of the male gender.

Secondly, concerning the research methodology, three main ideas that encompass the researches can be established. These ideas are: (1) Authors have more predispositions to use the transversal technique to analyze knowledge networks; (2) It can be detected a predominance of empirical papers over conceptual ones; (3) There are tendencies to use quantitative information instead of qualitative information. These last two ideas could be due to the fact that, if the research shows empirically the results and with quantitative information, the results are more quantifiable and, as a result, more credible for those who seek to know the evolution of knowledge networks and how they affect to their business.

In addition, moreover, we are able to conclude that all the articles that use the longitudinal temporal technique use quantitative information. Then, we can also state that the great majority of the articles that use transversal technique are developed used quantitative information. So, as said before, the most used type of information is quantitative information no matter with temporal technique is used.

To end with the research methodology part, we can affirm that "knowledge" and "networks" as individual concepts have been much more studied. Thus, we can say that "networks" could be because of its importance regarding to clusters for companies and "knowledge" because of its relevance in every field in companies and so on. Next, we cn

also state that "knowledge networks", as a unique concept, has been lightly studied if compared with the other keywords; in this way we might say that it is a reality which doesn't have an academic studied background.

Thirdly, in terms of analysis of the scope of application and sample characteristics, we start stating that a great majority of the studies have been done in the international field, specially, the countries were most studies were done were China and USA. Even though there is a variable which may not help to reach a clear conclusion about its implications; it is exceed due to the high frequency of the international field variable.

Added to that, the most used sample is Firms. Moreover, despite some researchers tend to use a high number of samples, the average is established in almost 40 participants, that is, authors prefer to use a limited number of them.

b. *Limitations and Future Research Directions*

Once the study has been finished, it is important to note some of the existent limitations as well as their future research directions. In this sense, as first issue to consider, it can be affirmed that the journals ranking used to search the researches has been considered in an international field, that is, all journals worldwide have been taken into account to establish the ranking. This reality could have a relevant implication; it may exist the chance to find articles that, due to the truth that are enclosed in journals with less impact factor,that have loss the opportunity to be included in the study. Related to it, it is also important to state that a higher number of articles have to be taken into consideration in further studies; as when using a higher sample, more reliable the data of the study might be. Then, using a higher number of different journals might also be a good idea for further studies on this area.

Besides, it is universally acknowledged that the culture and habits change depending on the country where scholars want to work. Owing to this, after elaborating this project, it might be important to those who want to know the reality of knowledge networks in their activity, to investigate about the evolution and implementation of this concept I the country of study. It could let them to find generalizable differences with respect to the country of destination.

Moreover, to complete the study and make it more interesting, it will be important to increase the use of qualitative sources, because as it has been said before, there are a high number of quantitative studies.

Finally, future work will have to take into account the present year due to the reality of the growing tendency of the appearance of a higher number of articles in the last two years. This tendency probably might continue over years. To sum up, further study of the issue of knowledge networks is still required and would be of interest.

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6. Appendix

<u>Analyzed Papers</u>

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